Oasis Greenways: 
A New Model of Urban Park and Bikeway 
within Constrained Street Rights-of-Way

A Thesis Presented

by

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ABSTRACT

Parks and greenways can offer many benefits to urban communities in many areas including recreational, public health, and increased land value. This research examines the approach of using only the right-of-way (ROW) of publicly owned streets to transform pavement into a new paradigm for a linear park. The needs of the linear park include it being continuous, green, and shared space, which involves ultra low motor vehicle speeds and volumes. This park is called an “Oasis Greenway,” which is a long series of interconnected low-speed, low-volume, shared-space, vegetated linear parks created from an assembly of residential streets.

To meet the objectives, an Oasis Greenway has to address traffic demands and spatial constraints while connecting to a greater greenway network. Using a calibrated trip generation ratio, this research develops a model by incorporating speed control, volume control, road user dynamic envelops, connections across high-volume roads, and enough greenspace to emulate a parklike environment. Using this model, residential streets can be converted into linear parks, potentially creating a usable network of Oasis Greenways and greenspaces.

The criteria and thresholds developed in this thesis can be applied to cities across the country to increase greenspace and give more opportunities for walking, biking, and recreation. The model was successfully applied to a corridor in Boston, which demonstrates that the traffic, space, and connectivity criteria for a linear park along a residential road have been met.
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"The smallest patch of green to arrest the monotony of asphalt and concrete is as important to the value of real estate as streets, sewers and convenient shopping."

- James Felt, former Chairman of the NYC Planning Commission

I Introduction

A. Background and Thesis Structure

With rising obesity levels, environmental concerns and quality of life issues at the forefront of society’s collective consciousness, municipal leaders are looking for innovative new ways to improve urban environments. It is well known that parks have a positive impact on urban communities beyond their apparent recreational value. Increasingly, urban areas are being re-imagined in a new context of economic opportunities, community health needs, sustainable development, changing demographics, and neighborhood equity. However, there are few opportunities to carve out green space in the built up parts of cities. One prospect involves using public ROW, or “right-of-way.” ROW refers to land or property owned by an agency, often for transportation purposes. It’s usually in the form of a continuous strip; a utility ROW is a long, linear corridor for large utility lines, a railroad ROW contains the rail lines, and street ROW generally consists of the sidewalk plus the roadway, any on-street parking, and potentially an area beyond that. It is that street ROW that this thesis uses to transform pavement into parks through an Oasis Greenway.

This thesis establishes a framework for a new paradigm, for a route that is truly “green,” for a greenway with latent demand for walking and cycling that rivals a traditional linear park such as Olmsted’s Emerald Necklace. The name for this facility is an “Oasis
Greenway,” which is a linear park that has been created from an assembly of residential streets, using traffic calming and diversion as necessary. It has low enough motor vehicle speeds and volumes to allow “low-stress” cycling, walking, and playing. Low-stress cycling routes are defined as “links on which people are willing to ride” (Mekuria, et al, 2012). At the same time, an Oasis Greenway is a shared space where all modes of traffic mix together, and it also has trees, bushes, and a sufficient amount of greenspace to function as a destination. Its key element is that, like a greenway, it is linear, continuous, and can be part of a greater seamless network, functioning both as a transportation corridor and a destination in itself. The “Oasis” term in the name complements the term “Greenway Desert” (Furth, et al, 2013) which refers to an urban area with no greenway.

This thesis creates a new model for a greenway. It will demonstrate that under a certain threshold of volume and speed of traffic, people will be attracted to “Oasis Greenways.” It will establish the methodology of how a trip generation ratio is chosen given a certain demographics and land use, and then how that ratio is calibrated. The thesis will detail the criteria that need to be met for the exemplar to be emulated in other cities. Moreover, the proposed Oasis Greenway model will be validated by applying it to a specific corridor.

In the model validation chapter, the case will be made that along a proposed corridor in Dorchester, Massachusetts, an Oasis Greenway is not only feasible but recommended for design and implementation. The narrow and often circuitous street network in
Dorchester makes for a challenging environment to build linear parks. There is a lack of greenways in Dorchester, yet there exists a “desire line.” (A desire line is a term used by planners to describe a route with latent demand for walking and biking.) It needs a greenway but there's no way to provide a traditional one. There is no river or abandoned railway that can be used for a linear park. A wide road with surplus space to be used as a greenway doesn't exist in Dorchester. There is an active railway but, as explained later in this thesis, it is not suitable for use as a linear park. The only way to provide a greenway is to find a way to use the narrow local streets to provide a new type of urban park, an urban park called an “Oasis Greenway.”

The structure of the thesis begins with chapter I-B, which delves into the benefits of trees, greenways, and by extension, Oasis Greenways. Then chapter I-C states the hypothesis of this thesis, that another paradigm for urban parks is possible. It also explains the constraint of the minimal amount of greenspace coupled with few opportunities to expand that greenspace into urban areas of several cities in the U.S.

Section II describes alternate models of developing greenspace, starting with the various types of green streets. It explains how Oasis Greenways utilizes the latest concepts and technologies. The thesis then explores other methods and paradigms used to make streets more “green.” Those methods vary from Pocket Parks and “Street-to-Park” conversions to bike boulevards and shared space. It includes local models as well as exemplars from as far away as the Netherlands.
Section III develops the generic model of an Oasis Greenway, which includes traffic demand analysis, parking analysis, both on-street and off-street, the background on choosing and calibrating an appropriate trip generation ratio, and the Dutch-style use of “Local Tributary Areas.”

Section IV is an application of the Oasis Greenway model to a corridor in Boston. It starts by introducing the existing conditions in Dorchester and Boston. It describes a previous study on the Fairmount Corridor and explains that this thesis builds on that previous work. The application includes building Oasis Greenways on residential streets as well as “low-stress connectors” on larger streets in order for the greenway to be continuous. Finally the last section, Section V, offers conclusions and recommendations for the application of Oasis Greenways.
B. The Benefits of Greenways

The benefits of greenways are numerous. Greenways can provide opportunities for recreation, appreciation of natural and cultural features, and opportunities for active transportation, a key element of the Oasis Greenway. Greenways maintain connectivity between parks, conservation lands, communities, and cultural and historic sites, allowing the possibility of a continuous network. A continuous low-stress greenway network, with permeability and accessibility to key destinations, is the key element to facilitate modal shift towards walking and cycling. An increase in walking and cycling trips often translates into a mode shift away from single occupancy vehicle (SOV) trips, which yield yet more advantages (Pennsylvania Commission, 2002). Those benefits include less carbon emission, less energy consumption, less congestion, less parking demand, and less demand for impermeable surfaces, which translates into both less stormwater runoff and a more aesthetically pleasing environment. This environment becomes more pleasant both due to less vehicles, slower vehicles, and more greenery, as explained in subsequent sections (Buchwald, 2003). Usable greenspace will not only foster active commuting, but will also increase leisure trips, whether it is going for an evening stroll, or going on bike rides with children (Pennsylvania Commission, 2002).

Aside from providing linear open space for use and enjoyment, greenways protect and even enhance natural, cultural and historic resources. Moreover, green spaces promote safer neighborhoods. When residents have more vested interests in a place, their participation in community vigilance increases, and they will watch to make sure it’s not being misused or vandalized (American Planning Association, 2003).
The benefits of increased walking and cycling as well as greenspaces includes a society that is healthy, both physically and mentally. A recent study shows that people living near green space experience less anxiety, depression, heart disease, back pain and asthma than those living in concrete jungles (Nauert, 2009). “The role of green space in the living environment for health should not be underestimated,” Dutch researchers wrote in a study published in the British Medical Journal's Journal of Epidemiology and Community Health (Hallam, 2009).

Debatably one of the biggest boons of green space is its social value. Green space gives a sense of social place, draws people outside and fosters social contact, allows one to bond with neighbors, enhances feelings of family kinship, and provide opportunity to reflect on personal and social values. Studies have found that residents living near green common spaces had more social activities and more visitors, knew more about their neighbors, reported their neighbors were more concerned with helping and supporting one another and had stronger feelings of belonging (Hart, 2008). The benefits from increased community, including more happiness and a higher quality of life, are innumerable (Mapes, 2009). Finally, there are gains from greenways relating to nature and the environment. Green spaces can reduce noise pollution by utilizing dense screens of trees and vegetation.

One major element of greenways is the “greening.” In order to create a greenway, “green” elements such as trees, bushes, and grass must be included. Trees have been
shown to absorb pollutants; as few as 20 trees can offset the pollution from a car driven 60 miles per day (Emagazine, 2004). One example of how plants, trees, and vegetation are valuable is through something called the urban “heat island effect.” The heat island effect is a phenomenon where land surfaces in urban areas absorb and retain heat and effectively raise the temperature of cities a few degrees higher than their surrounding rural areas. Urban trees act as shading and wind-shielding elements, modifying the ambient conditions around buildings, reducing energy use and lowering energy bills (Akbari, 1997). Trees are able to affect energy consumption in buildings in multiple ways, such as through evapotranspiration (Huang et al, 1987). Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other vegetative surfaces and by transpiration (giving off of moisture) from plants. A tree can also be regarded as a natural “evaporative cooler,” releasing up to 100 gallons of water a day (Kramer and Kozlowskki, 1960).

Understanding how drastically trees can affect the ambient air temperature around individual buildings can lead to understanding how, collectively, a significant increase in the number of urban trees can moderate the intensity of the urban heat island effect by changing the heat balance of an entire metropolitan area. Urban trees can modify the microclimate of a region and enhance urban thermal comfort in especially warm climates. The advantages of urban trees are not limited to the heat island effect; indeed, trees have numerous benefits (Figure 1).
Figure 1: Benefits of Trees in Urban Areas

- Reduce surface flood water run-off
- Provide sense of place & community
- Encourage walking
- Reduce stress
- Increase property values
- Provide habitats for wildlife
- Provide shade & reduce ambient temperature
- Lower levels of noise & dust
- Produce oxygen & reduce carbon dioxide
Thick urban forests make a pleasant environment for walking and biking (Figures 2 & 3).

**Figure 2: Tree Canopy along Las Ramblas in Barcelona**

**Figure 3: Street Tree Canopy in Porto Alegre, Brazil**

It is clear that trees and greenways bring benefits, and most cities in the U.S. have plans to develop more greenways (Ahern, 2003). But when simple greenway projects have been exhausted, creative new models are needed to implement more greenspace.
C. The Hypothesis and the Need for a New Model

The hypothesis of this research is that it’s possible to use street right of way to join a series of residential roads together to create an extended linear park that has park characteristics and is low-stress for non-motorized users yet still functions as local access for motorists. This research will determine the degree that the public right-of-way can be transformed to create a greenway with the potential to connect to an extensive linear park network. The goal includes developing a safe and comfortable greenway that is shared space and has a minimum number of street crossings. Building this network requires a two-pronged approach. One prong involves developing Oasis Greenways, which are new linear parks within road right-of-ways. The other prong is to tie in existing linear parks to create fully connected urban greenway system, maximizing active transportation accessibility across a metropolitan area.

The Need for a New Urban Park Model

Cities across the U.S. are developing more greenways (Ahern, 2003). Typically these greenways are developed along abandoned railway corridors, utility corridors, lakes, rivers, or along other bodies of water. Eventually these traditional locations for a greenway will be fully developed and a new model to establish greenways will be needed.

Many urban areas already have extensive greenway systems. Minneapolis, whose Midtown Greenway has been held up as a national model (Bikes Belong, 2010) also has a well-known and popular (Friedman, 2010) greenway network. (Figure 4)
As shown in figure 4, the Minneapolis-St Paul region has plans to expand their greenway network, but they will eventually run out of traditional locations to implement greenways. A new model for greenways will be needed.

King County, Washington has a far-reaching greenway system (Long, 2009) that is built around the 42-mile Burke-Gilman Sammamish Trail (Figure 5).
With the completion of the Chief Sealth trail along a utility corridor on Beacon Hill in South Seattle, the City is close to exhausting the conventional methods for implementing a greenway. A suitable candidate for a more innovative type of greenway is needed. Furthermore, Seattle’s urban forest has significantly declined over the last several decades as the City has grown (Figure 6). Approximately 18% of the city is covered by tree canopy as compared with 40% just 35 years ago.
The case of Boston is similar to Seattle as large regions lack green cover (Figure 7).

Figure 6: Side-by-side Comparison Greenspace in Seattle and its Suburbs

Figure 7: Satellite Image for the Boston Area showing lack of Greenspace
As figure 7 shows, suburban Boston often has extensive green cover, but centrally located areas do not. An ideal location to study greenway development in a place with very few parks to begin is Dorchester. Boston’s Dorchester region lies between two large park areas, Franklin Park and the Harbor Beaches. (Figure 8) However, because the distance between them is approximately three miles, most of its population lacks easy access to any large park.

Figure 8: A close-up image of Dorchester Sans Large Parks, Boston, MA
A 2013 study showed that 72% of the population of Boston’s greater metro area are within one kilometer of the proposed greenway network, which points to “greenway deserts” (areas with no greenway) that are in need of a new type of greenway (Furth, et al, 2013). This research proposes Oasis Greenways as that new type of linear park that is needed. After this thesis develops a model for an Oasis Greenway, it will apply that model along a corridor in Dorchester to test the hypothesis.

The model for Oasis Greenways will not be developed in a vacuum; rather, it will build upon the work of previous models. There are eight models, or paradigms, that already exist that Oasis Greenways build on and improve upon. The next chapter will explain those eight paradigms before the Oasis Greenway model is developed in the subsequent chapter.
II Street Design Paradigms Related to Oasis Greenways

Oasis Greenways build on many principles of street design. Oasis Greenways are facilities built for typical road users, such as motorists, cyclists, and pedestrians, while accommodating emergency vehicles and snow-plows. They are continuous and are designed to connect to a greater network. They allow space for parking while also providing greenspace. There are many other models that build on these basic street elements to create something akin to innovative bikeways and urban parks. The model in this thesis builds on other paradigms of linear parks. Paradigms were chosen for comparison based on their inclusion of key characteristics of Oasis Greenways, such as being low-speed, low-volume, parklike, and continuous.

A. Greening Streets

The first model, or paradigm, of the eight that are covered is green streets. The term “green street” is used for many types of streets with environmentally-friendly characteristics. This section will be limited to “green streets” as they specifically apply to the Oasis Greenway model. A brief background will be given, followed by an explanation of “Stormwater Management Streets” and two green street features, namely Porous Pavements and Grasscrete.
1. Green Streets Background

The last 20 years, a changing philosophy among designers and society as a whole has resulted a significant shift in how roads are designed. Increasingly, engineers are focusing on the “Triple Goals” of *movement, ecology and community*, goals that they meet to varying degrees. One way they have been meeting those goals is to build “Green Streets.” A Green Street is an umbrella term for a range of streets that adhere to one of several sustainability goals. It is generally agreed upon that a green street seeks to reduce stormwater runoff and associated pollutants, bringing swales, trees, vegetation, and natural elements into streets, while improving comfort and access for pedestrians and cyclists (Bureau of Environmental Services, Portland, 2008). As noted under “Complete Street” in the glossary, Green Streets often incorporate many of the bike and ped-friendly concepts of “Complete Streets.”

Green streets can:

(a) Create a built environment for improved travel performance with respect to movement, ecological, and economic objectives,

(b) Protect and enhance natural resources and human ecological interaction with those resources and

(c) Support urban development patterns that contribute to social, economic, public health, cultural, aesthetic and equitable improvements for the greater community.
Green streets fall into four categories:

i. *Mobility-based*, such as Pacific Boulevard in Vancouver, BC, or Sandy Boulevard in Portland, OR,

ii. *Revitalization-focused*, such as Riverfront Parkway in Chattanooga, TN, or First Street Livermore, CA,

iii. *Neighborhood-centered*, such as New Columbia in Portland, OR, or Garrison woods in Calgary, Alberta, or finally

iv. *Stormwater management streets*, such as Taylor Avenue in Seattle, WA, or Josey Heights Milwaukee, WI.

The first three categories, above, are lesser known and will not be examined in this paper. It is the fourth category, “Stormwater-centered,” that have the most similarities to Oasis Greenways, and they have been found across the country, as described below.
2. Stormwater Management Streets

The EPA’s website lists 11 cities in nine states with so-called “Green Streets projects,” and they all tend to be Stormwater Management Streets. The projects tend to be designed to reduce stormwater runoff by reducing impervious surface providing infiltration opportunities that closely mimic those in the undisturbed natural environment. General practice includes reduction of pavement and impervious surfaces in the public rights-of-way, provision of surface detention in bio-swales, additional vegetation and planting in the public rights-of-way. Figure 9 below illustrates how a swale regulates the flow of stormwater.

Figure 9: Stormwater Travels through a Swale
There are some subtle distinctions between these Stormwater Management Streets that the EPA refers to as Green Streets and Oasis Greenways. For starters, Green Streets are often overly wide due to trying to outdated engineering guidelines, and most have separate, paved walkways. Oasis Greenways reduce the paved cross-section to the bare minimum needed for local access and parking. They give a “park feel” to the users, adding enough trees and vegetation to give the user a pleasant and peaceful area in the middle of an otherwise grey cityscape. Finally, Oasis Greenways need a level of continuity and connectedness not present in most Green Street projects.

Stormwater Management Streets have been implemented across the United States, from Chicago to Tucson, Arizona. The City of Seattle has been one of the cities at the forefront of developing green streets, with perhaps one of the earliest U.S. examples of a street that replicates many of the features of Oasis Greenways. In 2001, the “Street Edge Alternatives” (SEA) Street project was among the first of its kind (SPU, 2003). Seattle removed a significant amount of pavement and built a meandering, serpentine layout, as well as incorporated bio-swales and other green street features. The street contains a significant amount of trees and vegetation, leading to a low-stress facility that gives a park-like feel. The SEA Street project was built along 2nd Ave NW between NW 117th St and NW 120th St, a low-density residential area that lacked sidewalks and drainage infrastructure. (Figure 10-13)
Figure 10: “Street Edge Alternatives” Street in Seattle - “Before”

Figure 11: “Street Edge Alternatives” Street in Seattle - “After”
Figure 12: “Street Edge Alternatives” Street in Seattle, “Before-and-After”

Figure 13: “Street Edge Alternatives” Street in Seattle, Plan View
The project was successful in building a street where pedestrians and cyclists were comfortable sharing the road with drivers. Moreover, stormwater benefits were realized. Two years of monitoring (2001-2003) showed that the SEA Street has reduced the total volume of stormwater leaving the street by 98% for a 2-year storm event, a not-uncommon severe high precipitation (SPU, 2003).

Seattle is but one of several cities with numerous green streets. The green streets program in Portland, Oregon, has been lauded by Streetsblog as “one of the best” in the country, with nearly five hundred “green streets” already built (Roth, 2009). In 2007 the Portland City Council passed the Green Street Resolution, which mandates that City-funded development, redevelopment, or enhancement projects must incorporate green street facilities (Moon, 2011). A typical Portland green street includes a curb extension for pedestrian safety in addition to a stormwater treatment facility (Figure 14).

![Figure 14: Typical “Green Street” Drainage Elements in Portland, OR](image-url)
On SE Rex Street, between 19th and 20th Streets, there exists a unique block that has inspired the Oasis Greenway model by using porous pavement for the on-street parking lanes. (Figures 15-16)

**Figure 15:** On-Street Parking with Porous Pavement in Portland, OR, Rex Ave

**Figure 16:** On-Street Parking with Porous Pavement in Portland, OR, “Close-up”
3. Porous Pavements

One major concern in developing a greenway is stormwater runoff, which usually contains pollution in urban areas. It is a problem for both “Combined Sewer Systems,” which bring both stormwater and sewer water to treatment plants, and “Separated Sewer Systems,” which bring sewer water to treatment plants and stormwater usually directly to local bodies of water, occasionally bringing it through wetlands first. When “Combined Sewer Systems” are overwhelmed with stormwater, any release into local bodies of water results in pollution in that water. On the other hand, “Separated Sewer Systems” also have issues, because runoff is typically released, untreated, into natural lakes, streams, and other bodies of water, and assumed to be clean. However, drainage from streets, especially the “first flush,” contains many organic and inorganic pollutants. Treating runoff is the next frontier of water quality. To address the negative impacts of stormwater runoff, and to reduce the costs of building large detention ponds or treatment facilities, municipalities have begun to look to alternative types of infrastructure, including porous pavements, that reduce runoff by promoting infiltration, which also helps capture pollutants.

Porous pavements take Stormwater-centered streets to the next level. They are also known as Permeable Pavements or Pervious Pavements, and can take many shapes and sizes. They are a paving system that allows water to infiltrate through the pavement as a means to reduce stormwater runoff and in some cases improve the aesthetics of an area. (Figure 17) The idea is that by allowing the stormwater to percolate, the pre-
development hydrologic cycle is more accurately imitated, potentially increasing from 15% to 50% if pervious surfaces are used in urban areas.

Figure 17: Permeable Surfaces Increase Infiltration

Stormwater-centered streets with porous pavements are easy to build as contractors can use the same equipment they use for conventional pavement construction. While porous pavements were first used over 100 years ago, it has taken until recent years for its application to become more commercially mainstream. When they came to North
America from Europe after World War Two, they mostly stayed in Florida and other coastal states until the last 20 years. There was a hesitation to move into the Midwest and Northern States was mainly due to freeze/thaw concerns. Now that those concerns are no longer considered a concern, the product has spread across the United States (CPG, 2012). One of the most important considerations in cold climate or on poorly drained soils is the aggregate base should be sufficiently deep to ensure standing water does not accumulate within the top-most pervious grade. Freeze/thaw issues are further discussed below. There are two types of porous pavements: pervious concrete (Figure 18) and pervious asphalt, and both can be used on low-traffic residential roads.
Concrete solution

Pervious concrete, widely used in the South, is becoming increasingly popular in northern climes. Tests have shown that the porous concrete, if installed and maintained properly, can hold up under the freeze-thaw cycles experienced in Ohio.

**Conventional concrete**

1. Strong, good for heavy truck traffic.
2. Smooth surface.
3. Deflects water.
4. Used on roads, parking lots sidewalks and airport runways.

**Pervious concrete**

1. Not as strong as conventional concrete.
2. Rougher surface.
3. Water seeps through, reducing stormwater runoff.
5. Used primarily on parking lots, sidewalks and some roads.

Gravel or crushed stone mixed with cement, water and sand.

Uses stone that is smaller than conventional concrete and cement with little or no sand in the mixture. This creates porous spaces that allow water to pass through.

SOURCE: Researchers at Cleveland State University and Iowa State University

The Plain Dealer
Pervious concrete is made of aggregate, water, and a paste of cementitious materials. Water to cement ratio is usually 0.28 to 0.40 and with a void content of 15 to 25%. Little to no sand or aggregate smaller than 1/8-inch is found in pervious concrete because it fills gaps and hampers the ability for the paste to leave voids. Although there are increased capital costs for pervious concrete, it is more economical in the long run. Typical flow rates for pervious concrete are 480 inches per hour or 5 gallons/square foot/min. Because it allows stormwater to percolate through its layer back into the soil, recharging groundwater levels immediately, there is less need for expensive stormwater management systems, leading to a space and cost savings. The open pore system also greatly reduces heat island effect caused by impervious concrete. The space savings is especially valuable in built up urban areas where real estate comes at a premium. Moreover, the loose aggregate in the soil allow critical air and water in to allow urban trees the rooting space they need to grow to full size. The traditional method of surfacing involves a surface course over a base course layer which is over a subbase. (Figure 19)
The base course layer should be designed so that the water level never rises into the concrete. It is often 18 inches to 36 inches in depth to provide this capacity. Using a geotextile between the base course and the subbase increases the cost but also increases the durability of the surfacing and is therefore recommended. Pervious concretes are typically used for parking lots, sidewalks, pathways, driveways, and residential roads. There is a 3-acre eco-friendly development near Salem, Oregon, named Pringle Creek, where all of the roads and alleyways are made of porous pavement. Certainly there have been environmental concerns have been raised regarding driving on pervious concrete and whether oil might leak from the car and into subsurface aquifers through voids in the pavement. Because of the way the pervious pavement forms, however, instead of directly conveying the runoff, it acts as a filtering device. Any oil that might leak from a car is filtered through the voids in the surface. It does not run through the pavement like water, but attaches itself as a layer on top of the hardened edges of the void. Natural bacteria and fungi then break down the oil. Studies have shown that up to 99% of oil introduced in this way will be biodegraded.

While pervious concrete is not typically used for high traffic locations, like main arterials or places where heavy semi-trucks will maneuver, the normal composite used can safely support 3,000 psi, the weight of a fire truck. Using special mixes will increase its strength.

In colder climates, the pavement must be designed so that the voids don’t become fully saturated. This is typically achieved by installing 8 inches to 24 inches of sublayer rock
(Ware, 2013). Under the right circumstances, pervious concrete can be used in roadways with "moderately high" traffic flows. Well designed roadways can include a mixture of various porosity densities, with the more dense material being located in high traffic areas and less dense or pervious material located in low traffic areas (Ware, 2013).

Both pervious asphalt and pervious concrete are based on a void structure and require subbase layers for added strength that were mentioned previous paragraphs. The main difference comes in the physical act of making and laying the permeable layer.

![Image of pervious asphalt close-up]

**Figure 20: Pervious Asphalt, Close-up**

Pervious asphalt (Figure 20) uses liquid asphalt cement as its binder. Different liquid asphalt cement should be used depending on if it is for foot traffic or motor vehicle traffic. For foot traffic, a PG 64-22 liquid is to be used and for motor vehicle traffic, a PG 76-22 liquid is to be used (Maryland Paving, 2013).
The petroleum-based binder used in asphalt mixtures will become tacky during summer heat, swelling and making the voids smaller. It will also provide less aid in preventing heat island effect compared to its concrete counterpart due to its darker color trapping more heat. Pervious concrete, however, requires less nighttime lighting because its color reflects more light naturally.

As with pervious concrete, the mechanism which makes pervious asphalt effective is giving water that filters through it a place to go, usually in the form of an underlying, open-graded stone bed. As the water drains through the porous asphalt and into the stone bed, it slowly infiltrates into the soil. The stone bed size and depth must be designed so that the water level never rises into the asphalt. This stone bed, often 18 to 36 inches in depth as with pervious concrete, provides a subbase for the asphalt paving. Maintenance for pervious asphalt is very similar to that of the concrete version, requiring an annual or bi-annual vacuum cleaning. It can be plowed and salted like other pavements, but sanding is not advised as it tends to fill the voids.

Studies show that only 25% of the salt needed for normal pavements is required for pervious ones. Moreover, if 99% clogging were to happen, which is extremely rare with regular maintenance, water would still pass through at a rate of 10 inches/hour, which is still more efficient that most sands and soils, making the pavement “transparent” as far as infiltration is concerned.
With proper design and installation, porous asphalt can provide cost-effective, attractive pavements with a life span of more than twenty years, and at the same time provide storm-water management systems that promote infiltration, improve water quality, and many times eliminate the need for a detention basin.

The surface of a porous asphalt pavement is smooth enough to meet requirements of the Americans with Disabilities Act (ADA). Even after twenty years, porous pavements usually show little if any cracking or pothole problems. The surface wears well. When well maintained, porous asphalt retains its ability to handle rain water for many years. The pervious pavement parking lot located at the Walden Pond State Reservation in Massachusetts, where it was constructed in 1977, has never been repaved and still drains effectively (Ware, 2013).
4. Grasscrete

Grasscrete, which is used here as a generic term for a vegetated pavement that uses concrete, is the next level of “greenness,” turning the look and feel of the street from grey to green, because it allows grass to grow in the roadway itself. (Figure 21)

![Image of Grasscrete Car Park](image_url)

**Figure 21: Grasscrete Car Park**

Grasscrete is defined as a “continually reinforced, ready mixed concrete that has a defined pattern of voids achieved through the use of a disposable form that once removed and replaced with stone or grassed soil allows water to pass through the concrete.” Grasscrete is a cast on-site cellular reinforced concrete system with voids created by plastic void formers. Not only is it used for fire access and parking spaces, it
has the ability to withstand traffic. This type of construction offers significant structural advantages over precast concrete and plastic systems: it has a load bearing capacity of up to 40 tons gross vehicle weight, optimizes drainage capability, resists differential settlement, reduces sub-base depths, and facilitates shared space by eliminating curb edges. The surface area of grasscrete is 47% concrete and 53% grassy five-inch-deep holes, to be seeded and cultivated. On level ground, fully concealed grasscrete can drain at 90% the rate of ordinary lawns. As with lawns, grasscrete may not be effective with clayey soils or steep slopes (SPS, 2012). (Figure 22)

![Grasscrete Cross-section](image)

**Figure 22: Grasscrete, Cross-section, Showing the Flow of Stormwater**

Grasscrete projects have been used for parking lots, pedestrian zones, playgrounds, alleyways, and other areas where low speeds apply. They are most commonly used for areas that require fire truck access and load bearing capacity, but otherwise can be allowed to have grass cover. In some cases they are used where motor vehicles park.
and even drive. Grasscrete is a pervious rebar-reinforced concrete structure for all types of areas that require traffic. Parking and driving of motor vehicles on grasscrete minimizes maintenance requirements by keeping down vegetative growth. Grasscrete cost 30% more than conventional concrete paving projects. However, overall project costs may not be higher because using grasscrete can eliminate or minimize the need for storm water collection systems which may in turn lead to substantial savings. Grasscrete reduces the heat island effect even more than porous pavements due to the grassy area and the improved reflectance of the grasscrete as compared to blacktop due to its color.

Grasscrete is made by pouring concrete over “Formers”, a tool or mold that leaves voids in the concrete. Typically the Formers are placed 8” x 8” on center each way and either reinforcing mesh or #3 rebar is used. (Figures 23 and 24) Formers can be made of material that naturally degrades into the soil below it.

**Figure 23: Concrete being poured on Grasscrete Formers with #3 Rebar**
Figure 24: Typical Steps for Grasscrete Installation
Once the concrete has been set, the void space can be opened and filled with materials such as loam or colored gravel. On a residential road, a common load bearing requirement for a slab is no vehicles over 57,000 pounds, which is sufficient for Oasis Greenways given that it can handle the weight of a large semi-truck. Vegetated pavements that use plastic instead of concrete do not have the structural strength to hold the same load.

A common concern is that if grasscrete is used along a roadway, then the motor vehicle will damage and even destroy the grass. However, the soil will settle to one inch below the surface level of the concrete. That will prevent vehicles from coming in direct contact with the roots as well as ensure that the roots can get started in the soil.

There are no known examples of residential through-roads that use grasscrete but there are plenty of examples of grasscrete parking lots, from Albuquerque to Ohio, and a few examples of grasscrete roads on campuses that are used daily (for employees commuting to work, for example.) Below are four examples of grasscrete in use.

**Covington Readiness Center, in Covington, Louisiana**

In 2008, the Army National Guard used 14,260 square feet of grasscrete for the parking lot at the Covington Readiness Center, in Covington, Louisiana. The Army was looking to get their center LEED-certified and consequently selected grasscrete due to its LEED characteristics. Using grasscrete leads to a reduction in heat island effect and mitigates stormwater issues. It uses recycled content used in the application process as well as in
the concrete and sub-base. The formers are 100% recycled content and degrade over time into the sub-soils. Several images of the project are shown in Figure 25 (SPS, 2012).

Figure 25: Grasscrete Parking Lot, Covington Readiness Center, Covington, LA
The Wentworth Golf Club, Surrey, England

In 1991, in Surrey, England, near the Wentworth Golf Club, a road with 3,500 m² of grasscrete was constructed. (Figure 26 and 27) Golfers, tourists, and even drivers of 40-foot long articulated trucks have found themselves using this road.

Figure 26: Grasscrete Road under Construction in Surrey, England

Figure 27: Grasscrete Road after Completion in Surrey, England
Goole Hospital in East Yorkshire, England

In 1985, a road with 800 m² of grasscrete was built at Goole Hospital in East Yorkshire, England, for fire access along one side of the facility. The photo in figure 28 shows the road being successfully tested by the fire department.

![Figure 28: Grasscrete Road in East Yorkshire, England](image)

The River Band Executive Center in Stamford, CT

Finally, in 1988, at One Omega Drive in Stamford, CT, the River Band Executive Center built a road for employee access out of Grasscrete. It is an important road that employees of River Band Executive Center use on a daily basis to get from one building to the other through the center of the campus. (Figure 29)
Figure 29: Grasscrete road in Stamford, Connecticut

Figure 29 shows the grasscrete road before loam was spread. Aside from the high traffic of the employees, there is high traffic of delivery trucks and tractor-trailers that use the grasscrete road daily to deliver their goods.

Issues with Wet Grass and Frost Heave

As with porous pavement, frost heave issues have been successfully mitigated by building a thicker subbase that doesn’t allow the water to sit in the grassy area (Stenmark, 1995). The vegetation in grasscrete should be salt-tolerant in snowy climates, which is common for European treatments of grasscrete (Grasscrete
Limited, 2012). During winter conditions, grasscrete roads can easily be plowed in the snow (McKain, 2013). When grass is planted one inch deep below the surface, the snowplow doesn’t damage the roots of the vegetation. In cold climates, the grass in the grasscrete will die off in the winter, but the roots will live on and new grass will come up in the spring (Bertulis, 2013).

For parking areas, a common concern was thought to be pedestrians getting their feet wet when walking on wet grasscrete. Types of vegetated permeable pavement systems made with rigid plastic instead of concrete tend to have a degree of grass cover that makes it difficult for pedestrians to walk after rainy conditions and not get their feet wet. However, the size of the concrete areas on grasscrete roads are such that people can walk on them without stepping on the grassy areas (McKain, 2013). (Figure 30)

![Figure 30: Dry Area for Walking next to Grassy Area in Grasscrete](image-url)
Mowing the grass is generally not necessary because vehicular traffic and parking naturally keeps the height of the grass down (Bertulis, 2013). For driving areas, the major concern was the structural strength would be sufficient for the size and volume of traffic on the road. That issue, however, is mitigated by the mix design and pavement design being sufficient to carry the needed loads, which hasn't been an issue in the case studies of grasscrete roads.
B. Road Diets to Create New Parks

A “Road Diet” (Burden and Lagerwey, 1999) or “Rightsizing” (Toth, 2012) removes lanes from roads with unneeded capacity, using the redeemed space for various purposes such as bike lanes, wider sidewalks, and planting strips. “Road Diets to Create New Parks,” where space on a roadway is transformed into a park, is one of the paradigms used by Oasis Greenways. Few places in the US have actually implemented this approach. One notable exception is Seattle, who has ambitious goals for park-space city-wide. For primarily single-family residential areas, the goal is: “1/2 acres of useable open space within 1/2 mile of every Seattle household” (Raya, 2006). One project underway is in one of Seattle’s densest neighborhoods: Belltown. The Bell Street Park Blocks project is located near downtown Seattle along Bell Street from First to Fifth Avenue. (Figures 31-34)

![Figure 31: Bell Street Park Blocks - Detail](image)
Figure 32: Bell Street Park Blocks – “Before”

Figure 33: Bell Street Park Blocks, Cross-section – “After”
Figure 34: Bell Street Park Blocks – “After”
As shown in figures 31-34, the Park Street Blocks will remove a lane of traffic and return greenspace to the city. At four blocks in length it is likely the largest project of its kind in the U.S. A lane will be removed for that entire distance so an urban park can be constructed in its place.

This $3.4 million project will transform four blocks of Bell Street into a 56,000 square foot new street park. The shared-street approach will encourage pedestrians, cyclists, strollers, skateboarders, and motorists to share the space at slow, courteous, speeds. Belltown currently has very little greenspace but per the City’s goals for open space, the neighborhood should have 8.64 acres of open space in 2013, and 13.34 acres by 2024. More information can be found at http://www.svrdesign.com/bell_street.html and http://www.seattle.gov/parks/projects/bell_street/boulevard_park.htm.

The Bell Street Park Blocks are not the only Street-to-Park conversion project that Seattle is working on. The City also has an on-going project in Ballard in the northwest part of the city. The project is located along 14th Ave NW in northwest Seattle, between NW 59th and NW 61st Streets. For an estimated $2.9 million for two blocks, it is a relatively expensive but groundbreaking project. It will take a two-lane street with central-island parking and no bike lanes and transform it into a street with parallel parking and bikes lanes and a 35-foot wide parkland strip. (Figure 35 ) More information can be found at http://www.seattle.gov/parks/projects/ballard_hub_uv.
Figure 35 illustrates the transformation of 14th Avenue NW. With 35-cross-sectional-feet in new park space, there is a significant amount of area reclaimed as greenspace, creating a park where there once was pavement. Like many green streets, it will incorporate rain gardens, bio-swales, and other green infrastructure to minimize stormwater runoff.

The street in Portland, Oregon, that most resembles an Oasis Greenway is Holman Street, where a street was transformed into an urban park. At Holman Park, Holman Street makes a jog right at a conflux of streets, including NE 13th Ave and NE Durham Ave. With support from the neighbors, the City of Portland converted a one-block
section of Holman Street into a park that was then incorporated into the existing Holman Park (Raisman, 2013) (Figure 36)

Figure 36: Holman Park Street-to-Park Project in Portland, OR, “Before-and-After”

As can be seen from figure 36, a one-block section of street has been fully transformed into a park. Permeability for cyclists is kept while motorists can still access their homes by driving around the block. The aesthetically pleasing park adds new greenspace to the city.
Although rare around the country, many cities have found opportunities and potential locations for street-to-park conversions, including Boston. A 2013 research paper found that traffic capacity analysis supports the feasibility of 11 “street-to-park” conversions in the greater Boston area that have a combined length of 14 miles. One example is Rutherford Avenue in Charlestown, which can be reduced to four-lanes from an existing 6-8 lane configuration, allowing construction of a new park strip 0.9 miles long on the edge of one of the region’s densest neighborhoods (Furth, et al, 2013).
C. Cycle Tracks

Cycle tracks are bicycle facilities that are physically separated from pedestrians and motor vehicle traffic with a barrier, such as with on-street parking, a raised curb, or flexible delineators. Cycle tracks alone are not green enough to be considered Oasis Greenways, but they are useful in connecting linear parks to each other. Several cities across the U.S. have reconfigured road space to create cycle tracks. Chicago has been held up as an example on how to build several cycle tracks in a short period of time (Maus, 2012). The most notable example may be New York City because they were the first city in the U.S. to build cycle tracks at a large scale and they helped spawn the development of cycle tracks across the country. The cycle tracks along Eight and Ninth Avenues in Manhattan are considered to be the first parking-protected cycle tracks in the country. (Figures 37-40)

Figure 37: Ninth Avenue Cycle Track in Manhattan, Cross-section, “After”
Figure 38: Eighth Avenue in Manhattan, Before Cycle Track Implementation

Figure 39: Eighth Avenue in Manhattan, After Cycle Track Implementation
As figure 40 shows, the cycle tracks were given credit for injury reduction as well as economic benefits. Although New York was among the first city to implement cycle tracks on a large-scale, many other have followed suit. Other cities have been even more innovative by implementing cutting-edge bi-directional cycle tracks, which have been legitimized by the Bikeway Design Guide published by the National Association of City Transportation Officials, abbreviated as NACTO (NACTO, 2011). (Figures 41-42)
Figure 41: Innovative Bi-directional Cycle Track in Washington DC

Figure 42: Innovative Bi-directional Cycle Track along NE 65th St in Seattle
As an indication of the popularity of cycle tracks, the Mayors of Chicago and Seattle were involved in a friendly “war of words” over who can build cycle tracks the fastest. The Mayor of Chicago proclaimed that he “wants Seattle’s bikers and the jobs that come with them” (Fucoloro, 2012). The Seattle Mayor responded by addressing his citizens, proclaiming that he would meet the challenge by focusing on separated cycle tracks and a network of safe neighborhood greenways (Fucoloro, 2013). Seattle has since then moved forward with innovative bi-directional cycle tracks. Seattle has cycle tracks planned for the South Lake Union area and along Broadway next to the planned Streetcar and it has two cycle tracks completed, on Linden Ave N and on NE 65th Street. (Figure 42)
D. Bike boulevards

A Bicycle Boulevard is a low speed street, usually a residential street, where bicyclists have been given priority (by design, but not by law) over motorists. Bicycle Boulevards were first developed in the 1980s, with Berkeley, Palo Alto, and Portland, Oregon, all developing variations. They have become quite popular in recent years. In Palo Alto bicycle boulevards arose out of discussions of bicycle-priority streets during the environmental movement of the 1970s and 1980s. In Berkeley bicycle boulevards were developed by accident, when engineers traffic calmed a street parallel to a main arterial and found large increases in cycling on that route. Bicyclists appreciate the lower speeds, the decreased noise and air pollution, and the potential for continuous routes over long corridors (BIKESAFE, 2006).

Bicycle Boulevards generally aim for a target speed of 20 mph for motor vehicle traffic as they aim to provide a low-stress cycling environment. Pedestrians generally use sidewalks unless crossing the street. Bike Boulevards may have different design features in different cities. In Portland, Oregon, many Bike Boulevards use speed humps to slow motor vehicle speeds and traffic diverters to minimize cut-through traffic. In Vancouver, BC, and Portland, OR, among other cities, Bike Boulevards use traffic calming circles to reduce speeds and various traffic diversion techniques to reduce motor vehicle volumes. Traffic diversion, a key characteristic in the development of Oasis Greenways, is an important part of Bike Boulevard plans in Los Angeles and on Morro Street in downtown San Luis Obispo, California. (Figures 43-44)
Figure 43: Traffic diversion on Bike Boulevard in San Luis Obispo, California

Bicycle gap in Traffic Diverter shows a critical characteristic of Oasis Greenways: Traffic Diversion

Figure 44: Proposal for Traffic diversion on a Bike Boulevard in Los Angeles
Figure 45: Typical Design Features used on Bicycle Boulevards
Bicycle Boulevards take advantage of several design features in addition to traffic diverters. (Figure 45) Local names for Bicycle Boulevards vary; in Boston and Somerville they are known as “Neighborways,” while in Seattle and Portland, Oregon, they are known as “Neighborhood Greenways” (Toole Design Group, 2011). Seattle now has two Neighborhood Greenways, one in Wallingford, west of the University District and one just east of the University District. These greenways, modeled after the Neighborhood Greenways of Portland, are not the Olmsted-style greenways with trees in a separated linear park; rather they are residential streets that have been calmed for walking, biking, and recreating in the spirit of the Bicycle Boulevards of Berkeley.

The Neighborhood Greenway Network of Portland, Oregon, is used as a model in other cities across the United States (Jacobson, 2012). Starting in the 1980s, the City of Portland began to build their first Bike Boulevards in inner southeast Portland. Those streets have become some of the busiest bike routes in the city. Bike Boulevards spread to the north and northwest part of Portland in the 1990s, and by 2002, Portland’s first generation of Bike Boulevards were accessible to about 20% of households. In 2009, the city began to implement the second generation of bike boulevards, which they renamed as “Neighborhood Greenways.” The reasoning for the renaming was to stress that these streets did not just benefit cyclists, but they had a wider community benefit including “lower speeds, improved crossings, connections to important destinations, increased street trees, improved public spaces, and increased community cohesion” (Raisman, 2013). Another important change occurred with the second generation of Bike Boulevards and that is that in addition to traffic calming, they also use traffic
diversion schemes regularly, leading to more comfortable facilities. For example, on SE Harrison Street, between 20th and Ceasar Chavez Avenues, there was a lot of cut-through traffic so the city installed traffic diverters and the ADT dropped from 5,000 to 2,000 (Raisman, 2013). (Figure 46)

![Bike-permeable Traffic Diverter at intersection with major road shows a critical characteristic of Oasis Greenways](image)

**Figure 46: Portland Traffic Diverter at on SE Harrison Street**

The photo in figure 46 shows a traffic diverter with gaps for bikes, a key element to control traffic volumes on Oasis Greenways. These bike gaps make the road network permeable for cyclists but not for motorists, allow through-cycling while preventing through motor vehicle traffic on this Neighborhood Greenway.

The Portland Bureau of Transportation is committed to building 15 miles of Neighborhood Greenways per year. As the network grows, by 2015, 80% of Portland households will have easy access to a tree-lined, low-traffic, low-speed street that has
been specifically designed to make biking and walking safe and comfortable. (Figure 47a)

Figure 47a: Portland, Oregon, Neighborhood Greenway network

The City of Portland has an innovative new way to connect bike boulevards as they cross busy roads that have off-set intersections. For the small stretch of road that connects the off-set intersections, the sidewalks are widened and a cycle track is installed next to the pedestrian area to give cyclists a continuous low-stress
environment. Two Jog Cycle Tracks have already been implemented in the City of Portland (Raisman, 2013). One is on SE Division St at SE 87th Ave (Figure 47b) and the other is on NE 33rd Avenue at NE Going Street, both of which connect into their Neighborhood Greenway system (Portland, N-NE Going, 2012).

![Jog Cycle Track facilitates bicycle movement on the offset residential roads](image)

**Figure 47b: Jog Cycle Track on SE Division St at SE 87th Ave, Portland, OR**
E. The Woonerf

Although most Woonerven aren’t particularly green, with relatively few trees and greenery, they were groundbreaking and influential not just in the Netherlands but around the world. Ever since Delft (in the Netherlands) built the first Woonerf in 1969, people around the world have been fascinated by the concept (Wimberley, 2010). (Figure 48)

Figure 48: A Typical Woonerf in the Netherlands

A woonerf is a pedestrian-priority street where motor vehicles are required to travel at walking pace. Woonerven (lit. “living yards”) were originally applied on old narrow streets with no yards and no place to play (Wimberley, 2010). They have the double benefit of providing a play area for children and making the street a pleasant place to be, effectively extending one’s front yard to include the street. On old, very narrow streets, woonerven are valuable because no sidewalk is needed. New developments
save space by not having to provide both a street and a sidewalk. The street, by default, becomes like a driveway.

Woonerven are usually applied to cul-de-sacs and loops and occasionally use bollards to eliminate cut-through traffic. By the nature of these streets not being through-streets or very long, their speeds are low. Motorists know to expect pedestrians in these shared-space areas and that brings the speeds down even further. Generally people driving along woonerven are those that live there and they are likely to be courteous to their neighbors. However, the Netherlands has only a few examples where woonerf treatments were applied to long streets, creating a through route that bikes can use like a bike boulevard.
F. Shared Space

Although designers have purposefully designed “shared space” since the 1980s, shared space has been the defacto design in parts of the world with no sidewalks for centuries. Until the invention of the traffic signal and other traffic control devices, horse carriages (and other forms of transport) traveled through intersections now considered shared space. Referred to in the New York Times as “naked streets,” shared space is an urban design approach where all signs, markings, curbs, and traffic signals are removed so that “uncertainty and intrigue” are emphasized in the street environment, which in theory leads to more eye contact, more cautious behavior, slower speeds, fewer crashes and, critically, a lower stress environment for cyclists and pedestrians (Chang, 2009). (Figure 49)

![Shared Space Intersection in Drachten](image)

**Figure 49: Shared Space Intersection in Drachten (formerly signalized)**
Woonerfs are an example of shared space but with little motor traffic, although the term “shared space” is more commonly applied to situations with more traffic. One example of shared space is in the town of Drachten, Netherlands, where 14 traffic signals have been removed in a bid to remove safety. Traffic crashes in Drachten have been reduced since the removal of traffic signals. At the most famous intersection, known as “the Laweiplein,” there were 39 crashes in the five years prior and only one crash in the two years after it was implemented. Nonetheless, shared space still remains controversial as some cycling and disability groups prefer to have designated travel areas rather than shared space (Noordelijke, 2007).
G. Pocket park

One definition of a pocket park is simply “a little park.” It is a small park accessible to the general public that can be urban, suburban or rural, and can be on public or private land. Pocket parks are often on disused land and the transformation into a pocket park incorporates a more community orientated use, such as benches, a waterfall or a play area. Pocket parks can be created from a single vacant building lot, a small, irregularly shaped piece of land, or even from a parking spot. When they are created from a parking spot they are known as “parklets.”

The original parklet sprung up in San Francisco in 2005 and has been increasing in popularity across the country. San Francisco has far more than any other city with 30 parklets. (Figure 50)

Figure 50: Parklet from the San Francisco Pavement to Parks program
The first parklet was just grass sod that was rolled over asphalt in a parallel parking spot, although since then they have evolved to include bike parking, trees, planters, artwork, benches, and even café tables with chairs. (Figure 51) In 2012, Mayor Thomas Menino promised to install parklets in Boston during 2013 (Acitelli, 2012).

![Figure 51: A Pocket Park (known as a “Parklet”) in Baltimore, MD](image)

A pocket park can be created from an abandoned lot, a wide, skewed intersection that has been narrowed, or out of the street ROW. A parklet can offer recreation and play spaces and is especially valuable in neighborhoods short on greenspace and/or public space. In addition, a citizen in Dallas has spearheaded the “Build a Better Block” program, where short sections of streets are transformed. (Figure 52)
Figure 52: “Build a Better Block” Street Conversion in Dallas, “Before-and-After”

As can be seen in figure 52, a “Better Block” has more space for people biking, walking, and sitting, including café seating, a parking-protected cycle track, and pedestrian-orientated details such as sidewalk lightening. Pocket parks such as “Better Blocks” beautify an area for those on foot, a design concept that Oasis Greenways intend to capture.
H. Courtesy Streets

Courtesy Streets, also known as Yield Streets, are streets that use a single travel lane to handle traffic in both directions. Due to their narrow width, a driver has to pull over into a driveway or an empty space to let an on-coming driver pass. (Figure 53) They tend to be low-speed streets by their nature with low crash rates (Grieve-Smith, 2009).

![Figure 53: A Courtesy Street in Arlington, MA, on Higgins Street](image)

A standard curb-to-curb cross-section of a courtesy street with parallel parking on both sides is 26-30 feet. With 7-foot wide parking on both sides, this would mean a single 12-16 foot travel lane for both directions of travel. (Sarazen, 2012) The book Suburban Nation points out that Courtesy Streets were common in almost every prewar American neighborhood, but are now "summarily rejected" by transportation departments. (Duany, 2010) Nonetheless, they remain an important paradigm for Oasis Greenways.
"Roads are built for those passing through, not for those watching the migration happen. It would be as if we built football stadiums purely for the enjoyment of the players."

– Steven Nutter

III The Generic Model for an Oasis Greenway

Each of the eight paradigms from the previous chapter plays a role in influencing the Oasis Greenway, but some have a greater role than others. This chapter will delve into the paradigms with the largest influence on the Oasis Greenway model, explaining the model development, as well as the specific elements of the model. Bicycle boulevards and shared space are the two most important paradigms, but all eight play a role in the development of the Oasis Greenway model.

A. General Characteristics of an Oasis Greenway

The idea is to develop a model for greenspace created within a narrow right-of-way for recreation and transportation, with through traffic for bikes and local access for motor vehicles. Out of the eight paradigms the model utilizes, the bike boulevard paradigm is the most important, due to the way a bike boulevard is continuous over several blocks and provides low-stress routes for biking and walking. Both a bike boulevard and an Oasis Greenway are a series of connected residential streets that provide a low-stress environment for non-motorized transportation. Similar to a bike boulevard, an Oasis Greenway can be used for transportation or recreation, and priority is given to pedestrians and cyclists. This priority is not a legal priority but priority by design.
Unlike a bike boulevard, an Oasis Greenway is meant to be a parklike environment. Because of the narrow right of way, it uses shared space principles to minimize the space needed for transportation. That means having very low volume, like the Dutch Woonerfs, and low speed.

Like a Dutch Woonerf, an Oasis Greenway is designed as a shared space with priority given (by design) first and foremost to the pedestrian. The design vehicle is a “mother pushing a stroller.” Bike boulevards tend to focus on bicycles while Oasis Greenways, due to limited space, expect pedestrians to mix with motorized traffic and therefore require very low speeds, and therefore are designed with pedestrian needs foremost.

Although the model Oasis Greenway is developed along small, residential streets which do not require removing lanes, the “Road Diets to Create New Parks” paradigm is nonetheless important to the model. Oasis Greenways must have enough trees, enough grass, enough vegetation, and enough greenery to have the look, feel, and function of a new park resource. When lack of ROW width is an issue, Oasis Greenways may act as a Courtesy Street, with one driver pulling their motor vehicle into an empty space to the side to let an on-coming car pass. Pocket parks are added in where possible, and the entire route is calm and green enough to earn the term “Oasis Greenway.” The use of grasscrete is maximized to give the “green” look and feel. (Figure 54)
Figure 54: Typical Grasscrete Parking Lot

Although stormwater management is not the primary purpose of Oasis Greenway, they can emulate the green street paradigm by including bio-swales and permeable concrete to mitigate stormwater issues. Combining the concepts from these eight paradigms, the model transforms a typical residential street into an Oasis Greenway. (Figure 55)
Figure 55: An Oasis Greenway versus a Traditional Street

Oasis Greenways are created when speeds and volumes are reduced enough to make for a pleasant walking and biking environment for all road users. It is a shared space with no sidewalks, but pedestrians are given improved walking areas on both sides of the street as well as in the middle of the street. Like a woonerf, the entire street becomes a walkable, crossable, shared area. The street is transformed into a corridor for leisure, recreation and non-motorized trips in an environment that is low-stress and
aesthetically pleasing. Both increasing tree coverage and decreasing motor vehicle
volumes are crucial elements to creating these modern-day greenways. To decrease
volumes, through traffic must be diverted to limit motor vehicles to local access traffic
only. The nine characteristics that any given facility must include to be called an Oasis
Greenway are the following:

1. Extremely low traffic volumes, including Traffic Diversion as needed;
2. Extremely low traffic speeds, including Traffic Calming as needed;
3. Shared Space, without sidewalks, with motorists sharing the space with
   pedestrians and cyclists, like a Woonerf;
4. Continuous. Oasis Greenways must be continuous for at least several blocks and
   have connectivity through busy intersections;
5. Terminal vista. They must make use of the “Terminal vista effect,” where the line
   of sight straight down the street is partially obscured, usually by trees or an on-
   street parking chicane.
6. Parklike, which refers to using grasscrete as the default in areas that aren’t
   travel-ways for cyclists and pedestrians;
7. Park & Parking Strip. They must have a wide area where on-street parking,
   parklets, trees, vegetation, and play areas are located.
8. Minimal parking footprint. They must minimize the parking footprint based on a
   parking needs analysis; and
9. Small and large play areas. They must have both small and large play areas,
   with the small play areas referring to the Park & Parking Strip and the large play
   areas referring to Oasis Greenway sections with “ultra-low volumes” where the
play area temporarily becomes the entire cross-section of the street, not too different from when hockey is played in the street.

The above nine criteria can be met with Oasis Greenways that have trees, vegetation, minimal parking spaces, and a lack of motor vehicles that make for a truly pleasant, low-stress pedestrian experience, such as many of the residential streets in the Netherlands. (Figure 56)

Figure 56: Example from Haarlem, NL, that is similar to an Oasis Greenway

In figure 56, there are strips of green areas next to strips of paved areas where children are playing. The vision is for an Oasis Greenway to have a strip of grasscrete in the roadway such as in the photo shown to create a green area that is park-like. This chapter will explain and illustrate the development of the aforementioned nine key elements in the Oasis Greenway model.
B. The Impact of Motor Vehicle Traffic on Oasis Greenways

This section develops the fundamental components of the Oasis Greenway model. It presents the volume and speed targets, which are based on literature reviews and a stopping sight distance analysis. It describes the “local tributary area” concept and the traffic diversion measures they use. This section also details the calibration of the trip generation rate and uses the traffic space needs of different road users to develop the spatial layout for the model.

1. Volumes and the Oasis Greenway Model

Reducing traffic volumes is the most important criteria in Oasis Greenway model development. Motor vehicles are a threat, both real and perceived, to pedestrians on any given road. They are a real threat because of the number of fatalities they cause. Motor vehicle crashes are the leading cause of death in the U.S. for children and young adults (CDC, 2012). Moreover, they are a perceived threat because of the psychological effect of two-tons of steel moving towards a vulnerable pedestrian. Indeed, research (Rosenbloom, 2008) has concluded for that traffic safety curriculums, children need both knowledge (of crossing dangers) components and emotional components (such as arousing the negative effects of fear and danger) for more effective results. Children need to be taught an increased sense of the perceived threat of motor vehicles for them to be safer.
Cyclists and pedestrians are intuitively attracted to locations with fewer motor vehicles, where not only they are able to deal with less noise, air, and visual pollution, but they are able to focus on the beauty of the surroundings. From Donald Appleyard’s landmark 1981 book *Livable Streets* (Appleyard, 1981) to the 2012 Mineta Institute report (Mekuria, et al, 2012) on “Low-Stress Bicycling and Network Connectivity,” the effect of high volumes of motor vehicles on street attractiveness and livability is well documented. *Livable Streets* found that residents of streets with low traffic volumes had three times more friends than those living on streets with high traffic volumes, while the Mineta report showed that more travel lanes and more volume added significant stress to bike travel. It is well known in the real estate industry that homes along low volumes streets are more desirable for people to live in (Burden, 1999). British research has revealed that there is a drop in biking and walking in areas with high motor vehicle traffic (Hart, 2008). It is clear that lower traffic volumes will attract more cycling and walking.

The British “Manual for Streets” guide has published shared space volume thresholds based on pedestrian-motor vehicle interaction research. It found that in shared space situations, above 100 vph, "pedestrians treat the general path taken by motor vehicles in a shared space as a road to be crossed rather than a space to occupy." (DfT, 2010) Using this research, the Oasis Greenway model adopted a figure of 90 vehicles in the peak hour (or 900 vehicles per day, using the common assumption that peak hour trips make up 10% of daily trips) as the maximum acceptable volume threshold and 30 vehicles in the peak hour (or 300 vehicles per day) as the desirable volume. (Table 1)
Table 1: Volume Targets for the Model Oasis Greenway

<table>
<thead>
<tr>
<th>Target</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum allowable volume</td>
<td>One peak-hour vehicle arriving every 40 seconds or 900 vehicles per day</td>
</tr>
<tr>
<td>Desirable volume</td>
<td>One peak-hour vehicle arriving every 120 seconds or 300 vehicles per day</td>
</tr>
</tbody>
</table>

As per the literature review mentioned on the previous page, when low-speed vehicles arrive at intervals of a maximum of 900 per day, then the level of stress is reduced to an acceptable range for pedestrians to share the space with the vehicles. A volume of 900 vehicles per day translates into a vehicle arriving every 40 seconds during the peak hour, and less frequently at other times. This is commonly expressed as the Average Daily Traffic, or ADT. So the maximum allowable ADT is 900. Although a vehicle arriving every 40 seconds is the maximum allowable, the desirable allowable volume of traffic is one vehicle arriving every two minutes. When the two-minute threshold is used, the previously-mentioned “large play street” characteristic is valid and children may use the entire cross-section of the street as a play area, such as for hockey or even beach volleyball. (Figure 57)
For Oasis Greenways there are two main ways to reduce traffic volumes: (1) to limit traffic to local access only and (2) to minimize use of long segments that allow local access traffic to accumulate. If through traffic can be removed using traffic diversion measures and only the local access traffic (from the local residents) uses the street, then traffic volume can be determined from trip generation. “Trip generation” is a term that planners commonly use when referring to how many trips start or end at a particular site based on its land use and size. The number of trips generated by each unit of land or type of activity varies according to social, economic, geographic, and land use factors. The Institute of Transportation Engineer (ITE) publishes standard trip generation rates, but they don’t include a spectrum of rates to account for all the factors that influence those rates (ITE, 2012). Household trips generated are usually a function of median income per family, household size, density, distance from the city center, as
well as automobile ownership and availability. However, ITE just collects self-reported
data and then averages them. There is quite a variation in that self-reported data. For
“Single Family Detached Housing,” reported rates range from a low of 4.31 daily trips to
a high of 21.85 daily trips, while a rate of 1.83 trips per day has been reported for high-
density apartments. The average rates that the ITE publishes are shown in the table 2
(ITE, 2012).

Table 2: ITE Residential Trip Generation Rates

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Rate (trips per day per DU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Family</td>
<td>9.57</td>
</tr>
<tr>
<td>Apartments, Low Rise</td>
<td>6.59</td>
</tr>
<tr>
<td>Apartments, Mid Rise</td>
<td>4.68</td>
</tr>
<tr>
<td>Apartments, High Rise</td>
<td>4.20</td>
</tr>
<tr>
<td>Residential Condos &amp; Townhouses</td>
<td>5.81</td>
</tr>
<tr>
<td>High Rise Condos &amp; Townhouses</td>
<td>4.18</td>
</tr>
</tbody>
</table>

In order to develop a rate for the Oasis Greenway model, the ITE residential trip
generation rates from table 2 must be considered and all land use and other factors
must be taken into account. An old, dense city like New York City will have markedly
different rates than a new city like Las Vegas. To determine trip generation in Boston,
local factors can be taken into account to adjust the ITE rates. The “Single-Family” rates
from table 2 are based on suburban auto-orientated developments and don’t apply to an
urban area such as Boston. Even the other rates in the tables don’t explicitly account for
factors such as degree of auto ownership and level of transit dependency.
Boston planning regulations (Boston Transportation Department, 2012) specify much smaller parking requirements than national norms, revealing a smaller demand for parking and trip generation in general. A calibration conducted on the trip demand model for Dorchester showed a small demand for automobile trips, supporting previous hypotheses on the matter.

The three-story high apartment buildings and multi-family attached-homes located along the Fairmount corridor, would tend to push the trip generation rate to the mid-range of the values in table 2. However, Dorchester is dense, has low car ownership, is close to regular bus service, and is generally of low socio-economic status, all factors that aren’t considered by ITE (City of Boston, 2002). Based on these factors and the range of values in table 2, a value of four trips per day per dwelling unit was initially chosen, just below the bottom of the range of values in the table. The section on model calibration confirms this value of 4.0 trips.
2. Local Tributary Areas in the Model

One of the most important aspects of the Oasis Greenway model is dividing the residential area around the Oasis Greenway into something called “local tributary areas.” In structural engineering, a tributary area refers to the load-bearing area that a structure such as a beam or column supports. In a similar manner, a “local tributary area” is the area whose motor vehicle traffic a certain street must carry due to given circulation patterns. A section on the Northeastern University wiki site (found at http://wiki.coe.neu.edu/groups/nl2011transpo/wiki/343ea/ and written by Steve Palkovic and Mike Morrissey) explains the concept of “local tributary area” by using the town of Houten in the Netherlands as an example, which the text below summarizes.

The Municipality of Houten in the Netherlands applies the principles of “local tributary area” better than any place in the western world. The town has a population of around 44,000 inhabitants and is located south of the major urban area of Utrecht. Houten’s developers used an innovative approach to design the town, using local tributary areas and the “cell model” to layout the town for thousands of people.

Figure 56 illustrates the local tributary areas for South Houten. The red lines are collector roads that provide access to only one neighborhood. The blue lines represent access points between two different neighborhoods. More information can be found at: wiki.coe.neu.edu/groups/nl2011transpo/wiki/074aa/11_Houtens_Bicycling_Network.html
This Houten model is based around one central idea: permeability for walking and biking but not for motor vehicles; motorists must use a ring road around the town. The town is broken up into different neighborhoods or tributary areas that can only be accessed with a single access point to the ring road. That access point is through its tributary road. A split of the tributary area with only one access road means that every resident must take that street to get to their home, maximizing the volume on that street. A value for trip generation, which is read from a table (such as from the ITE Trip Generation Manual) or chosen from a range of values and then calibrated, is used to calculate the roadway volume. The trip generation value times the size of the tributary...
area equals the volume on tributary road. The Oasis Greenway model will use this methodology and this formula to calculate the demand for traffic on a potential Oasis Greenway. For the Oasis Greenway model, the phrase “fraction used” or “impact fraction” will represent the fraction of the street’s generated trips that contributes to the Oasis Greenway’s volume. Consequently if the tributary area only has one access road, then the “fraction used” or “impact fraction” is 1.0, meaning all the traffic from that tributary area will be using that road.

At the same time, in order to promote low speed, streets are narrow and have few long tangent sections, meaning they are winding and turn often. No straight section longer than 250 feet is allowed in the Houten model (Koonce, 2012). The low volume and speed means it is safe for bikes to share the road with motor vehicles, for children to play in the street, and for pedestrians to cross the street safely. Pedestrians generally have their own sidewalks.

Northern Houten is split into 19 neighborhoods, which are serviced by 16 tributary roads connected by the outer ring road. The ring road, with no biking or walking (or destinations) and a speed limit of 70km/h, is accessible to each of the neighborhoods through their own access point. The large number of tributary roads ensures that no single access street will accumulate excessive traffic and be unsafe for cyclists and pedestrians. Inside the ring road, like along Oasis Greenways, only local, slower traffic is allowed along the peaceful streets with colored patterns and self-enforcing 30km/h speed limits (Figure 59).
A typical neighborhood in Houten has approximately 400 homes. Trip generation in the Netherlands is considered to be 5.5 car trips per dwelling unit per day. Multiplying 400 by 5.5 results in 2,200 trips per day for each neighborhood. To reduce traffic even further, each tributary road splits in two within 100 meters of the ring road, before reaching the first home. Consequently, there is approximately 1,100 trips per day or less on all streets in Houten (Palkovic, 2011). Oasis Greenways will emulate this model, but with its own particular volume target.
3. Traffic Diversion and Traffic Volume from Tributary Areas

In the “Volumes and the Oasis Greenway Model” section, Average Daily Traffic (ADT) limits were established as 900 maximum and 300 desirable. If volume is limited to local access, it can be determined using trip generation from streets in a tributary area. If this tributary area has only one entry/exit point, volume at the entry/exit point is total trip generation from that tributary area, as shown in the Houten model.

If the Oasis Greenway street is one-way, half of its trip generation will pass each point, since on a one-way street each pair of trips entering and exiting a home results in one trip passing any given point. If the Oasis Greenway street is the only access path to another street, all of that other streets trip generation will contribute to the volume on the Oasis Greenway. But if it has multiple access paths, the Oasis Greenway street will get only a share of its trip generation. If half the trips from a neighboring street use the Oasis Greenway street because the neighboring street is a one-way street, then the fraction used for that street is 0.5.

In order to reach volume targets, traffic diversion can be put in place to keep all but local access traffic from using a section of the Oasis Greenway, and to limit its tributary area. These traffic diversion features can be physical, such as with neck-downs, half-closures, full-closures, and center median island barriers, or they can be non-physical, such as with alternating one-way streets that require drivers to turn at every intersection, not allowing any continuous through movements. Alternating one-way
streets are used in the Netherlands as well as many parts of Boston and Somerville. All these features are used to eliminate or at least minimize the trips on a street above and beyond the basic traffic demand.

The number of Dwelling Units along an Oasis Greenway can be obtained by counting Dwelling Units along any given block. (Table 3) “Dwelling Unit” (DU) refers to a standard, single dwelling unit, a place of residence not for business purposes, although the trip generation rate can be recalibrated for other land use types. A parcel may have multiple Dwelling Units. The trip generation rate for this corridor is assumed to be 4.0 (Chapter III, B, 5).

When the volume limits, trip generation rate, and fraction of the street is known, then it is easy to find the maximum number of dwelling units (DU) allowed for the desirable Oasis Greenway volume and the maximum Oasis Greenway volume (table 3).

<table>
<thead>
<tr>
<th>Volume</th>
<th>Allowable Trips per day</th>
<th>Trip Generation Rate</th>
<th>Fraction used*</th>
<th>Total Allowable DU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>900</td>
<td>4.0</td>
<td>1.0</td>
<td>225</td>
</tr>
<tr>
<td>Desirable</td>
<td>300</td>
<td>4.0</td>
<td>1.0</td>
<td>75</td>
</tr>
</tbody>
</table>

*Fraction of the street’s trip generation that contributes to the Oasis Greenway’s volume

As shown in table 3, the maximum number of DU allowed for the desirable Oasis Greenway volume, where the street is a play street, is 75, and the maximum Oasis Greenway volume, on a typical street, is 225. This threshold uses a trip generation ratio
of 4.0 trips per DU, which takes into account factors such as mode split and proximity to transit.

For an application of the values in table 3, Norwell Street in Boston was considered as an Oasis Greenway candidate. The tributary area is this block of Norwell Street, and Radcliffe Street, which has one other entry besides Norwell Street (table 4). Traffic diversions can be designed that will limit the tributary area of the one-way southbound block of Norwell Street between Harvard Street and Vassar Street.

**Table 4: Example Application to Norwell St between Harvard St and Vassar St**

<table>
<thead>
<tr>
<th>Street</th>
<th>Dwellings</th>
<th>Trip Gen Rate</th>
<th>Fraction used*</th>
<th>Daily Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norwell</td>
<td>60</td>
<td>4.0</td>
<td>0.5</td>
<td>120</td>
</tr>
<tr>
<td>Radcliffe</td>
<td>99</td>
<td>4.0</td>
<td>0.5</td>
<td>198</td>
</tr>
<tr>
<td>Norwell &amp; Radcliffe</td>
<td></td>
<td>4.0</td>
<td></td>
<td>318</td>
</tr>
</tbody>
</table>

*Fraction of the street's trip generation that contributes to the Oasis Greenway's volume

Considering that on a one-way street two “trips” (one leaving, one entering) produce only a single vehicle trip passing every point along the street, the fraction of 0.5 is used for Norwell Street. Since Radcliffe Street is also a one-way street, and since it has one other entry besides Norwell, half of the trips generated by Radcliffe Street will need to use Norwell Street, hence the fraction of 0.5 is used for Radcliffe Street. As per table 4, adding the traffic demand for each street leads to a total of 318 vehicles per day, which is well below the maximum volume of 900 vehicles per day, meaning Norwell Street would make a suitable candidate for an Oasis Greenway.
4. Speeds and the Oasis Greenway Model

After reducing volumes, reducing speeds is the second most important criteria in the Oasis Greenway model. Reducing speeds decreases both the risk of a pedestrian getting hit as well as the risk of a fatality if a pedestrian does get hit. As far as fatality risk is concerned, studies have shown that if the impact speed is 10 mph, the pedestrian has a 99% chance of surviving (Ashton, et al, 1979). (Figure 60)

![Fatality Risk as a Function of Impact Speed](image)

**Figure 60: Fatality Risk as a Function of Impact Speed**

The other aspect is reducing the risk itself of a pedestrian getting hit by a motor vehicle. It is more common than a fatality and therefore a more salient scenario for analysis. It is
determined by using Stopping Sight Distance (SSD). Per the AASHTO guidelines (AASHTO, 2004) the SSD formula is given as follows:

\[ d = 1.47vt + \frac{v^2}{30\left(\frac{a}{32.2}\right)\pm G} \]

where \( d \) is SSD in feet (ft); \( t \) is brake-reaction time in seconds (s), where typically a value of 2.5 seconds is used; \( V \) is design speed (mph); \( a \) is deceleration rate (11.2 ft/s); and \( G \) is grade (decimal). Consider the SSD of a vehicle traveling at 10 mph versus a vehicle traveling at 20 mph along a road. (Figure 61)

**Figure 61: Stopping Sight Distance for Vehicles Traveling at 10 mph and 20 mph**
For the 20 mph speed, the braking distance is 83 feet. However, for the 10 mph speed, the braking distance is only 21 feet, slightly more than the length of a car, which is reassuring to the pedestrian knowing that the vehicle can stop in that short of a distance. The total Stopping Sight Distance (SSD) for the vehicle traveling 10 mph is 37 feet (perception-reaction distance) plus 21 feet (braking distance) which equals 58 feet (total). The total Stopping Sight Distance (SSD) for the vehicle traveling at 20 mph: is 73 feet (perception-reaction distance) plus 83 feet (braking distance) which equals 156 feet (total), almost three times the distance as compared to the 10 mph vehicle.

For a pedestrian that is crossing the 14-foot travel way, it takes approximately 4.7 seconds for a slow pedestrian and 3.5 seconds for a fast pedestrian to cross. An approaching vehicle traveling at 20 mph needs 2.5 seconds (perception-reaction time) plus 2.6 seconds (braking time) which equals 5.1 seconds (total). A vehicle traveling at 10 mph only needs 2.5 seconds (perception-reaction time) plus 1.3 seconds (braking time) which equals 3.8 seconds (total). In both cases, the 2.5 second perception-reaction time is a conservative estimate, and the range could be anywhere from 1.0 to 2.5 seconds. In any case, it is far safer for that pedestrian crossing the travel way to have a motor vehicle approaching at 10 mph, given that a pedestrian checking before crossing is far less likely to misjudge when the distance to the vehicle is small. With the slower vehicle speed, it's easier to predict where car will be in the time it takes to cross the street.
For a person that is already in the roadway, whether playing or just walking, there are three possible scenarios, as follows:

A. The driver sees the pedestrian but the pedestrian doesn’t see the driver. In this case, the total SSD applies, and the 20 mph vehicle would need 156 feet to avoid the pedestrian but the 10 mph vehicle would only need 58 feet to avoid the pedestrian.

B. The driver doesn’t see the pedestrian but the pedestrian sees the driver. In this case, the pedestrian simply has to move out of the way. Worst case scenario, the pedestrian is in the middle of the 14-foot travel way, and would have to move seven feet either direction. Walking seven feet takes a slow pedestrian 2.3 seconds and a fast pedestrian 1.8 seconds, although a quick-moving pedestrian is likely to scurry seven feet in less than a second. In each of the cases the pedestrian needs approximately one second of reaction time. It is easier for a pedestrian to notice an approaching vehicle 21 feet away or less than an approaching vehicle than threatens when it’s within 82 feet of the pedestrian.

C. The driver sees the pedestrian and the pedestrian sees the driver. In this case, it depends on if they move in the same direction or in the opposite direction. For a vehicle that only needs about a car-length to brake, it is much easier to make eye contact than with a vehicle than needs four times that distance to brake and therefore it is safer with the vehicle traveling at 10 mph because they are more likely to move in the opposite direction.
In addition, a motor vehicle traveling at 10 mph is traveling at what is, for driving, an unusual speed; at that speed the driver is continually in a "yielding posture", predisposed to yield to anything that may come into the road, further increasing the safety. At higher speeds the driver is in a "driving posture" and has to make an abrupt change to yield to a pedestrian or animal that enters the roadway.

For both drivers and pedestrians, their peripheral vision plays a role in safety. For drivers, there is a “tunnel vision” effect as speeds increase, the higher the speed, the more of a “tunnel vision” the driver has. (Figure 62)

Figure 62: Example Showing the “Tunnel Vision Effect” of Increased Speeds
For pedestrians, peripheral vision also plays a role. Normal peripheral vision is approximately 100 degrees on each side and 60 degrees above and 75 degrees below the horizontal median (Van Houten, 2013), so a pedestrian should be able to use peripheral vision to see down a roadway. However, children perform poorly on the task of being able to discriminate the speed of a motor vehicle with peripheral vision (Van Houten, 2013). In both adults and children, peripheral vision is poorer than foveal vision, but there is evidence that detection in peripheral vision is relatively poorer in children than it is in adults. Moreover, children are able to use peripheral vision on the left easier than on the right, leading to more safety issues (David, 1986).

Both a lack of traffic experience and the state of cognitive development affects children’s road crossing behavior. Adults take into account both the speed of the motor vehicle and the distance to the motor vehicle when making crossing decisions. However, research has shown that for children, “conceptualizing speed was the primary pedestrian risk factor, while distance played a minor role in determining children’s appraisals of fear and danger” (Rosenbloom, 2008).

Based on the aforementioned research, the chosen design speed for motor vehicles on Oasis Greenways is 10 mph. When vehicles travel around 10 mph or less, as on a campground road, motorists are hardly a danger to pedestrians. When a street has sidewalks, 20 mph is considered a safe speed. However, for a shared space situation like Oasis Greenways, 10 mph is the preferable design speed.
Speed Reduction Measures

Traditionally, speeds on urban streets have been reduced reactively, using “traffic calming.” Traffic calming has been described as “the combination of mainly physical measures that (a) reduce the negative effects of motor vehicle use, (b) alter driver behavior, and (c) improve conditions for non-motorized street users” (ITE, 1999). It can take many forms, with physical measures usually divided into horizontal devices (such as chicanes and bulb outs) and vertical devices (such as humps and raised intersections). Chicanes can be created on an Oasis Greenway by shifting the planting / parking strip from one side to the other, requiring vehicles to shift sides of the street as they approach the chicane. Physical changes to the street, known as “Self-enforcing measures,” are more effective at slowing speed, and therefore more recommended, as compared to signing alone (Lockwood, 1997). Chicanes and traffic circles are particularly attractive for Oasis Greenways because of the “terminal vista” effect they have. Plantings and parked cars can create a terminal vista in which the line of sight straight down the street is partially obscured, slowing speeds and increasing peripheral acuity, a key part of Oasis Greenway design.
5. Calibration of the Trip Generation Rate

To calibrate the trip generation locally, counts were made on Maybrook Street, a small residential street in the neighborhood with little convenience for cut through traffic. (Figure 63) It is a 400-foot long street and by its layout it is not likely used by any drivers except those for local access. A traffic analysis was performed for Maybrook Street to determine the traffic demand. (Figure 63)

Figure 63: Maybrook Street, Boston, Traffic Generation Rate Calibration Location

A one-hour count was performed on Maybrook Street during the evening rush hour to determine the pm peak hour volume. Counts on Maybrook Street were conducted, mid-week, during normal weather, outside of any anomalous event. Eleven motor vehicles were counted during the evening rush hour. With the peak hour considered to be 10% of daily trips, the ADT was estimated to be 110. Dividing by the 30 dwelling units counted on the street results in a trip generation rate of 3.67, close to the chosen rate of four trips per day. Consequently, this field measurement validates the ratio being used.
6. Traffic Space Needs and Dynamic Envelopes

Since a key element of an Oasis Greenway is the reallocation of ROW, and the added challenges that come with shared space scenarios, determining the space needed for users is certainly key to the design. The space needed by a pedestrian or a bicyclist to travel down a roadway safely and comfortably depends on three factors:

(1) The pedestrian’s or bicyclist’s dynamic envelope;
(2) The speed of the motorists; and
(3) The shy distance needed or buffer to traffic and fixed objects.

Previous convention dictated that minimum space given to cyclists on roadways should be constant regardless of prevailing speeds, but speed is indeed an important aspect of the space a cyclist needs. As the speed differential between cyclists and motorists increases, a larger buffer between the two road users is needed. Research has shown that if the speed of the automobiles is 30 mph, then a 1.50 meter (4.9-foot) buffer is needed. However, if the speed of the automobiles is only 20 mph, then only a 1.0 meter (3.3-foot) buffer is needed (U.K. Department for Transport, 2008). A 10 mph automobile speed, the design speed for Oasis Greenways, would require an even smaller buffer. This is a critical concept because it hasn’t yet been fully embraced by planners and engineers in the U.S. The most recent NACTO bike design guide has made strides in its recommendations, such as recommending that bike lanes next to parking lanes extend 14.5 feet from the curb to avoid the door zone. However the guide doesn’t account for the change in required buffer based on the change in speed of the motor vehicles.
The NACTO and AASHTO bike guides do not account for speed in bicycle space needs requirements (AASHTO, 2012). Determining the width requirement for the cyclist starts with the 2.5-foot physical width of the cyclist. (Figure 64)

![Figure 64: Space Requirement for a Bicyclist (CROW, 2007)](image)

The basic width of a cyclist is 2.5 feet (figure 64). Certainly for cyclists their speed affects their wobble and consequently their dynamic envelope. Dutch research has shown that for normal cyclists, once they reach a speed of 7.5 mph or higher, they can ride comfortably with only a slight wobble of 8 inches (20 cm). At speeds below 7.5 mph, the wobble increases significantly and the zig-zagging may require space as wide as 32 inches (80cm) (CROW, 2007). Other external effects, such as winds, gradients,
gutters, or other obstacles certainly cause the cyclist to swerve as well but are beyond the scope of this thesis.

The diagram in figure 65 shows the dynamic envelope of a cyclist getting passed by a motorist along an Oasis Greenway, showing how cyclists’ space has been designed for a 30-inch bike width, an 8-inch wobble, and a buffer of 2.8 feet (CROW, 2007). The NACTO bike guide (NACTO, 2011) does not discuss bicycle space needs. The AASHTO bike guide does not mention the bicycle dynamic envelope or wobble at low speeds, but it does refer to a minimum 2.5-feet required for the physical space needs, the same as the Dutch CROW guide, and therefore the AASHTO guide is accommodated in the spatial layout of the Oasis Greenway in the subsequent pages.
The cyclist needs 3.1 feet of space

Figure 65: A Cyclist with a 3.1-foot Dynamic Envelope

Washington State’s *Pedestrian Facilities Guidebook* states that two people walking side by side take up an average of 4.7 feet (1.4 meters) with adequate buffers on either side.
of them. The figure 66 shows two pedestrians walking using 4.7 feet of space and getting passed by a motorist along an Oasis Greenway.

Figure 66: Two Pedestrians with a 4.7-foot Dynamic Envelope
Figure 67 shows a 6-foot car passing a stopped 6-foot car with a 2-foot shy distance between them. Approximately 6-feet to 6-feet 1-inch is the typical mirror-to-mirror width for a car in the United States (Memebridge, 2012). Certain motor vehicles that are wider or when motorists don’t feel comfortable passing with such a small buffer, they can pull into the first unoccupied area and use the road as a “Courtesy Street.” In the same manner, motor vehicles approaching a fire truck would also treat the street as a Courtesy Street with the vehicle pulling over to let the fire truck pass.

Figure 67: Two Cars Passing each other with a Two-foot Shy Distance
7. Spatial Requirements for the Oasis Greenway Model

The first part of spatial design is determining the demand for on-street parking. Parking competes for greenspace; the less space that can be devoted to on-street parking, the more can be devoted to greenspace. Suburban parking rates, often higher than two parking spots per dwelling unit, are not appropriate for an urban environment. The City of Boston also uses lower parking rates than national values. In Boston, the recommended parking maximums are as follows:

(a) Within a 10 minute walk of an MBTA station: maximum 0.75-1.25 spaces per dwelling unit.

(b) More than a 10 minute walk to an MBTA station: maximum 1.0-1.5 spaces per dwelling unit (Boston Transportation Department, 2012).

The streets along the Fairmount corridor are generally more than a 10 minute walk from an MBTA station but are close to several frequently running bus routes. Moreover, several MBTA stations will be constructed along the Fairmount Corridor in the next few years. Therefore, this paper will use 1.0 spaces/dwelling unit for resident parking to develop the spatial design, as seen in the subsequent section. The low parking requirements, coupled with relatively low parking usage on several of the streets along the Fairmount corridor, lead to a potential for removing pavement and turning it into greenspace for the Oasis Greenway.
This need for parking can be met by a mix of on-street and off-street parking. However, there should be enough on-street parking to allow for visitors. Research has found that parking needs for visitors is 0.2 parking spots per dwelling unit (Willson, 2011). That 0.2 parking spots can be considered to be part of the 1.0 parking spots per DU mentioned previously, but experience shows that communities worry about having too little parking, so 1.2 parking spots per DU will be used for Oasis Greenway design, acquiescing to residents’ perceived needs.

For a street being converted to an Oasis Greenway, if parking needs are calculated to be higher than the existing number of on-street plus off-parking spots, then there is no room for converting parking to greenspace. However, parking underutilization (compared to estimated parking demand at 1.2 spots per dwelling) was observed along the Fairmount corridor. Hence, a parking need of 1.2 per DU is more than liberal with respect to resident needs, and this may be used to justify removing parking spots to install parklets, greenspace, and a shared area for all road users. The spatial design for a generic Oasis Greenway is shown on the next page (Figure 68).
Figure 68: Generic Oasis Greenway: Cross-section and Plan-view
Figure 68 illustrates and explains the space needs for the design. Determining the space needed for users is critical to a functioning greenway. The main objective is that the area would be wide enough for side-by-side pedestrians and motor vehicles, while still serving side-by-side cyclists and motor vehicles. The design incorporates the minimum widths and required buffers for each of the road users as specified in American and Dutch design manuals. Side-by-side car-car movements could be met using courtesy street operation. Head out angled parking (HOAP) allows drivers pulling out to more easily see playing children and oncoming cyclists or pedestrians. The travel and park / parking zone switch sides regularly to produce a chicane effect to slow traffic and create a terminal vista. For two-way operation, the same cross-section can be used; alternatively, parallel parking can be used with a narrower park / parking zone.

In order to slow speeds and give the street a park-like look, the design uses grasscrete for the travel and parking areas except in three 5-foot no-grass strips of pavement intended to give pedestrians and cyclists a smooth pavement surface and to allow them to avoid walking through wet grass. Two of the strips are in the travel area in order to accommodate two-way bike traffic; the third is at the back edge of the parking zone for accessing the car trunk. Motor vehicles wheels can roll on the no-grass strips as well as on the grasscrete.

Figure 68 shows how a 40-feet of ROW was divided up. There is 4 feet of grasscrete between two of the 5-foot strips, with motorists likely to drive in at least part of that 4-foot strip. The 5-feet plus 4-feet plus 5-feet strips create a 14-foot wide travel zone that
will allow a slow-moving car to pass by a pair of pedestrians walking side-by-side. There is a 2-foot grasscrete buffer between those three strips and the parking area, and then a 19-foot “park-plus-parking-strip,” and finally a 5-foot smooth paved area for unloading groceries, walking, and playing, among other activities available in a shared space with no curbs. When not used for parking spots, that 24-foot wide zone can be used for plantings, benches, pocket parks, basketball courts, play areas, or for an activity chosen by the community. Given the aforementioned design, it appears that the criteria for an urban greenway have been met.

Space required for head out angled parking are shown in figure 69. The amount of play space that can be included depends largely on how much parking can be removed. On Maybrook Street, an on-street parking survey was carried out and it revealed that very few car owners park on the street. At 5:35 pm there were 7 motor vehicles parked on-street and at 6:35 pm there were 11 motor vehicles parked on-street and 9 motor vehicles parked off-street. At a rate of 1.2 parking spots per unit, the 30 units with parking access to Maybrook Street would need 36 parking spots, of which at least six should be on-street parking for visitors. Counting off-street parking capacity for those 10 parcels showed there were a total of 36 off-street parking spots, enough to meet the need of all except visitor spaces.
Figure 69: Measuring the Parking Required Based on the Angle of Parking

\[ W = \text{Width of Car} \]
\[ L = \text{Length of Car} \]
\[ W \times \sin \theta = \text{length needed, part 1} \]
\[ L \times \cos \theta = \text{length needed, part 2} \]
\[ \text{Full length needed} = \text{part 1} + \text{part 2} \]
"Make no small plans. They have no magic to stir men’s souls."

- Daniel Burnham

IV Application of the Model to the Fairmount Corridor

This chapter takes the generic model for the Oasis Greenway that was developed in the previous chapter and tests whether it can be applied in a given corridor. Early in this thesis, the examples of Seattle, Minneapolis, and Boston were given as places that had a need for an Oasis Greenway, although almost any city in the United States could have been mentioned. This chapter has chosen the Dorchester area of Boston, Massachusetts, to apply the model. Boston happens to be a city with a long history in developing linear parks. After putting the Fairmount Corridor into context, this chapter will apply the model to several streets in the corridor.

A. Background

1. History of the Parks Movement in Boston

The parks movement can trace its history to the 18th century and earlier, when landscape architecture (or “landscape gardening” as it was called) was focused on greenspace and landscaping private land near palaces, royal properties, religious complexes and centers of government (Downing, 1841). The philosophy took a major turn with Fredrick Law Olmsted, known by some as the “father of landscape architecture” (Orser, 2012).

Fredrick Law Olmsted, believed that parks and landscapes were an essential part of democratic society (Orser, 2012). His designs were well liked and well known nationwide. Frederick Law Olmsted gave a different meaning to “landscape
architecture,” using the term to include the design of drainage, earthworks, structures, landform, and the composition of planting in public areas. He recognized the need to give people access to natural space and open air, and understood the mental and physical health benefits of walking in greenspace within urban areas. In the late nineteenth century, starting with the Back Bay Fens, he set out to design an entire system of parks and interconnecting parkways to connect to green spaces in the Boston area with the idea that all citizens, not just the wealthy, should have access to greenspace (Orser, 2012). He pushed to preserve high ground not yet developed in Boston, such as Franklin Park and the Arboretum. Olmsted's design of the Emerald Necklace (Figure 70) was admired around the world, inspiring Europeans to use the term “Landscape Architect” professionally for the first time.

Figure 70: Olmsted’s Emerald Necklace, Boston’s Most Famous Linear Park
The Emerald Necklace is a 1,100-acre chain of parks linked by waterways and green areas in Boston and Brookline, connecting the Public Garden, Back Bay Fens, Arboretum, and Franklin Park, mostly following the Muddy River. It became the first “linear park” in North America still in existence today (MMOC, 2012).

The “linear park” or “greenway” concept was groundbreaking because long, narrow “greenways” could maximize the number of residents with easy access to it, reaching more people with less area. The length of these paths allowed for long continuous walking and horseback riding. The bridle paths have since become shared-use paths for walking, biking, and other recreational activities. Disuse in the mid-20th century, especially during the Eisenhower-freeway era, led to breaks several areas as large roadways were constructed, such as Route 9 and Charlesgate, severing critical greenway routes.

In Boston several parks were created close to the Charles River, some from filling in land, and some from reclaiming industrial land. Initially, the planning around the Back Bay Fens stemmed from mitigation measures due to growing sewage pollution in the Boston marshlands. The adjacent area of marshland to the west of the Shawmut peninsula was a tidal flat of the Charles River. The area became contaminated with sewage and the solution was to fill in the land and redesign the drainage system with the up-and-coming field of sanitary engineering (MMOC, 2012).
For the dual purpose of eliminating the health and aesthetic problem created by the polluted marshlands west of the Shawmut peninsula and carving out new Boston real estate, a series of land reclamation projects was begun in 1820 and continued through the 1800s. The filling of present-day Back Bay was completed around 1882, leading to the rest of the Emerald Necklace project. Aside from the Emerald Necklace, the Boston region has several major greenways. (Figure 71)

**Figure 71: Major Boston Area Greenways**
2. The Greenways of Boston

For a major American city, Boston has the potential to have a high number of safe, comfortable greenways, with 72% of the region within one kilometer of an existing or proposed greenway (Furth, et al, 2013). More than 300,000 Bay Staters live within the Emerald Necklace’s watershed area, a number that could increase drastically if more linear parks could connect to the existing park system (Prickett, 2010). Major existing greenways in the Boston area, aside from the Emerald Necklace, include the Minuteman Path, the Charles River Path, the Harborwalk, and the Southwest Corridor. Due to highway severance, none of these major greenways connect to each other. The HarborWalk doesn’t connect to the Southwest Corridor, which doesn’t connect to the Muddy River, which doesn’t connect to the Charles River. However, there are several proposals to make these connections, such as the Charlesgate connection from the Muddy River to the Charles River and the World Series Bicycle Path, which travels along the campus of Northeastern University from the Southwest Corridor to the Emerald Necklace. Those reports can be accessed at:
http://www.coe.neu.edu/transportation

Some areas, known as “Greenway Deserts,” have no linear parks at all. Dorchester is considered to be a Greenway Desert (Furth, et al, 2013). Dorchester’s current population stands at 92,000, according to the Boston Redevelopment Authority (BRA, 2010). It is a working class community with a large minority population, including 36% Black, 32% White, 12% Latino, and 11% Asian. With high density, narrow roads, and
proximity to stores and other destinations, Dorchester has a strong latent demand for cycling if suitable infrastructure were in place. Oasis Greenways are the type of infrastructure that leads to high levels of cycling and walking. Moreover, pedestrians along the proposed Fairmount route commonly walk in the roadway. There is a need for a greenway there but due to the lack of abandoned rail lines or reserved parkland, there is no way to implement a traditional one. An Oasis Greenway could fill that need.
3. Background on Dorchester

Dorchester is Boston’s largest neighborhood and a historic area covering over six square miles. The town was founded by Puritans who emigrated from Dorchester, England in 1630. It was founded a few months before the city of Boston in 1630. In 1870 it was still a primarily rural town and had a population of 12,000 when it was annexed to Boston (Clapp, 1890). Railroad and streetcar lines during the late 1800s brought rapid growth, increasing the population to 150,000 by 1920. At that time, Dorchester had dense urban development, except in small enclaves for wealthy residents. Built for immigrants, Dorchester was crowded, had few parks, narrow streets, lacked greenery, and had small lots with few trees in private yards. Dorchester at the time was a streetcar suburb, which influenced its design of roads and dense residential areas. The need for a greenway in Dorchester has been well established due to the conspicuous lack of green areas. There were no parks, with very small yards, if any, along narrow streets with multi-family homes (Seasholes, 2003). As a working-class streetcar suburb, Dorchester becomes an ideal candidate for an innovative type of greenway.

North Dorchester only has an 18 percent canopy, compared to the Boston average of 29 percent tree cover (Stidman, 2007). The southern half of Dorchester has a higher coverage with a 32 percent canopy, while Dorchester on average has a 26 percent tree canopy. Oasis Greenways are one way to add trees to a part of Boston with inadequate
tree cover. Indeed, innovative new ways to add trees are needed if Mayor Thomas Menino's goal of 100,000 new trees in Boston by 2020 is to be met (Stidman, 2007).

4. **Background on the Fairmount Line**

As mentioned in the opening chapter, a greenway should ideally have a minimal number of street crossings, and to be attractive for bicycling, should have a level grade. A simple way to accomplish this is to develop a linear park parallel to the Fairmount train line, which has minimal at-grade crossings by design. The Fairmount train line is a nine-mile rail line that cuts through the heart of Dorchester in Boston and lies along the largest missing gap in the greenway network. It is the ideal location to apply an innovative model of a walking and biking route within a linear park. (Figure 72)

Because Dorchester has a reputation for a high crime rate (Bernadeau-Alexandre, 2008) residents have said that they would not feel comfortable using a secluded path that was squeezed between a train line and a row of homes' back yards. Also, several sections of the route are too narrow for an active rail line and shared use path. Therefore it makes sense to take residential streets in the neighborhoods and turn them into “Oasis Greenways.”
The proposed greenway will roughly parallel the Fairmount Train line, shown here.

Figure 72: Location of the Fairmount Line through Dorchester, Boston, MA
B. Previous study: The Fairmount Greenway Concept Plan

In March 2011 a consultant in Boston, Crosby Schlessinger Smallridge (CSS), with help from Bryant Associates, presented their Fairmount Greenway Concept Plan for the Fairmount corridor. The CSS route extends from the Neponset River path to Massachusetts Avenue near William Eustis Playground. CSS worked closely with several community development corporations and other stakeholders to develop the plan, which helped identify desire lines along the corridor. The study identified the amount of commercial space and affordable and mixed-use housing that was planned for the area, alluding to the importance of avoiding gentrification that occurs often with new development. The plan highlights the high crime rates and environmental injustice that Dorchester residents have historically suffered from. It points out that the Fairmount Corridor has been designated as one of five pilot corridors by the “Partnership for Sustainable Communities Program.” (see glossary)

As mentioned in the CSS plan, the project area includes the land within one-half mile of either side of the Fairmount Train line from South Station in downtown Boston to Readville Station in Hyde Park. CSS studied the potential for a traditional “rail-with-trail” greenway within the existing Fairmount rail corridor. However, that turned out to be problematic for several reasons. For starters, there are several bottleneck points where a pathway couldn’t fit in due to obstructions. Plus, where the path could be put in, there would be very little space for trees, vegetation, and other greenery once tracks and trail are installed. Moreover, the rail right-of-way tends to be along backyards, isolated from streets. Given that the corridor is in a relatively high-crime area (Bernadeau-Alexandre,
2008) the path along the MBTA right-of-way may deter use. In any case, the whole issue became a moot point when CSS met with the MBTA. Through a series of meetings it became clear that there would be few if any locations where the right-of-way could accommodate the proposed greenway due to issues such as surrounding grade changes and limited space within the right-of-way (CSS, 2011). Consequently, the route in this corridor will have to use streets. Fortunately, many low-volume streets parallel the tracks with low-levels of cross traffic, offering a low-traffic environment ideal for a greenway.

This thesis does not replicate the work done by CSS in the “Fairmount Greenway Concept Plan”; rather it develops a new model and builds on work already done by applying the model to the Fairmount Corridor. The CSS Concept Plan delves into the landscape architecture and general urban design details for the greenway. The plan proposes a specific route. Design features are superimposed on aerial photos. Locations of crosswalks and new street trees plantings are shown in these aerial images. The proposed route is illustrated with GIS maps. Details including benches, picnic tables, interpretive art, and community gardens are elaborated on in the study. The plan calls for implementation of the greenway over a ten to twenty year period and lists several areas in need of further analysis, including traffic engineering. While the CSS plan includes green elements and pocket parks, it leaves basic street cross-sections unchanged, typically with hard paving covering the entire ROW as either street or sidewalk. This thesis considers a more radical form of greenway, an alternative offering additional benefits, albeit with substantial additional cost.
C. The Proposed Fairmount Oasis Greenway Route

As part of this research study, several field visits were conducted, covering the entire length of the Fairmount line by bicycle, based on which a route was designed for a low-stress linear park along the Fairmount line (Figure 73). The figure shows an overview of the corridor with the potential Oasis Greenways colored in green and the missing sections that require jog cycle tracks or other suitable treatments for low-stress biking and walking are colored in blue with yellow circles around them.

The following describes the route the author chose as well as how it differs from a route chosen by Crosby Schlessinger Smallridge (CSS). As seen in figure 73, the route starts where the South Bay Harbor Trail meets I-93. It starts at that crosswalk but instead of turning west from the I-93 Frontage Road and following the north side of the Mass Ave Connector, the route follows the I-93 Frontage Road, in the crosswalk, under the Mass Ave Connector, and then follows the south side of the Mass Ave Connector as a cycle track. The route continues on the south side of the Mass Ave Connector as a cycle track, approximately half-way to Massachusetts Avenue, where it connects with a desire line ("goat trail") in the grassy area that brings cyclists and pedestrians to Bradston Street. A proposed cycle track will connect with Bradston Street at this point. Here the routes turns into an Oasis Greenway, through a low-traffic industrial area. The Oasis Greenway continues along S Bay Ave to Topeka Street until it reaches Southampton Street.
Figure 73: Proposed Route of Oasis Greenways & other Facilities, Dorchester, MA
After crossing Southampton Street the route becomes bike lanes along Theodore Glynn Way and finally Newmarket Square Street, where it intersects with Massachusetts Avenue in the vicinity of Clifford Playground. As the route crosses the road south to Shirley Street it becomes a parking-protected cycle track next to Clifford Playground, where there are no intersections to deal with.

When the route reaches Norfolk Ave, it becomes advisory bike lanes, until it reaches Marshfield Street, where it turns south and becomes an Oasis Greenway. It continues as an Oasis Greenway as it turns south onto Batchelder Street and then east on Clifton Street until it reaches the Uphams Corner MBTA station. There it continues south as an Oasis Greenway as the route travels along Alexander Street and Ceylon Street. As the route reaches the intersection with Columbia Road, it crosses the road and continues as an Oasis Greenway first along Richfield Street and then it turns south on Westwood Street. This is the first divergence from the CSS route, which recommends the route go straight on Richfield Street until Puritan Avenue, where they recommend a turn to the south and the route travel through the grounds of Holland Elementary School.

However, the author of this thesis does not recommend that route for two reasons: (1) the change in elevation to get the route back to Olney Street would make the design more complicated and expensive than need be, and (2) the pedestrian-cyclist interaction at the school would be problematic and make the route difficult to commute on. This author recommends that the route follow Wilrose Street until Rock Terrace,
where it should head south. That intersection is blocked off to motor vehicles but open to cyclists and pedestrians and therefore would make an ideal non-motorized route.

(Figure 73a)

Figure 73a: Wilrose St & Rock Terrace, Boston, Permeable for Bikes, Not for Cars

Granite blocks allow permeability for cyclists but not for motorists

The route should be an Oasis Greenway along Rock Terrace, and then it should turn into a Jog Cycle Track along Olney Street until it reaches Geneva Avenue. After it crosses Geneva Street it should stay on Olney Street but at this point turn into an Oasis Greenway. This is another place where the author’s route diverges from the CSS route. The CSS route avoids the hill on Olney Street south of Geneva Avenue and instead travels to Columbia Road and takes the bike lane south on Columbia Road before
cutting back on Washington Street. However, the bike lane is on a high-speed, high-volume four-lane roadway and it is not low stress, nor is it easy to make such a bike lane low-stress. Consequently, this author recommends that the Oasis Greenway continue up the hill along the low-volume, low-speed Olney Street, then turn west on Rossetter Street, and then turn south onto Eldon Street, where it meets up with Washington Street. The route is an Oasis Greenway on Eldon Street but then turns into a Jog Cycle Track along Washington Street, until it reaches Norwell Street, where it turns south and becomes an Oasis Greenway again.

The Oasis Greenway route stays on Norwell Street, crosses Talbot Avenue, and continues as an Oasis Greenway as the street name changes to New England Avenue. It then becomes a Jog Cycle Track as it heads west on Woodrow Avenue, and becomes an Oasis Greenway again as it heads south on Ballou Avenue. The route continues as an Oasis Greenway on Ballou Avenue and as it turns south on Willowwood Street. From Willowwood Street it turns south on Norfolk Street, unless right of way can be acquired to connect Hannon Street to Astoria Street, then it would use those streets, contact through the park behind “the City of Boston School” on Mildred Avenue, and then connect with Mildred Avenue, all as an Oasis Greenway. If that right of way is not able to be acquired, then the route would travel on a cycle track along Norfolk Street to the southwest. The CSS route assumes the ability to acquire right of way near Astoria Street, just south of Morton Street MBTA station as well as near the park behind “the City of Boston School” on Mildred Avenue. In any case, from Norfolk Street the route continues southwest and then turns to the southeast at Babson Street, where it would
be a cycle track until it reached Fremont Street and head east as an advisory bike lane. At the bottom of Fremont Street it would connect with the proposed Neponset River Trail.

Overall, the route is mostly flat, although there are some hills in the Eldon Street / Rosseter Street / Olney Street area, as well as Fremont Street heading down to the Neponset River. Moreover, the route is mostly residential, with the exception of the early part of the route, especially along Newmarket Square, which is quite industrial and has several distribution centers used by heavy vehicles. The route would potentially travel near a handful of small commercial areas, such as going directly next to an Enterprise-Rent-a-Car location, if right of way could be acquired and Astoria Street could be connected to Hannon Street. Finally, Norwell Street is an eclectic mix of residential and industrial, especially with an oil delivery business mixed into otherwise residential areas. (Figure 73b)

![Figure 73b: Oil Delivery Businesses along Norwell Street, Dorchester, MA](image)
D. Alexander Street Example

This section will consider the feasibility of Alexander Street, between Lebanon Street and Oleander Street, for use as an Oasis Greenway, which is one-way for motor vehicles (figure 74). Using the traffic analysis methodology from previous sections, traffic demand on Alexander Street was estimated. (Table 5) Given that the parallel Magnolia Street is also a one-way street, and half of the trips generated on that street need to use Alexander Street, a fraction of 0.5 was used for both Magnolia Street and Alexander Street (table 5).

**Table 5: Traffic Demand on Alexander Street**

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Street</th>
<th>Fraction used*</th>
<th>Dwelling Units</th>
<th>Trip Gen Rate</th>
<th>Trips per day</th>
<th>Trips per peak hr</th>
<th>Minutes between cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oasis Greenway</td>
<td>Alexander</td>
<td>0.5</td>
<td>32</td>
<td>4</td>
<td>64</td>
<td>6.4</td>
<td>9.4</td>
</tr>
<tr>
<td>Local</td>
<td>Magnolia</td>
<td>0.5</td>
<td>36</td>
<td>4</td>
<td>72</td>
<td>7.2</td>
<td>8.3</td>
</tr>
<tr>
<td>Combined</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>136</td>
<td>13.6</td>
<td><strong>4.4</strong></td>
</tr>
</tbody>
</table>

*Fraction of the street’s trip generation that contributes to the Oasis Greenway’s volume

The estimation of 4.4 minutes (264 seconds) between motor vehicles is far below the maximum threshold of 40 seconds and the desirable threshold of 120 seconds established in a previous section. Alexander Street should be satisfactory for development into an Oasis Greenway.

Aside from counting parcels, it’s important to count both on-street and off-street parking spaces and compare them to existing parking availability. The result will show how much parking can be removed and turned into greenspace for the Oasis Greenway. The methodology involves counting the parking spots and then comparing it to the required
parking for that area. A new layout was designed for Alexander Street between Lebanon Street and Oleander Street. Figure 74 shows the general area of the street.

Figure 74: Alexander St between Lebanon St and Oleander St, Dorchester, MA

Figure 75 show a plan view of the proposal for Alexander Street. Three feet of paved area was used behind the parking instead of five feet because there is two feet less of right-of-way available on Alexander Street (38 feet instead of the 40 feet shown in the generic Oasis Greenway.)
Figure 75: Alexander St Design between Lebanon St & Oleander St, Dorchester
As previously explained, the proposal is to design strips of pavement for pedestrians and cyclists with a gap between them. The gap as well as the head out angled parking (HOAP) on the side will have “Grasscrete,” where grass grows to give the street a green feel and the grass is naturally maintained by vehicles driving and parking on it. The drawing in figure 76 shows the proposed oasis greenway for Alexander Street. The areas colored in magenta are the HOAP, the grey areas are the smooth paved areas in the street, the dark green areas are the grasscrete in the street, and the bright green areas are the walkways and driveways to the homes.
Figure 76: Alexander Street as an Oasis Greenway, Dorchester, MA
Adding greenspace leads to pavement removal opportunities for Alexander Street between Lebanon Street and Oleander Street. (Table 6)

**Table 6: Reduction in Impervious Area along Alexander Street, Dorchester, MA**

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>“Before-and-After” Impervious Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>7032</td>
<td>Existing paved sidewalk area (before)</td>
</tr>
<tr>
<td>15236</td>
<td>Existing curb-to-curb paved area (before)</td>
</tr>
<tr>
<td>22268</td>
<td>Total existing paved area (before)</td>
</tr>
<tr>
<td>5860</td>
<td>Two proposed five-foot travel strips (after)</td>
</tr>
<tr>
<td>1758</td>
<td>One proposed three-foot unloading strip (after)</td>
</tr>
<tr>
<td>7618</td>
<td>Total proposed impervious area (after)</td>
</tr>
<tr>
<td><strong>14650</strong></td>
<td>Total reduction in impervious area</td>
</tr>
</tbody>
</table>

In addition, table 7 shows the calculations of the number of parking spots, using the Total Dwelling Units (DU) and the Parking Spots per DU to calculate the Total Parking Spots required.

**Table 7: Parking Demand, Trees Proposed, for Alexander Street, Dorchester, MA**

<table>
<thead>
<tr>
<th>Value</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>Total Dwelling Units</td>
</tr>
<tr>
<td>1.2</td>
<td>Needed Parking Spots per Dwelling Unit</td>
</tr>
<tr>
<td>38</td>
<td>Total Parking Spots</td>
</tr>
<tr>
<td>0</td>
<td>Total number of Trees (before)</td>
</tr>
<tr>
<td>23</td>
<td>Total number of Trees (after)</td>
</tr>
</tbody>
</table>

A parking survey was conducted on Alexander Street and 11 motor vehicles were counted parked off-street and 7 motor vehicles were counted parked on-street at 6:30pm during a weekday. The grand total of 18 parked motor vehicles is far less than the estimated demand of 38 spots using 1.2 spots per DU, including a demand of at least seven off-street parking spots to accommodate visitor parking. A total of 56 off-street parking spots were counted along Alexander Street from Lebanon Street to Oleander Street, which is more that the total demand for off-street parking.
D. Greenwood Street and Norwell Street Examples

Another area that’s a candidate for an Oasis Greenway is the area around Greenwood and Norwell Streets. Greenwood Street is parallel to Norwell Street so this section will consider the two streets as alternatives. (Figure 77)

![Map of Greenwood Street and Norwell Street](image)

**Figure 77: Greenwood St & Norwell St on Opposite Sides of Train Line, Boston**

Greenwood Street is just west of the railway tracks. A series of short one-way streets connect Greenwood and the parallel Glenway Street. The drivers traveling on those one-way streets have no choice but to use Greenwood either on their arrival or their departure, increasing the local access demand for vehicular flow on Greenwood.
Greenwood Street does not have any traffic diversion so it is popular with through traffic. Traffic diversion is an important tool in developing Oasis Greenways to minimize vehicular traffic flow.

Norwell Street lies on the opposite side of the Fairmount line and has fewer intersecting streets. But it has dense development on its north end and therefore more dwellings. Norwell Street also has a diversion because although it is two way from Harvard Street to Carmen Street, it becomes one-way, southbound only, from Carmen Street to Washington Street.

In deciding between Greenwood and Norwell Streets, it’s important to consider connectivity. Connectivity is a key consideration in route selection, trying to find residential streets that can be strung together in a way that minimizes inconvenience and loss of greenway character where the route transitions from one street to the next. Both Greenwood Street and Norwell Street are amenable to Oasis Greenway treatments based on traffic and space criteria. But how connected they are and how large a detour they require varies. Further sections of this paper will discuss how much they detour and how to connect Oasis Greenways with other Oasis Greenways when the route must travel along busy roads.

To compare Greenwood Street and Norwell Street, first the number of parcels were counted that fronted on each road affected. Then the number of Dwelling Units (DU) per parcel was estimated. As explained earlier, a trip generation figure of 4.0 trips per
dwellings were used. Tables 8 and 9 compare expected traffic volumes for Greenwood Street and Norwell Street for the circulation plan in figure 78, including the number of trips per day and per peak hour, plus the minutes between vehicles, based on the fraction of the street that was used.

**Table 8: Local Access Traffic Demand on Greenwood St for New Circulation Plan**

<table>
<thead>
<tr>
<th>Street type</th>
<th>Street</th>
<th>Fraction used*</th>
<th>Dwelling Units</th>
<th>Trip Gen</th>
<th>Trips per day</th>
<th>Trips per peak hr</th>
<th>Minutes between cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Maybrook</td>
<td>0.5</td>
<td>30</td>
<td>4.0</td>
<td>60</td>
<td>6</td>
<td>10.0</td>
</tr>
<tr>
<td>Local</td>
<td>York</td>
<td>0.5</td>
<td>36</td>
<td>4.0</td>
<td>72</td>
<td>7.2</td>
<td>8.3</td>
</tr>
<tr>
<td>Oasis Greenway</td>
<td>Greenwood</td>
<td>0.5</td>
<td>27</td>
<td>4.0</td>
<td>54</td>
<td>5.4</td>
<td>11.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>186</td>
<td>18.6</td>
<td>3.2</td>
</tr>
</tbody>
</table>

*Fraction of the street’s trip generation that contributes to the Oasis Greenway’s volume

As shown in table 8, Greenwood Street has a lower amount of expected traffic and longer time between vehicles. However, Greenwood Street other disadvantages compared to Norwell Street, which will be explained later.

One of the key principles of Oasis Greenways is to divert the through traffic when necessary so only local traffic accesses a given street. One idea to divert the through traffic along Norwell Street is to change the circulation pattern in the area. That way the vehicles can still reach their destination but the streets will not encourage cut-through traffic. Moreover, alternating one-way streets give cyclists an advantage over cars while, if designed correctly, still minimizing the detour for motor vehicles.
The concept would be to change the direction of Radcliffe St between Vassar St and Harvard St so that it is southbound only instead of northbound only and at the same time to change the direction of Norwell St between Vassar St and Harvard St so that it is southbound only instead of bi-directional. Motor vehicles can still get to where they are going but volumes would be severely reduced on Norwell Street. A new circulation plan was developed for the Norwell Street area using the alternating one-way street concept. (Figure 78)
Changing the circulation pattern along Norwell Street will divert traffic to Radcliffe Street. The portion of traffic diverted to a nearby street is known as the “impact fraction,” which is generally 0.5 for loop access and a value between 0 and 1 for where people have a choice of loops, as for Radcliffe Street. However, given the layout of the streets, Radcliffe Street is likely to have an impact fraction of close to 0.5. Table 9 estimates the local access traffic demand for Radcliffe Street and adds it to the previously calculated Norwell demand for a total demand on Norwell Street.

**Table 9: Total Traffic Demand for Norwell Street Accounting for Route Diversion from Radcliffe Street in Boston, MA**

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Street</th>
<th>Fraction used*</th>
<th>Dwelling Units</th>
<th>Trip Gen Rate</th>
<th>Trips per day</th>
<th>Trips per peak hr</th>
<th>Minutes between cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oasis Greenway</td>
<td>Norwell</td>
<td>0.5</td>
<td>60</td>
<td>4.0</td>
<td>120</td>
<td>12</td>
<td>5.0</td>
</tr>
<tr>
<td>Local</td>
<td>Radcliffe</td>
<td>0.5</td>
<td>99</td>
<td>4.0</td>
<td>198</td>
<td>19.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Combined</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td>318</td>
<td>31.8</td>
<td>1.9</td>
</tr>
</tbody>
</table>

*Fraction of the street’s trip generation that contributes to the Oasis Greenway’s volume

As can be seen in table 9, the total estimated traffic demand on Norwell Street, when including the traffic from Radcliffe Street that is likely to be diverted to Norwell Street, is 318 trips per day. This translates to 32 trips in the peak hour or 1.9 minutes between cars in the peak hour, which is below the volume threshold for Oasis Greenways.
Norwell Street Application of Parking Demand

The generic design chapter laid out the model for accommodating parking demand along an Oasis Greenway. This chapter will apply that model to Norwell Street and the surrounding area. In some cases, such as on Maybrook Street, the demand for parking can be met by the off-street parking supply. However, if an Oasis Greenway were to be built on this street, for purposes of providing at least 0.2 parking spots per DU of on-street visitor parking, the spatial design would likely include at least some on-street parking spots. The 1.2 parking spots per DU figure is used to calculate demand for parking spots for several blocks along the Fairmount Corridor. The remainder of the park / parking zone can be programmed as green space, with trees mixed among the parking area. (Figure 79)
Figure 79: Trees Mixed among the Parking Area on Norwell St Oasis Greenway

Norwell Street between Vassar Street and Harvard Street has a demand for 80 parking spots, and it currently has 58 off-street spots, so it needs 22 on-street spots. That
translates into the block needing approximately six parking spots for every 300 feet.

Even if the on-street supply is doubled to 12 spots every 300 feet, angle parking spaces are only 10 ft wide, leaving 180 ft in every 300 ft for trees and pocket parks. Some of this green space can be used to separate small groups of parked cars so that there are no long areas without trees; the remainder of the green space can be concentrated and in some cases furnished with play equipment or benches. Field visits and conversations with residents along Norwell Street revealed that a 50% car ownership rate is common for the residents there, and empty on-street parking spaces supported that conclusion. Nonetheless, given that some residents may prefer to park on the street for convenience, a total of 44 on-street spots were provided, making the total supply equal to 1.27 spots per DU.

When an analysis of Alexander Street between Oleander Street and Lebanon Street was undertaken, the result is that there were more off-street parking spots than are needed in the design. Similar to Norwell Street, on-street parking spots were nonetheless included in the design for visitors and traffic calming.
E. Using Washington Street as a Connector

When Oasis Greenways on a series of residential roads are all implemented, there isn’t necessarily a continuous bike route due to possible breaks in the corridor. Residential streets are often planned with deliberate discontinuities in order to deter through traffic. The graphic below shows an example of how Norwell Street and Eldon Street, another residential street that could be the continuation of the Oasis Greenway, both meet Washington Street (a minor arterial) at 3-way intersections, with an offset of 360 ft separating the two residential streets. Connecting those streets means that the greenway route includes a 360-foot dog-leg along Washington Street. That compares to a 160-foot dog-leg if an Oasis Greenway on Eldon Street were to connect along Greenwood Street via Erie Street. Figure 80 shows the two dog-legs on Washington Street and figure 81 compares the entire distance traveled for the Norwell Street option versus the Greenwood Street options.

Figure 80: Offset Intersections separating two Oasis Greenways
Figure 81: Oasis Greenways on Norwell St (right) & Greenwood/Standish St (left)
Greenwood Street does have some advantages. The shorter dog leg on Washington Street (figure 80) would translate into less parking removal and less cost for the dog-leg cycle track. Moreover, the route would avoid the commercial area and intense development at the northern end of Norwell Street. However, using Greenwood Street would bring the route straight into St Mary’s Cemetery. Using Norwell Street avoids crossing the train line two times. (Figure 81) It is much more direct and a significant cost savings, considering the cost of constructing low-stress connections along busy roads. For that reason, it is recommended that the route follow Norwell Street and not Greenwood Street. The next step is to design a facility along Washington Street that could connect Oasis Greenways on Norwell Street and Eldon Street.

Because sidewalks are available along Washington Street, the offset intersection is not a substantial deterrent to walking; however, because the 9-foot sidewalks are too narrow to be shared for cycling and the road carries heavy motor vehicle traffic, dog leg intersections can be major obstacles for an Oasis Greenway to serve as a low-stress and continuous bicycling route, unless a low-stress bicycling facility is provided the length of the dog-leg. The figures below show a possible design for a “dog-leg cycle track,” a short section of cycle track connecting a pair of offset residential streets. Its design assumes the removal of a parking lane for the dog-leg section, replacing it with a bike path. The greenway is designed for biking and walking in both directions; the arrows are just to show one possible route. The figure below shows the existing and proposed cross-sections for a special type of bicycle facility along Washington Street, known as a Jog Cycle Track, which serves as a connection for the Oasis Greenway.
Figure 82: Existing and Proposed Cross-Sections for Washington Street

Washington Street, shown in figure 82, is an example of a planned connector from a proposed Norwell Street Oasis Greenway to an Eldon Street Oasis Greenway. The curb to curb width of Washington Street is 40 feet while the sidewalks are nine feet wide. There are a significant amount of empty lots and parks along Washington Street between Norwell Street and Eldon Street, which points to the potential for building a Jog Cycle Track along the corridor.

The idea is to emulate the Portland Jog Cycle Track example. On Washington Street, the connector is proposed for the southwest side of the road as that's where most of the empty lots are located. The design will include the removal of a parking lane; that way the combined sidewalk-cycle track-tree zone can cover an 18-foot area. Portland’s
Going Street example has no trees so the Washington Street project will be considered an improvement over that design.

With 18 feet from face of curb, the trees will be centered 11 feet from the curb. Assuming a tree diameter of 1 foot allows an 8 foot cycle track adjacent to a 2 foot buffer next to the street. There is also a 6-inch buffer to the tree and 1.5 feet of the cycle track overhang the rubberized tree well cover. The pedestrians have a 6.5 foot clear area between the trees and the edge of the sidewalk zone, which potentially could lead to a frontage zone if a commercial establishment is constructed in the empty lot. The pedestrian zone also hangs 1.5 feet over the rubberized tree well cover.

Using the 4-foot tree well gives a physical width of a 5-foot sidewalk, 4 feet for the tree well, 7 feet for the cycle track, and a 2 foot buffer to the road. Since the tree well will be laid with a permeable rubberized mat that is traversable by foot and by bike, the effective width is increased by use of the tree well. With use of the tree well mat gives us an effective width of 6.5 feet for the pedestrians, 1 foot for the diameter of the tree, 8.5 for a bi-directional cycle track, and a 2 foot buffer to the road. The recommend dimensions of the tree well of 4’ by 10’ are taken from the New York Tree Planting Guidelines (Park & Recreation Department, 2008). (Figure 83)
Figure 83: Washington Street Connector Plan and Cross-Section
V Conclusions and Recommendations

In many cities, there is a vexing need for more linear parks and the Oasis Greenway model is an inventive way to fill that need. They have been proposed as a way to create a greenway in a dense urban area using the rights of way of local streets. This thesis combines eight existing models, including the woonerf, bicycle boulevard, pocket park, and green street, to create a new paradigm for an urban park within a constrained space. It hypothesizes that even within a limited right of way, a model could be developed that would provide a continuous path in a park environment while preserving access to people’s homes. The model would have the potential to be not just connections between linear parks but pleasant low-stress urban parks in themselves. This model is known as the “Oasis Greenway.”

To meet the objectives and address the hypothesis, the model has to address traffic demand, parking needs, connectivity issues, and dynamic envelope requirements. Residential streets can then be converted into linear parks, potentially creating a usable network of Oasis Greenways and greenspaces. To validate the model, it was tested by applying it to streets along the Fairmount corridor in Dorchester, a neighborhood of Boston identified as a “Greenway Desert” (Furth et al, 2013). Given the demographics and land use in the area, a trip generation value was chosen and calibrated and that value was used for model validation. Ultimately the thesis lists and describes (on page 76) nine key characteristics that form the Oasis Greenway and differentiate it from the other models studied.
Reducing volumes were shown to be the most critical aspect of the model. A literature review shows that when the threshold of approximately one car every 40 seconds is reached, the facility becomes comfortable enough for pedestrians to share space with motor vehicles, but not for an entire section of the street to become a play area. When the threshold of one car every 120 seconds is reached, the car volumes become low enough and the facility becomes sufficiently comfortable for an entire section of the street to become a play area. Local tributary areas were used in conjunction with traffic diversion methods to reduce volumes as needed.

Despite the name “Oasis” greenway, one of the key elements of their design is that they are generally not isolated but they have the potential to connect into a linear park network. The addition of Jog Cycle Tracks, which have less trees and park-like qualities than Oasis Greenways, make up a critical part of a continuous network. Application to a short section of the Fairmount corridor in Dorchester demonstrates the criteria for a linear park along a residential road have been met, with solutions that address the traffic, space, and connectivity needs inherent in the concept. The criteria and thresholds for the development of Oasis Greenways in this thesis can be applied to many cities across the country to increase greenspace and give more opportunities for healthy transportation and recreation.

From a “big picture” perspective, Oasis Greenways are likely to be a boon to society. Research has shown (Moon, 2011) that people are more likely to move to a city with green infrastructure such as linear parks, infrastructure that will help ensure the
competitiveness of a city in the 21st century in attracting new business, residents, and developments. Technical knowledge is not the only limiting factor to the implementation of a project such as an Oasis Greenway. In order for such a project to be successful, it must employ the trifecta of key project characteristics, which are collaboration, political approval, and financial support. Nonetheless, technical knowledge, such as from this thesis, is a key component for the implementation of Oasis Greenways.

The near-term recommendation is for the methodology of the model to be used as a pilot project to implement an Oasis Greenway along the Fairmount corridor in Boston. The model can then be expanded to other regions. The long-term recommendation is for a city or agency to use the model to determine the potential of converting an assortment of local streets into Oasis Greenways. The methodology could be used to determine the feasibility of various routes within a greater greenway network.
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APPENDIX
Glossary

Several terms and acronyms in this report will be unfamiliar to the reader and this section will attempt to define them as follows:

ADT – Average Daily Traffic. The total volume of traffic during a given time period (less than one year) divided by the number of days in that time period. Traffic volumes averaged over a year or more are known as Annual Average Daily Traffic (AADT).

Bicycle Boulevards - A low speed street, usually a residential street, where bicyclists have been given priority (by design, but not by law) over motorists. There are numerous names for Bike Boulevards. For example, in Boston and Somerville they are known as “Neighborways,” while in Seattle and Portland, Oregon, they are known as “Neighborhood Greenways.”

Bicycle lane - A portion of a roadway which has been designated by pavement markings, generally a bike symbol in addition to bike lane striping.

Bicycle Path - A path that is exclusively used by bicyclists. In these cases, a separate, parallel path is provided for pedestrians. Most pathways are shared between bicyclists, pedestrians, and other users. See Shared Use Path.

Bicyclist’s dynamic envelope - The space a bicyclist needs to safely maintain balance while in motion.

BTD – Boston Transportation Department

Cycle track – a bicycle facility separated from pedestrians and motor vehicle traffic with a physical barrier, such as with on-street parking, a raised curb, flexible delineators (aka plastic knock-down bollards) or, as in the case with Manhattan’s newest cycle track, with bicycle parking. (http://vimeo.com/64205368#at=0)

Complete Streets – Previously known as “Routine Accommodation,” Complete Streets are streets that are designed and operated to enable safe access for all users. Pedestrians, bicyclists, wheelchair users, the visually impaired, motorists and bus and train riders of all ages and abilities are able to safely and comfortably move along and across a complete street. Green Streets often incorporate many of the bike and ped-friendly concepts of “Complete Streets.”

Dwelling Unit - a structure or the part of a structure that is used as a home, residence or sleeping place by one person who maintains a household or by two or more persons who maintain a common household.

DOT – Department of Transportation

EPA – Environmental Protection Agency
FHWA – Federal Highway Administration, a division of the United States Department of Transportation

GIS – Geographical Information System

Green Street – “Green Street” is an umbrella term for a range of eco-friendly streets. It is generally agreed upon that a green street seeks to reduce stormwater runoff and associated pollutants, bringing swales, trees, vegetation, and natural elements into streets, while improving comfort and access for pedestrians and cyclists (Bureau of Environmental Services, Portland, 2008).

Heat Island Effect – A phenomenon where land surfaces in urban areas retain heat and effectively raise the temperature of cities a few degrees higher than their surrounding rural areas.

HUD – Department of Housing and Urban Development (U.S.)

Jog Cycle Track (JCT) – A cycle track installed on a short section of a busy road between a pair of offset intersections which offset local streets. Those local streets may contain a bicycle boulevard, an Oasis Greenway, or another similar bike route typical of residential roads. In order for cyclists to travel safely and comfortably along the busy road to get from one local street to the other, a low-stress connector is built along that main road. That connector is known as a Jog Cycle Track.

K-Factor – A factor which represents the proportion of ADT expected to occur in the design hour, often taken to be 10% or 0.10. For example, if the ADT is 12,000 and the K-Factor is 0.10, then the peak hour volume (usually used as the design volume) is taken to be 1,200.

LEED - Developed by the U.S. Green Building Council, Leadership in Energy and Environmental Design (LEED) is a voluntary, consensus-based, market-driven program. It provides third-party verification consisting of a suite of rating systems for the design, construction and operation of high performance green buildings, homes and neighborhoods.

MassDOT – Massachusetts Department of Transportation

MBTA - The Massachusetts Bay Transportation Authority is the public operator of most bus, subway, commuter rail, and ferry routes in the greater Boston area. In addition, the MBTA owns the right-of-way along the Fairmount train line where an original proposal for the Fairmount greenway would run.

MUTCD – The Manual on Uniform Traffic Control Devices, a document issued by the FHWA to specify the standards by which traffic signs, signals, and road markings are designed, installed, and used.
Neighborhood Greenways – A term developed in Portland, Oregon, for their Bicycle Boulevards to better reflect a growing emphasis on Bicycle Boulevards being more for just bikes. They are designed for families out for a stroll, kids playing, and neighbors socializing with physical features that provide many benefits to the community.

Neighborways – A term used by the City of Boston for Bicycle Boulevards given that in Boston the word “Greenway” has other connotations.

Parklets - A parklet is a type of pocket park. Specifically, it is an urban park created by replacing one or more parking spots with a more community orientated use, such as bike parking or café seating. Parklets were first implemented in San Francisco.

Partnership for Sustainable Communities Program – It is an interagency program of the national DOT, EPA, and HUD agencies that will be funding improvements along the Fairmount Corridor in Boston.

Pedestrian dynamic envelope - The space a pedestrian needs for comfortable perambulation.

Pocket park - A small park accessible to the general public that can be urban, suburban or rural, and can be on public or private land. They are usually on disused land and the transformation in a pocket park incorporates a more community orientated use, such as benches, a waterfall or a play area. When they are created from a parking spot they are known as “parklets.”

Right-Of-Way (ROW) - A general term indicating land or property, usually in a strip, owned by the public for transportation purposes.

Shared space – Also referred to as “naked streets,” shard space is an urban design approach where modes that are normally separated, such as pedestrian and motor vehicle modes, share space in a “curbless” environment. Curbs and traffic signals are removed to increase vigilance, improve safety, and create more available space in a built-up urban environment. The idea behind shared space is road users are required to make eye contact, slowing speeds and increasing opportunities to develop a more livable and aesthetically appealing built environment.

vph - Vehicles Per Hour

Woonerf - A street where pedestrians and bicyclists have priority, both by law and by design, over motorists. On Woonerfs motorists must drive at the speed of pedestrians.