Planning for Active Transportation in the Western United States: An Alternative Future for Cache Valley, Utah

Stephanie A. Tomlin
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PLANNING FOR ACTIVE TRANSPORTATION IN THE WESTERN UNITED STATES: AN ALTERNATIVE FUTURE FOR CACHE VALLEY, UTAH

by

Stephanie A. Tomlin

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE in

Bioregional Planning

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UTAH STATE UNIVERSITY
Logan, Utah

2018
ABSTRACT

Planning for Active Transportation in the Western United States: An Alternative Future for Cache Valley, Utah

by

Stephanie A. Tomlin, Master of Bioregional Planning
Utah State University, 2018

Major Professor: Bartlett (Barty) Warren-Kretzschmar, Ph.D.
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Until WWII, the cities of the U.S. developed around the three major modes of active transportation: cycling, walking, and public transportation. However, at the conclusion of WWII, the concept of mobility changed abruptly when the efficient and comfortable private automobile became readily available to the public. With the private automobile came a new and unprecedented type of growth and development within cities. We see evidence of this growth in today’s cities. The once dense and compact cities began to expand further away from city centers, and in no other location is that growth and expansion more apparent than in the iconic “sprawl” of the cities in the western U.S.

The unique characteristics and quintessential landscapes of the western U.S. are being threatened by widening freeways and tailpipe pollution—consequences of prioritizing the private automobile in city design. Active transportation (walking, cycling, and utilizing public transit) provides an opportunity to reimagine transportation
throughout the west. It offers affordable mobility options that promote physical activity, avoid air pollution, and densify cities, encouraging vibrant urban landscapes and natural open-space preservation.

This thesis research developed a methodology for establishing a comprehensive active transportation network within cities of the western U.S. Through documenting active transportation best practices and analyzing case study cities, which have achieved high active transportation modal splits, this research developed grounded theory detailing the operationally significant perquisites for active transportation. The perquisites were prioritized based on their significance and vetted by planning professionals to insure accuracy and validity.

The fitness of the documented prerequisites was then assessed by using them to develop an alternative future for active transportation in Cache Valley. The alternative future consisted of a GIS spatial representation of the prerequisites in Cache Valley to demonstrate the reproducibility of the research, coupled with detailed descriptions of each necessary element.
Planning for Active Transportation in the Western United States: An Alternative Future for Cache Valley, Utah

Stephanie A. Tomlin

Mobility in the western U.S. is defined primarily by the private automobile. Since the conclusion of WWII, the private automobile has become readily available to the public, and as a result, has heavily influenced the design of our modern cities in the west. In recent years the connections between high motor vehicle use and rising obesity rates, crumbling road infrastructure, and deteriorating air quality have caused city officials to reexamine the transportation systems of the west. One solution advocates, city officials, and planning professionals have begun examining is active transportation (walking, cycling, and public transit). Research suggests that a robust active transportation network not only diversifies mobility options, it also encourages compact urban development, cleaner air, and a more active population.

This thesis developed a methodology for examining and documenting the components of an active transportation network in the western U.S. This was done through a comprehensive literature review to glean important active transportation policies, infrastructure, and best practices. Then, two western U.S. case study cities with relatively high amounts of cycling, walking, and public transit use were selected and analyzed with site visits and planning professional interviews. The data gathered throughout this first phase of the research was then synthesized, and reoccurring themes...
about cycling, walking and public transit were identified. These themes were labeled as the prerequisites for active transportation in cities of the western U.S. and were documented and prioritized based on their potential impact. The themes were vetted by planning professionals in the two case study cities as well as in Cache Valley to insure accuracy and validity. A final version of the prerequisites was then documented.

The final phase of this research applied the prerequisites to the transportation system in Cache Valley, UT in order to insure the list was valid and reproducible under a variety of conditions. The outcome of this phase was GIS map displaying an alternative future for active transportation in Cache Valley, UT.
I would like to extend a huge “thank you” to my family, friends, Aggie Blue Bike colleagues, and committee members for helping me make this dream become a reality. My love for cycling was the impetuous for this work, but it grew into much more than just bikes. I have been analyzing these concepts formally and informally through my position at Aggie Blue Bikes, personal exploration, bike tours, and planning committees I was fortunate enough to be involved in long before I sat down to write this thesis. Although there are countless people who deserve thanks for contributing to this work in some way or another, I would like to thank the following individuals specifically for their support throughout this process:

Barty Warren-Kretzschmar—for helping me transform my individual, and often sporadic, ideas into one cohesive vision, and for acting as a sounding board in moving that vision forward. I would also like to thank her for the countless opportunities she provided me throughout my time as a student.

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onboard when I told him I was going to take on a master’s degree while working.

My parents—for encouraging me on through this process and for telling me I should write my thesis instead of escaping to the desert or mountains.

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Stephanie A. Tomlin
CONTENTS

Page

ABSTRACT ................................................................................................................... iii

PUBLIC ABSTRACT ................................................................................................... v

ACKNOWLEDGMENTS ............................................................................................. vii

LIST OF TABLES ......................................................................................................... xi

LIST OF FIGURES ....................................................................................................... xii

GLOSSARY OF TERMS .............................................................................................. xv

CHAPTER

I. INTRODUCTION ............................................................................................ 1

   Project Background .......................................................................................... 1
   Project Context ................................................................................................. 5
   Goals and Objectives of this Research ............................................................. 12
   Significance ...................................................................................................... 13

II. LITERATURE REVIEW ................................................................................. 15

   Benefits and Best Practices for Cycling ........................................................... 16
   Benefits and Best Practices for Walking .......................................................... 19
   Benefits and Best Practices for Public Transit ................................................. 22

III. METHODOLOGY ........................................................................................... 25

   Research Questions ......................................................................................... 25
   Literature Review .......................................................................................... 27
   Scope .............................................................................................................. 27
   Focus Research Question ................................................................................. 29
   Case Study Data Collection ............................................................................ 29
   Grounded Theory ........................................................................................... 31
   Expert Validation ............................................................................................ 32
   Alternative Future for Active Transportation in Cache Valley ................. 33
   Implementation and Monitoring ..................................................................... 33
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prerequisites for Active Transportation</td>
<td>81</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The spatial pattern of growth in automobile suburbia since 1920</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>A map of the interstates in 1976</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Variation among countries in obesity rates and modal split shares of urban travel by public transport, walking, and cycling, 1995-1999</td>
<td>10</td>
</tr>
<tr>
<td>4.</td>
<td>Curb extensions and pedestrian refuges</td>
<td>21</td>
</tr>
<tr>
<td>5.</td>
<td>Hawk lighting</td>
<td>22</td>
</tr>
<tr>
<td>6.</td>
<td>Estimated CO² emissions per passenger mile for transit and private autos</td>
<td>23</td>
</tr>
<tr>
<td>7.</td>
<td>Example of a bus bulb</td>
<td>24</td>
</tr>
<tr>
<td>8.</td>
<td>Process diagram</td>
<td>26</td>
</tr>
<tr>
<td>9.</td>
<td>Modal split in Portland, OR</td>
<td>27</td>
</tr>
<tr>
<td>10.</td>
<td>Modal split in Boulder, CO</td>
<td>27</td>
</tr>
<tr>
<td>11.</td>
<td>Location of Portland, OR</td>
<td>34</td>
</tr>
<tr>
<td>12.</td>
<td>Oregon emissions by sector</td>
<td>35</td>
</tr>
<tr>
<td>13.</td>
<td>Portland bicycle plan</td>
<td>37</td>
</tr>
<tr>
<td>14.</td>
<td>BIKETOWN bike</td>
<td>38</td>
</tr>
<tr>
<td>15.</td>
<td>Map of trails in Portland</td>
<td>40</td>
</tr>
<tr>
<td>16.</td>
<td>Cyclist riding the Springwater corridor trail</td>
<td>41</td>
</tr>
<tr>
<td>17.</td>
<td>Pedestrians on the Springwater Corridor trail</td>
<td>41</td>
</tr>
<tr>
<td>18.</td>
<td>TriMet transit routes</td>
<td>43</td>
</tr>
<tr>
<td>19.</td>
<td>Location of Boulder, CO</td>
<td>44</td>
</tr>
<tr>
<td>Figure</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>20.</td>
<td>Colorado emissions by sector</td>
<td>46</td>
</tr>
<tr>
<td>21.</td>
<td>Boulder trips by type</td>
<td>47</td>
</tr>
<tr>
<td>22.</td>
<td>Active transportation underpass, Boulder</td>
<td>48</td>
</tr>
<tr>
<td>23.</td>
<td>Man using the Boulder B-cycle program</td>
<td>49</td>
</tr>
<tr>
<td>24.</td>
<td>Boulder active transportation paths and trails</td>
<td>51</td>
</tr>
<tr>
<td>25.</td>
<td>Flatiron Flyer route map</td>
<td>55</td>
</tr>
<tr>
<td>26.</td>
<td>My route to bicycle mechanic school</td>
<td>57</td>
</tr>
<tr>
<td>27.</td>
<td>Morning ride on a Portland Greenway</td>
<td>58</td>
</tr>
<tr>
<td>28.</td>
<td>Ride along a buffered bike lane in Portland</td>
<td>60</td>
</tr>
<tr>
<td>29.</td>
<td>Pearl Street, Boulder</td>
<td>63</td>
</tr>
<tr>
<td>30.</td>
<td>Boulder Transit Station</td>
<td>64</td>
</tr>
<tr>
<td>31.</td>
<td>Broadway underpass, Boulder</td>
<td>65</td>
</tr>
<tr>
<td>32.</td>
<td>Boulder Creek path</td>
<td>66</td>
</tr>
<tr>
<td>33.</td>
<td>Mt. Hood Freeway project</td>
<td>71</td>
</tr>
<tr>
<td>34.</td>
<td>Representation of the Blue Line</td>
<td>75</td>
</tr>
<tr>
<td>35.</td>
<td>A desire line heading off the sidewalk in Logan, UT</td>
<td>96</td>
</tr>
<tr>
<td>36.</td>
<td>Plat of Zion grid system</td>
<td>104</td>
</tr>
<tr>
<td>37.</td>
<td>Existing active transportation networks in Cache Valley, UT</td>
<td>106</td>
</tr>
<tr>
<td>38.</td>
<td>Parking lot in Logan, UT</td>
<td>111</td>
</tr>
<tr>
<td>39.</td>
<td>Main Street, Logan, UT</td>
<td>116</td>
</tr>
<tr>
<td>40.</td>
<td>Pedestrian walking without a sidewalk in Logan, UT</td>
<td>123</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td>41.</td>
<td>Current progress of active transportation prerequisites in Cache Valley, UT</td>
<td>128</td>
</tr>
<tr>
<td>42.</td>
<td>Proposed bike + walk transportation networks in Cache Valley, UT</td>
<td>129</td>
</tr>
<tr>
<td>43.</td>
<td>Proposed transit transportation networks in Cache Valley, UT</td>
<td>130</td>
</tr>
</tbody>
</table>
GLOSSARY OF TERMS

Arterial Road: An arterial road is a high-capacity urban road. The primary function of an arterial road is to deliver traffic from collector roads to freeways or expressways, and between urban centers at the highest level of service possible.

Bicycle Corral: Bicycle Corrals are groups of bicycle racks installed in areas with high bicycle parking demand. Bicycle Corrals accommodate large numbers of bicycles in spaces where few vehicles could be parked.

Bicycle (Bike) Share: Bike share is a public bike rental system owned, operated and maintained by one or multiple entities. A system is typically comprised of multiple docking stations where bikes can be rented for short trips. The docking stations are typically less than a mile apart. The bicycles available are all the same and tend to be durable with fenders and a storage rack.

Buffered Bike Lane: A buffered bicycle lane is designed with an additional 1- to 2-foot painted “buffer” on either side of the bicycle lane to provide a more protected and comfortable space for cyclists. The buffer can be both on the side closest to the moving vehicles and/or on the side closest to the parked cars to prevent “dooring.” A buffered bike lane also increases visibility for both motorists and cyclists because the additional buffer space moves any visual barriers, including parked cars, landscaping, etc., farther away from the cyclists on either side.

Bus Rapid Transit (BRT): A bus-based mass transit system that operates within a fully or partially dedicated right-of-way to avoid traffic congestion. Stations for BRT closely resemble rail stations to increase the boarding and alighting speed of passengers.
Central Business District (CBD): The CBD is a smaller location within a metropolitan area that is comprised of the highest density of business development. It generates a high percentage of trips because of its high employment to area ratio.

Collector Road: a low-to-moderate-capacity road which serves to move traffic from local streets to arterial roads. Collector roads are designed to provide access to residential properties.

Commuter Rail: Commuter rail, also called suburban rail, is a passenger rail transport service that primarily operates between a city center, and the middle to outer suburbs beyond 10 miles. Commuter rails are often placed in locations that connect major origins to major destinations.

Contra-Flow Bike Lanes: Contra-flow bicycle lanes are bicycle lanes designed to allow bicyclists to ride in the opposite direction of motor vehicle traffic. They convert a one-way traffic street into a two-way street: one direction for motor vehicles and bikes, and the other for bikes only.

Controlled Pedestrian Crossing: A pedestrian crossing where motorists are required to stop by either a stop sign or traffic signal.

Crosswalk Lighting: Street lighting applied at a pedestrian crossing to help approaching motorists see a crossing pedestrian. Crosswalk lighting is at a “vehicular scale” like normal street lighting rather than a “pedestrian scale” that is often used along a sidewalk.

Crowdsourcing: Crowdsourcing is the act of getting data or information from a crowd of people (typically online).
Curb Extensions: A roadway edge treatment where a curbline is bulged out toward the middle of the roadway to narrow the width of the street. Curb extensions are sometimes called “neckdowns,” or “bulbouts” and are often used at the location of a pedestrian crosswalk to minimize the distance and time that a crossing pedestrian must be in the roadway.

Curb Ramp (curb cut, ramp down): Is a solid (usually concrete) ramp graded down from the top surface of a sidewalk to the surface of an adjoining street.

Cycle Track: A cycle track is a bicycle only facility that provides full separation between the cyclists and the motor vehicles. The separation can be in the form of bollards, planters, raised medians or landscaping.

Cyclist: A person using a transportation facility while riding a bicycle.

Desire Line: A path created as a consequence of erosion caused by human or animal foot-fall or traffic. The path usually represents the shortest or most easily navigated route between an origin and destination.

First and Last Mile: First and last mile is a term used to describe how transit users begin and end their total trip that involves transit. Because transit stations/stops are typically located some distance from trip origins/destinations, amenities are needed to facilitate the trip from a transit user’s home to the station and from the station to the transit user’s destination. First and last mile amenities are facilities within and surrounding transit stations, like sidewalks, bike lanes, parking lots, wayfinding signage, seating, sun and wind protection, etc.

HAWK Beacon (Hawk lighting): A pedestrian hybrid beacon is a type of overhead
crossing treatment used to both warn and control traffic at a pedestrian crossing. The beacon is actuated by a pedestrian push button and uses a combination of circular yellow and red traffic signal displays to first warn motorists of a pedestrian that is about to cross the street, then require the motorist to stop for the pedestrian crossing, and then release the motorist to proceed once the pedestrian has cleared the crossing. The beacon is a hybrid between a pedestrian traffic signal and a stop sign.

*Lane:* A portion of the roadway surface designated for motor vehicle travel, typically in a single direction, that is delineated by pavement marking stripes. Types of lanes include: “through lanes” for travel along the length of the roadway, often through intersections; “turn lanes” which are typically on intersection approaches and provide space for left or right turning motorists; “bike lanes” which are designated for bicycle travel in the same direction as the automobile travel, are typically narrower than vehicle lanes, and are usually located along the outside edges of the roadway.

*Level of Traffic Stress (LTS):* A raking system that assigns roads a 1—4 based on presence of a bicycle facility, speed limit and average traffic volume. A 1 is considered a very low level of traffic stress, while a 4 is considered a high level of traffic stress. Most adults specify feeling comfortable in the LTS 2 or 1.

*Light Rail:* Light rail is rail-based transit system that is often located in urban centers. Light rail systems typically have shorter distances between stops (>1 mile), and often are located on the same grade as the vehicle facilities.

*Marked Crosswalk:* A pedestrian crossing that is delineated by white crosswalk pavement markings. Marked crosswalks typically also are delineated by a variety of
traffic signs. Marked crosswalks would also have curb ramps if there is curb and gutter in an area.

**Median Refuge (Pedestrian Safety Island):** An area in the middle of a roadway where a crossing pedestrian can take shelter from approaching traffic in either direction. The median refuge must include a raised median of some width. A median refuge allows a pedestrian to cross each direction of approaching traffic in a separate phase. By using the refuge, the pedestrian must only find an acceptable gap in traffic for one approach direction at a time.

**Modal Split:** is the percentage of travelers using a particular type of transportation or number of trips using said type.

**Multi-Use Path Crossing:** A location where a sidewalk designated as a multi-use path intersects a roadway at-grade, and the path extends on both sides of the roadway.

**Neighborhood Greenways:** Streets with low traffic volume and speed where bicycles, pedestrians and neighbors are given priority.

**Pedestrian:** A pedestrian is a person walking on a transportation facility.

**Pedestrian Mall:** A pedestrian zone or street, lined with store fronts and closed off to most automobile traffic.

**Pedestrian Traffic Signal:** A conventional traffic signal with circular red, yellow, and green displays for motorists and Walk/Don’t Walk signals for pedestrians that is applied at a pedestrian crossing. Typically, a pedestrian signal would be applied in a mid-block location since it would be considered a normal intersection related traffic signal if it were to be applied at an intersection.
Raised Median: An area in the middle of a roadway, commonly separating vehicles traveling in opposite directions, that is surrounded by curb and gutter and is physically raised above the surrounding pavement where vehicles travel. Raised medians often contain landscaped areas.

Rectangular Rapid Flash Beacons (RRFBs): RRFBs are small rectangular yellow flashing lights that are deployed with pedestrian crossing warning signs. They are typically actuated by a pedestrian push button and flash for a predetermined amount of time, to allow a pedestrian to cross the roadway, before going dark. RRFBs are warning devices and do not themselves create a legal requirement for a vehicle to stop when they are flashing.

Right-Of-Way (ROW): The ROW is the area where the transportation facility is located. This includes any type of motor, rail, or active transportation facility. The ROW is the area that is legally owned and maintained by the transportation facility provider. Often the ROW is wider than the surface used for the transportation facility to allow enough space for maintenance, fencing, or other safety measures.

Safe Routes to School Program: Safe Routes to School (SRTS) programs are sustained efforts by parents, schools, community leaders and local, state, and federal governments to improve the health and well-being of children by enabling and encouraging them to walk and bicycle to school.

School Crossing: A School Crossing is defined as a crossing location where ten or more student pedestrians cross per hour.

Separate Bicycle Facilities: bikeways have been built to physically separate
bicycles from automobiles with a physical barricade.

**Shoulder:** A shoulder can be referred to as a hard or soft shoulder depending on the type of roadway, speed of travel and width of shoulder facility. A section of the roadway that is a part of the overall right-of-way but is not part of the travel lane. It is located on the outside edge of the roadway and can be used for emergency stopping, parking, non-vehicular travel, etc. Shoulder use often has restrictions and is determined by the right-of-way owner.

**Transit Oriented Development:** A transit-oriented development (TOD) is a mixed-use residential and commercial area designed to maximize access to public transport, and often incorporates features to encourage transit ridership.

**Transportation Demand Management:** Transportation Demand Management or TDM is a general term for strategies that increase overall system efficiency by encouraging a shift from single-occupant vehicle (SOV) trips to non-SOV modes or shifting automobile trips out of peak periods. Strategies include; carpooling, vanpooling, bicycle sharing, compressed work week, telecommuting, etc.

**Truncated Domes:** Truncated domes are sheets of tightly spaced domes that are roughly an inch in diameter. They are used at curb ramps to assist those who are visually impaired understand where the sidewalk ends, and the road begins.

**Uncontrolled Pedestrian Crossing:** An established pedestrian crossing that does not include a traffic signal, a HAWK beacon, or a stop sign that requires motor vehicles to stop before entering the crosswalk.

**Utility cycling:** Utility cycling encompasses any cycling done simply as a means
of transport rather than as a sport or leisure activity. It is the original and most common type of cycling in the world.

*Vehicle Queue:* A line of stopped vehicles in a single travel lane, commonly caused by traffic control at an intersection.

*Vehicular cycling:* is the practice of riding bicycles on roads in a manner that is in accordance with the principles for driving in traffic.
CHAPTER I

INTRODUCTION

Project Background

There are few inventions in history that systematically changed the way the urban centers of the United States developed than the mass production of the private automobile. After WWII, with the use of the assembly lines, and other subsequent construction techniques, vehicles could be built with greater speed and consistency than ever before, making them more reliable and most importantly, more affordable. The personal vehicle was no longer a luxury or recreational diversion (Muller, 2004), it was affordable and readily available to the public, and the public reacted by purchasing them quicker than manufacturers could produce them.

While, from a personal freedom and exploration perspective, the personal vehicle represented a feat of human ingenuity, from a city design perspective it represented a massive paradigm shift. Until the personal vehicle became widely available, city dwellers had to rely on active (cycling and walking) and public transportation to move about the cities.¹ City design reflected this mobility reality in their layout and placement within landscapes. Cities were compact and did not radiate very far from there centers because they were designed to be accessible by foot, bike, horse, train, and trolley. At that time, traveling great distances required large amounts of both resources and time, luxuries that many could not afford. However, as demonstrated in Figure 1, the personal automobile

¹ Mobility options referred to included: walking, cycling, horseback riding, rail trollies, trams and trains.
shrunk the amount of time and resources required to travel, and thus expanded the boundaries of travel distances that were possible to a greater portion of the population. Suddenly, miles and time as they related to travel, became a much smaller concern for those with a personal vehicle.

As this new form of mobility grew, so too did the realization that personal vehicles interfaced with the built environment much differently than other forms of transportation. More vehicles required larger rights-of-way (ROWs) to move about, they needed proprietary systems to regulate and control their movement, they needed places to be left when not in use, and they needed reasonably spaced gas stations. Simply stated, in
order to accommodate the growing number of personal vehicles, cities had to readapt and redevelop, quickly.

Cities that were once concentrated, because of necessity, with robust trolley and train networks crisscrossing pedestrian corridors, began fragmenting to make room for the roads the vehicles needed to move around. Where space was limited, it was often given to vehicles. Parking lots sprang up everywhere, and quite often historic buildings or city centers where leveled to make room for more parking stalls. Cities not only redeveloped, they also expanded. City dwellers began moving outside existing city limits, a reality that was made possible by their personal vehicle. Outside the cities there was room for single family homes on a half-acre of land, and many people decided this was a more desirable way of living. This phenomenon of moving outside the cities became known as the suburbs or suburban sprawl because the single-family homes stretched out for miles outside any given city. In a matter of years, suburbs began springing up around most major cities, often blurring the boundaries between the different urban centers and increasing the commuting radius.

In 1956, the Interstate Highway Act was passed, mobilizing the construction of over 41,000 miles of freeways throughout the country over a 10-year period (see Figure 2). The new freeways developed quickly and threaded the landscape together, giving people access to places that had never been seen before. Their presence created a culture of unbounded interstate travel (Muller, 2004).

The personal automobile changed the urban fabric in other ways as well. It allowed cities to become much more divided based on land use. As Berry (1981) stated, a
mosaic culture was born out of the personal vehicle. Component tiles of the city were stratified along age, class lines, occupation, etc. This allowed people to become more isolated among their peer group. The automobile provided privacy and choice in transportation, concepts that had not been available without it.

During the late 40s and 50s, the communities of the western U.S. also experienced this rapid change, catalyzed by the private vehicle. However, there was a slight difference in the way the west developed, because it had a great commodity that other parts of the country had much less of, and that was space. The car became the means by which Americans were able to inhabit the harsh, dry, landscapes of the west. The car also became the way citizens experienced the west. “The individual freedom that cars seemed
to offer was in step with the open vistas of the West” (Sullivan, 2015, p. 19). The car provided an opportunity for western development to occur with very few limiting factors, turning the historic metropolitan city inside out (Muller, 2004).

Many cities of the eastern U.S. had developed before the proliferation of the private automobile, their historical urban form apparent in the dense design and active transportation networks ubiquitous through the city. Much of the West, however, developed in conjunction with the vehicle. Therefore, the influence of the car on city development is perhaps most prominent in the West. “The places where most of us westerners live are quasi cities that are too spread out to walk in or for mass transit but too close together to be a home on the range. They are perfect for one thing: driving cars” (Sullivan, 2015, p. 28).

**Project Context**

While the personal vehicle was an exciting new development that created opportunities in an age of exponential growth and unprecedented development, there were some who were concerned about how it promoted the disassembly and abandonment of existing active transportation systems. In 1961 Lewis Mumford cautioned that the private automobile was going to rapidly dismantle urban form and create a one-mode transportation system that is unsustainable and space intensive (Mumford, 1961). He stated:

Far from supplementing public rail transportation, the private motor car became a clumsy substitute for it. Instead of maintaining a complex transportation system, offering alternative choices of route and speed to fit the occasion, the new suburban sprawl has become objectively dependent upon a single form, the
private motor car, whose extension has devoured the one commodity the suburb could rightly boast: space. (p. 506)

Mumford (1961) went on to say:

By discouraging and eliminating the pedestrian, by failing to extend and to perfect mass transportation, our municipal officials and highway engineers have created a situation that calls for extremely low residential densities. Here again the monopoly of private space not merely reduces the social facilities of the city but sacrifices public open space to private. (p. 510)

Jane Jacobs was also weary of the fragmentation in cities the personal automobile could cause. In her book, the Dark Age Ahead (Jacobs, 2004) she describes that “now TV or illegal drugs but the automobile has been the chief destroyer of American communities. Highways and roads obliterate the places they are supposed to serve…” (p. 37).

Were Mumford and Jacobs correct in their predictions about what the car would do to the U.S., particularly the western U.S.? A study conducted in 1960 revealed that 59 percent of the ground area in Los Angeles’ central business district (CBD) was devoted to streets and parking (Melosi, 2010). A more recent study conducted in 2015 suggests that parking is still a dominant attribute in the CBD of Los Angeles, however, technological advancements have put the parking structures underground, so they are less obvious (Manville & Shoup, 2013). Phoenix, AZ has over 1,405 lane miles of freeways as of 2005, and as of 2010 the total U.S. Highway System was comprised of 47,182 miles of roads, making it the largest public works project in history.

There is evidence to suggest that since the personal vehicle became convenient and affordable, the U.S. has embraced it and built a transportation system devoted to it. But why does this matter? What reason is there to be concerned about the
private automobile? There is no single answer to these questions. In fact, it is very complex, but there is evidence to suggest that our car centric transportation system is exacerbating the obesity epidemic in the U.S. while costing billions in roadway maintenance costs, fuel costs, and wasted productivity time that we spend in traffic jams, in addition to polluting the air. The following segment provides and overview of how our transportation system is affecting the aforementioned aspects of society.

The current state of obesity in the U.S. is alarming. According to the Centers for Disease Control (CDC), in 2015, one third of U.S. adults were obese. The estimated annual medical cost of obesity in the U.S. was $147 billion in 2008 U.S. dollars while the medical costs for people who were obese were $1,429 higher than those of normal weight (Ogden, 2015). Obesity is a chronic disease that is preventable and reversible through diet and exercise, and it is correlated to the amount of time American’s spend sitting or being sedentary which has been on the rise since the late 1950s. According to a study done in 2015, Americans sit an average of 13 hours a day (Biswas, Faulkner, Bajaj, Silver, & Mitchell, 2015). They sit at work, they sit to watch television, they sit at the computer, and they sit in their vehicles on their way to work. A different study stated that Americans sit in traffic the equivalent of 1 week per year (Schrank, Eisele, Lomax, & Bak, 2015).

When it comes to roadways the U.S. road infrastructure is deteriorating faster than it can be repaired. The American Society of Civil Engineers (ASCE) rate the U.S. road system with a “D,” or severely lacking on their “Infrastructure Report Card” (American Society of Civil Engineers, 2016). Thirty-two percent of major roads are reported to be in
poor or mediocre condition, meaning they are in need of immediate repair. However, there is not enough funding available to make those immediate repairs. Estimates suggest that $101 billion in annual capital investment between 2008 and 2028 is needed to maintain the current system. Currently, only $91 billion is being spent annually, creating a gap in necessary funding that will reach 54% of total need by 2040.

The most conspicuous annually earmarked source of federal funding for transportation comes from the Highway Trust Fund. This Fund is composed of revenue primarily from the federal fuel tax established in 1956. The federal fuel tax (in addition to a state fuel tax) is passed through to users at the pump, meaning it is embedded into the cost of fuel and paid by those who use gasoline or diesel fuel. Today the federal gas tax is 18.4 cents per gallon for gasoline fuel and 24.4 cents per gallon for diesel fuel. For various reasons the federal fuel tax has not increased since 1993. Due to inflation and other market forces, the value of the tax in 2016 is less than it was in 1993, meaning revenue from the gas tax is decreasing.

In addition to the static federal fuel tax, more fuel-efficient vehicles and electric vehicles are beginning to penetrate the market. As technology continues to advance we can expect to see a greater percentage of hybrid and electric vehicles making up the fleet mix into the future. While these types of vehicles are good from the standpoint of air quality and cost at the pump; they do not pollute as much as older vehicles and they require less gasoline to operate, they contribute less into the gas tax revenue stream (or they do not contribute at all) due to their efficiency or use of electricity as a fuel source. (American Society of Civil Engineers, 2016). This means that there is a downward trend
of revenue replenishing the Highway Trust Fund proportional to the number of vehicles using the transportation infrastructure.

Transportation choices also affect air quality. According to the American Lung Association (2016), as of 2016 half of people living in the U.S. reside in counties with air quality that does not meet EPA standards during some parts of the year. A study conducted by the Union of Concerned Scientists in 2013 showed that transportation accounted for more than half of the carbon monoxide and nitrogen oxides, and almost a quarter of the hydrocarbons emitted into the air in the U.S. According to the United Nations Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2014), industry accounted for 21% of total greenhouse gas emissions, electricity and heat production for another 25%, and transportation accounted for 14%. The health effects of air pollution have been difficult to diagnose definitively, however there are studies linking air pollution to premature mortality, cardiovascular diseases, heart disease, certain cancers and dementia (World Health Organization, 2015).

It would be inaccurate to suggest the private automobile is the sole cause of the problems relating to obesity, transportation infrastructure, and poor air quality. The problems are simply too complex to simplify to one facet of society. However, there are compelling examples of how discouraging car use can make a positive impact in overall community health. Figure 3 models the relationship between obesity and the percentage of people who walk, bike and take public transit in different countries around the world. The countries with the highest percentage of active transportation have the lowest percentage of obesity.
Driving an automobile is a heavily subsidized activity in the U.S. and more funding is required to keep up with current diving rates. The Highway Trust Fund is operating in a deficit and yet the federal fuel tax remains at its 1993 rate. One study suggests that each mile traveled on a bike saves a city roughly 42 cents, based on a lower impact to the road and public health benefits. The same mile traveled in a car costs the community roughly 20 cents, based on road maintenance/construction and air quality degradation (Copenhagen City of Cyclists, 2010). The cost of building cycling and walking infrastructure is also much less expensive than auto-oriented infrastructure. For example, a corner curb extension for a pedestrian costs $78,000, and one mile of
protected bikeways (in San Francisco) costs $445,000. The most inexpensive reported cost per mile figure for an urban arterial road is roughly $6.75 million, with averages usually being much greater than that (League of American Bicyclists, 2009). Additionally, vehicles are expensive to own and maintain. According to the American Automobile Association (AAA) the average annual cost of driving a sedan is roughly $9,122 (American Automobile Association, 2014). As a percentage of total annual expenses, transportation costs account for nearly 20% for American families, which is the second highest annual cost percentage behind housing (Bureau of Labor Statistics, 2016). Overall, transportation, specifically vehicle ownership, is a substantial cost burden for individual families and the nation alike. Decreasing transportation costs for families could free up capital for other investments.

Moving forward the U.S. needs to reevaluate its transportation system. It is apparent that the social, economic and biological systems can no longer support the car dependent culture fostered over the past 60 years. And as the population grows these issues may only increase. The country’s overall health, air quality, and financial stability have suffered as a result of this “one mode fits all” system. The future of transportation should look to the past for solutions. It should embrace the benefits of cycling, walking, and public transit—the modes of transportation this country relied on before the private automobile. These modes of transportation can again be the way to move people efficiently, while trimming down waistlines and cleaning up air pollution. This research aims to demonstrate how active transportation can become a reality for cities of the western U.S.
Goals and Objectives of this Research

The overall goal of this research is to lay a foundation for understanding how cities of the western U.S. can prepare their urban landscape for a comprehensive active transportation network. A methodology is developed and implemented that delivers a list of prerequisites for cities in the western U.S. that are needed to achieve high active transportation modal splits. Prerequisites are based on documentation of holistic historical accounts as well as relevant research, and include policy recommendations, Transportation Demand Management (TDM) strategies, programs, plans, infrastructure recommendations, advocacy initiatives, and project prioritizations.

In order to produce a comprehensive, well vetted, list of active transportation prerequisites that are reproducible in any western U.S. city, the methodology focuses on achieving the following goals.

- **Review the State of Active Transportation Research.** A thorough understanding of the existing research in active transportation best practices and benefits is developed through an extensive literature review. Topics analyzed in the literature review include:
  
  o Bike and pedestrian infrastructure design
  o Transit oriented design strategies
  o Health benefits of active transportation
  o Metrics for measuring active transportation use

  Special attention is paid to articles and literature that examine the western U.S. and the specific challenges that region faces in relation to active transportation.

- **Determine the Existing State of Active Transportation in the Western U.S.** Two case study cities in the western U.S. are examined that have a relatively high active transportation modal split. The analysis includes a site specific historical review, a site visit, and an interview with a local active transportation planner.
• **Build Theory.** By identifying and documenting the active transportation themes throughout the research, ground theory is developed about prerequisites for active transportation.

• **Vet Theory.** The initial list of prerequisites is reviewed by the two case study city site experts and a Cache Valley planning expert.

• **Spatially Reproduce the Theory.** In order to demonstrate and visualize the spatial significance of the documented prerequisites, they are used to develop an alternative future for active transportation in Cache Valley, UT.

**Significance**

This research develops a theory outlining the prerequisites needed for a city of the western U.S. to begin implementing a comprehensive active transportation network. The western U.S. faces unique challenges for active transportation found in the present design of its cities, distances between major metropolitan areas, and the notion of “freedom” the personal vehicle currently symbolizes to many westerners. The expansive landscapes and a unique sense of place needed to be considered when developing a theory on active transportation.

The theory was created by analyzing existing research on active transportation best practices, in addition to examining the history of active transportation in two case study cities in the western U.S. Interviews of working professionals were conducted, and the theory grew out of documenting a compilation of reoccurring themes in the research and in the case studies. The compilation was then submitted to professionals for verification and validation.

The final phase of this research also demonstrates how these prerequisites can be applied to the landscapes of Cache Valley, UT and how they can be spatially defined.
This modeling exercise provided an important opportunity to validate and scrutinize the theory through visual observations instead of merely conceptual inferences. This exercise also demonstrated that the theory recommendations are repeatable.

The theory developed in this research lays the foundation for decision makers to integrate active transportation into their transportation plans. By providing a list of prerequisites that can guide the development of active transportation in communities, this thesis offers an initial step in rethinking transportation opportunities in western towns and cities.
CHAPTER II
LITERATURE REVIEW

The benefits active transportation has on people and their communities has been the topic of many papers from an array of different disciplines. Articles on active transportation have been found in medical journals, as health professionals have begun researching and exploring the myriad benefits associated with incorporating physical activity into transportation choices. Active transportation has also been the subject in many landscape architecture and urban planning journals, as its effects on urban design and city development have become topics of discussion. Active transportation is also an important component within the field of sustainability and natural resources because of the potential it has to lower the carbon footprint of cities.

The compilation of research done within the field of active transportation have made discoveries not only in health, urban design, and sustainability, but also in user preference and the evolving designs and best practices. There are street design guides available now that outline new standards for active transportation facilities, including lane widths, street configuration and design controls. These design standards are critical components in the quest to institutionalize active transportation in the streets of our cities.

This literature review will delve into the benefits and best practices of the different modes of active transportation in order to create a baseline of understanding for the entirety of this research. It is important to note that this literature review represents current best practices and design standards. These standards are not static and will continue to evolve over time.
Benefits and Best Practices for Cycling

Bicycles are still considered the most efficient mode of transportation in the world today. Thirty-five calories are burned for every mile traveled on a bicycle; whereas 1,860 calories are required to travel that same mile in a personal car (Lowe, 1989). There are many benefits to cycling that range from positive physical health impacts to increased mental health effects. The physical health benefits often associated with cycling include, but are not limited to, lower overall body fat content, increased energy, decreased risk of mortality, increased work productivity and increased energy levels (Saelens, Sallis, & Frank, 2003). The general range and amount of these benefits experienced by an individual vary, depending regularity of cycling and intensity of those cycling sessions.

However, it is undebatable that cycling on a regular basis, as one might do commuting to work by bicycle, has positive health benefits. One study suggested that “bicycling to work decreased risk of mortality in approximately 40% after multivariate adjustment, including leisure time physical activity” (Andersen, Schnohr, Schroll, & Hein, 2000, p. 1624). Another study suggested that the health benefits of cycling outweigh the risks often associated with cycling. The “beneficial effect of increased physical activity due to cycling resulted in about nine times more gains in life years than the losses in life years due to increased inhaled air pollution doses and traffic accidents” (de Hartog, Boogaard, Nijland, & Hoek, 2010, p. 1112).

Best practices for cycling infrastructure in the U.S. has been developing over the past decade and are inspired mostly from European designs. In the 1970s and 80s many cities of the U.S. promoted “vehicular cycling,” which required little additional cycling
infrastructure because cyclists rode with vehicular traffic. Throughout this cycling era city planners, officials, and cycling advocates alike believed that cyclists fared best when they acted and were treated as drivers of vehicles. In the late 1990s, city planners began to realize that vehicular cycling was not encouraging and promoting cycling to many people. Cycling fatalities were a common occurrence in many cities, and in general, people reported feeling uncomfortable riding a bicycle. Utility cycling was rare, unsafe and generally avoided.

Realizing that vehicular cycling was not an acceptable plan for cycling and dissuaded people from riding a bicycle, many city planners looked to Europe for design standards. They discovered that many cities in Europe with a high cycling modal splits had been separating cyclists from motor traffic through infrastructure design. This idea of separation, although simple in concept, had huge implications for utility cycling in the U.S. Since then, U.S. has been working to emulate the famous cycling cities of Europe, such as Copenhagen and Amsterdam, and design facilities that separate cyclists from vehicles.

Many studies have been done to examine bicycle infrastructure preference amongst cyclist. Roger Geller of Portland, Oregon, conducted a study in 2009 that categorized U.S. cyclists into four categories: strong and fearless, enthusiastic and confident, interested but concerned, and no way no how (Geller, 2009). The Interested but Concerned category consisted of 60% of the survey group, and this category is “founded on this experience of other countries that have created extensive cycling systems, as well from a basic assumption that under conditions where people feel safe
and where bicycling makes sense, they will ride” (Geller, 2009, p. 5).

While Geller’s research indicates that cyclists and potential cyclist have a preference of the type of cycling facility they would like to use, based on perceived sense of comfort, it does not specify which types of facilities are safer than others. According to Harris et al. (2013), protected bike lanes reduce bike-related intersection injuries by about 75 percent compared to comparable crossings without infrastructure. A separate study found,

In 2007, the city of Seville, Spain, rapidly connected a network of protected bike lanes. They grew the bike network from 7.5 miles of protected bike lanes in 2006 to 94 miles in 2013. During the same time period the number of bike trips grew 435 percent from 3 million in 2006 to more than 16 million in 2013. At the same time, the risk of being involved in a crash with a motor vehicle dropped 61 percent. (Marqués, & Hernández-Herrador, 2016, p. 188)

By today’s standards, cycling infrastructure should protect the user from vehicular traffic as often as possible, ensuring they feel safe in the roadway (Caulfield, Brick, & McCarthy, 2012). Completely separated facilities are preferred, but if that is not possible, buffered facilities are acceptable (see Appendix A for protection examples). A rating used to determine the comfort of a bicycle facility is called Level of Traffic Stress (LTS). LTS assigns a ranking to a road based on speed limit, presence of a cycling facility and traffic volume. The ranking is 1 through 4, with 1 being the lowest stress and 4 being the highest stress. Level of traffic stress 1 (LTS 1) is meant to be a level that most children can tolerate; LTS 2, the level that will be tolerated by the mainstream adult population; LTS 3, the level tolerated by American cyclists who are “enthused and confident” but still prefer having their own dedicated space for riding; and LTS 4, a level tolerated only by those characterized as “strong and fearless” (Mekuria, Furth, & Nixon, 2012). An
example of a bicycle facility in the LTS 1 ranking would be a separated bicycle path, while a facility with an LTS 4 would be a shared shoulder without a “sharrow” or other marking. While most adults in the U.S. would prefer bicycling in an LTS 2 or less, most bicycle facilities are LTS 3.

The National Association of City Transportation Officials outline a comprehensive list of cycling infrastructure best practices in their 2014 Urban Bikeway Design Guide. The guide is based on the experience of some of the most recognized cycling cities in the world, defining design standards, while illustrating best practices for conventional bike lanes, buffered bike lanes, contra-flow bike lanes, cycle tracks, bicycle intersection treatments, and bicycle signals.

This research recognizes preceding research that suggests there will be higher volumes of cycling and fewer cycling fatalities when there is a greater level of separation between the cyclist and the vehicular traffic. Implementing cycling facilities that are low-stress for the user, falling into the ranking of LTS 1 or 2 have been shown to increase cycling. Physical separation from vehicular traffic is preferred whenever possible.

**Benefits and Best Practices for Walking**

The Centers for Disease Control (CDC) recommend that adults get 30 minutes of modest physical activity at least five days per week. In 2014, less than half of all American’s met that recommendation (CDC, 2014). Additionally, U.S. Department of Health and Human Services (1996) reports that physical inactivity accounts for as much as 23% of all US deaths from major chronic diseases. Thirty minutes of physical activity
equals roughly one and half miles of walking. Again, the health benefits of walking are similar to those of riding a bicycle, including reduction of body fat, and lower reported rates of depression. Frank et al. (2006) discovered that,

A 5% increase in walkability to be associated with a per capita 32.1% increase in time spent in physically active travel, a 0.23-point reduction in body mass index, 6.5% fewer vehicle miles traveled, 5.6% fewer grams of oxides of nitrogen (NOx) emitted, and 5.5% fewer grams of volatile organic compounds (VOC) emitted. (p. 110)

Couple these reported benefits with the fact that according to a 2001 National Household Travel Survey (NHTS), nearly 48% of all 2001 trips in the U.S. were under 3 miles (Hu, P., & Reuscher, T., 2004). It is clear that walking could be implemented into American’s lives either for utility or recreational purposes.

The benefits of walking are extensive. As a form of transportation walking could potentially replace upwards of 20% of trips in the U.S. What can city planners do to help encourage more walking? What are the design standards that are known to increase walking as a modal split? One study suggests that “the presence of sidewalks, busy streets, enjoyable scenery, and hills promote walking” (Brownson, Baker, Housemann, Brennan, & Bacak, 2001).

Attractive, connected sidewalks truly catalyze walking behaviors observed in urban areas by creating inviting places that provide an experience rather than simply a transportation mode. According to the National Association of City Transportation Officials (NACTO), “sidewalks play a vital role in city life. As conduits for pedestrian movement and access, they enhance connectivity and promote walking” (NACTO, 2013, p. 37). It is universally agreed that sidewalks must be present in order to increase
walking. In recent years, the sidewalk has become a transportation design feature, in and of itself. NACTO, in their Urban Street Design Guide, has set a minimum design standard of 5-foot sidewalk in urban cores, enough room that two people can comfortably walk side by side. However, the guide goes on to recommend much wider sidewalks for increased comfort and ease of access.

Sidewalks are only one component of walking best practices. Sidewalks must be connected with safe street crossings. The NACTO guide encourages intersection designs to be as compact as possible, prioritizing pedestrian movements to the highest degree, through curb extensions and pedestrian safety islands (see Figure 4). The guide goes on to recommend that intersections should have highly visible delineations between pedestrians, bicycles, and vehicles. Signal timing plays a crucial role in overall safety of the intersection; it is recommended that signals be enhanced to incorporate all modes of travel expected at the intersection.

Mid-block crossings are referenced as facilitating crossings to places that people

![Figure 4. Curb extensions and pedestrian refuges (source: www.gcpvd.org).](image_url)
want to go but that are not well served by the existing network. As demonstrated in Figure 5, if a mid-block crossing is warranted in a certain area, it is recommended that the crossing be raised and be augmented with overhead, pedestrian activated lighting, such as hawk lighting or Rectangular Rapid Flash Beacons (NATCO, 2013).

Benefits and Best Practices for Public Transit

Cheng and Chen (2015) suggest that,

As public transportation is regarded as a solution to problems related to difficult mobility in cities, a user-friendly public transportation system should consider the accessibility to public transportation stations, the mobility of the public transportation system, and seamless connectivity with various other transportation systems. (p. 386)

Public transit\textsuperscript{2} is the important link that ties together the other forms of active transportation, by providing longer distance travel options. The benefits of public transportation can be quantified in personal health, as well as environmental health.

Some studies have suggested that public transportation provides an opportunity to

\footnotesize{Figure 5. Hawk lighting (source: www.fha.gov).}

\textsuperscript{2} This research uses the phrase “Public Transit” to refer to buses and trains. The phrase “Public Transportation” is synonymous with “Public Transit”
introduce routine, daily physical activity into the lives of large groups of people and thus can be thought of as an important population health intervention tool (Wasfi, Ross, & El-Geneidy, 2013). Public transportation is also much less expensive for the user than owning a personal vehicle, providing a much more affordable mobility option, and saving a citizen upwards of $9,000 annually.

In terms of environmental impact of public transportation, according to the Federal Transportation Association (FTA) in 2010, public transportation demonstrates significant greenhouse gas emissions savings (see Figure 6).

Leading the way is heavy rail transit, such as subways and metros, which produce 76% less in greenhouse gas emissions per passenger mile than an average single-occupancy vehicle (SOV). Light rail systems produce 62% less and bus transit produces 33% less (FTA, 2010). Transit greenhouse gas emissions per passenger mile are still significantly lower than those from driving, even taking into account emissions from construction, manufacturing, and maintenance. Efficiency of public transportation increases as ridership increases.

Figure 6. Estimated CO² emissions per passenger mile for transit and private autos (source: www.transit.dot.gov).
The documented best practices within public transportation include efficiency measures within the realms of accessibility, mobility, and connectivity with other modes of active transportation (Cheng & Chen, 2015). NACTO (2013) goes on to point out that supporting transit entails considering every passenger’s trip from start to finish. Dedicated transit lanes, appropriate base signal timings, and operational traffic improvements insure that transit modes (bus, streetcars, light rail) experience minimal wait times at intersections and can move freely regardless of traffic congestion (NACTO, 2013). Transit stops are another component of streetscape design that can encourage or hinder ridership. Well-designed transit systems will have shelters incorporated into the system, as well as bike parking, lighting and legible transit information and maps. Bus bulbs and in-line transit stops, demonstrated in Figure 7, are recommended if the stop is located in a place where merging into traffic may be difficult.

The benefit and best practices of active transportation outlined in this section provide context for this thesis. While most of the best practices described are not necessarily design requirements, there is research outlining their relative effectiveness.

*Figure 7. Example of a bus bulb (source: www.streetsblog.org).*
CHAPTER III

METHODOLOGY

This research sought to determine how cities of the western U.S. prepare their urban landscape for a comprehensive active transportation network. A literature review as well as documentation of significant elements shaping the active transportation network in two case study cities of the western U.S. was conducted. The key elements gleaned from the case studies and literature review were documented. The list of key elements was identified as prerequisites and necessary components for an active transportation network in similar western cities. The prerequisites were used to create recommendations for Cache Valley, UT, spatially and conceptually.

To accomplish these tasks within the research, a mixed-method approach was used. The steps are discussed in the following sections. Figure 8 outlines the research process.

Research Questions

This thesis began with two initial scoping questions about active transportation that were based on prior interests, discussions, and research: What are the unique challenges the western U.S. faces when building active transportation and are there best practices to use as guides? What are the components of a comprehensive active transportation network? These questions guided the literature review.
Figure 8. Process diagram
Literature Review

With the two research questions serving as a basis for discovery, a comprehensive literature review to understand the best practices and benefits of active transportation was completed. Database search resources available through the Utah State University Library were used to complete a comprehensive key word search, including: Scopus, Web of Science, Science Direct, and Academic Search Premier. Key words searched were: “active transportation,” “active transportation networks,” “bicycle commuting,” “pedestrian networks,” “public transportation accessibility,” and “land use and active transportation.”

Scope

The scope of this study was determined to be the western U.S. because of its unique geography, landscapes and city design. The western U.S. also has significant cultural differences that effect decisions, policies, and perceptions of active transportation. The case study cities were determined to be Boulder, CO, and Portland, OR, based the following criteria for selection.

- Located in the western U.S.
- Over 20% active transportation mode-share split (bicycle, walk, and public transit). See Figures 9 and 10.
- University present in the city.
- One major edge of the city abutting a mountain range.
Figure 8. Modal split in Portland, OR (source: U.S. Census Bureau, 2014).

Figure 9. Modal split in Boulder, CO (source: U.S. Census Bureau, 2014).
Focus Research Question

Once the literature review was complete and the scope of the research established, the research questions were reconfigured into one question that encompassed the scope of the work and the intent of the research. The original questions established a base for the literature review, but they evolved with the scope of the research. The focused research question was determined to be: How do cities of the western U.S. prepare their urban landscape for a comprehensive active transportation network?

Case Study Data Collection

The case study data collection phase served as an opportunity to observe and document how cities of the western U.S. have implemented active transportation into their urban landscape. The data collection occurred in three separate ways, as discussed below.

Case Study Analysis

Once the case study cities were chosen, a site-specific literature review and analysis for both of the cities was conducted. Each city’s planning division was researched and important policies that related to active transportation were examined. Master plans were also inspected and information about active transportation in each city was aggregated into a list.

Site Visits

The next stage involved a site visit to Boulder, CO, and Portland, OR, to examine
the active transportation facilities and infrastructure, in person. The site visits differed in nature, but both involved city exploration. The Boulder, CO, visit occurred in May 2015 and involved a full day, comprehensive tour of Boulder city on foot, on bicycle, and on the public transportation system. A transportation planner for the city of Boulder was present to answer questions about the active transportation network. The site visit to Portland occurred in April 2013 and involved a 2-week visit to the city without a personal vehicle. All trips made throughout the 2-week period were made on a bicycle, by foot, or on public transportation.

**Interviews**

After the site visits were complete, interviews with transportation planners in Boulder, CO, and Portland, OR, were conducted to create a backcasted documentation of significant events and legislation, in chronological order, which helped establish the active transportation network that both cities have today. A transportation planner in both cities and asked the following questions.

1. Your city has a relatively high active transportation mode-share split. What were the historical decisions, legislation, grassroots movements and champions that were critical in making this happen?

2. Were there specific decisions made that had a greater impact than others?

3. Were there decisions or ideas that were not effective in promoting active transportation?

4. Were there people in government that advocated for active transportation infrastructure, or did the momentum generate from grassroots movements?

5. What is the city’s annual budget for active transportation (infrastructure construction and maintenance, education, advocacy)?

The purpose of the interviews was to fill in any gaps in knowledge after the case
study analysis and site visits. The planner’s insight could offer unique perspectives on how the city they represented evolved to become active transportation friendly. They could also provide additional information illustrating the history of active transportation in the city such as, historic master plans, and the names of influential figures.

**Grounded Theory**

Once the case study data collection phase was complete, all of the information was inspected and analyzed. The analysis involved identifying and documenting reoccurring themes present throughout the entire collection of data, producing grounded theory detailing the prerequisites and necessary components of active transportation networks in western cities. Forty-one prerequisites were discovered within four different categories: city-wide policy elements, bicycle elements, walking elements, and public transportation elements. Each element was assigned a priority level based on:

- Whether or not its historical significance shaped the progression of active transportation into the future.
- Whether or not it had the capability of directly influencing subsequent active transportation policy.
- Whether or not it occurred in both the case study cities.

A “High” priority indicated that all three criteria were met, and “Medium” priority meant that two out of the three criteria were met, and a “Low” priority meant that one out of the three criteria were met.

“Grounded theory offers tools to get at varied constructions or competing definitions of the situation, as given in action, not merely stated in reconstructed accounts” (Charmaz, 2006, p. 180). Charmaz defines grounded theory as a process that
encourages researchers to interact with data in an iterative fashion. She asserts that grounded theorists should not allow some of the rigid definitions of what is considered genuine grounded theory distract from the processes intent. Charmaz challenges her readers to think of grounded theory as a comprehensive exploration of a topic in order to unearth connections and themes (Charmaz, 2006). “Grounded theory involved taking comparisons from data and reaching up to construct abstractions and simultaneously reaching down to tie these abstractions to data” (Charmaz, 2006, p. 181).

This research applied Charmaz’s concept of grounded theory by documenting and categorizing reoccurring themes that surfaced throughout a comprehensive data gathering and interpretation phase. The broad exploration of active transportation best practices conducted in the literature review of this research, coupled with the data collection and interpretation done throughout the case study phase of this research resulted in a list of common themes or elements important for active transportation. I assert that Charmaz would consider these common themes as “abstractions,” and as such, the process of using the data to induce these abstractions while using the data to defend abstractions, a grounded theory is produced.

**Expert Validation**

The prerequisites list developed in the previous step was then vetted by the planning professionals interviewed in previous stages of this research as well as a planning professional working in Cache Valley, UT. They were asked to provide feedback on the prerequisites. If they had critique that needed to be considered the
prerequisites were reworked, then resubmitted to the experts a second time. This step served as confirmation that the recommendations produced through this research were accurate and relevant.

**Alternative Future for Active Transportation in Cache Valley**

In this stage the existing transportation conditions and plans in Cache Valley were documented, then the active transportation prerequisites were spatially modeled for the study area. This stage served as a visioning exercise—what should happen in Cache Valley to prioritize active transportation, and what that prioritization could look like.

**Implementation and Monitoring**

Although this final phase in the process was considered outside of the scope of this thesis, it is important to draw attention to it as a part of the holistic process. The recommendations in the plan for active transportation in Cache Valley should be considered and integrated into the development of Cache Valley by those agencies responsible for planning the future growth of the area. Once the recommendations are implemented they should be monitored on a semiregular basis (to be determined). Success or failures should be documented, and best practices from case study cities should continually be examined and implemented if appropriate.
CHAPTER IV
RESULTS

Case Study Data Collection

The case study data collection portion of this research resulted in a thorough examination of the two different case study cities: Portland, OR and Boulder, CO.

Portland, Oregon Overview

Portland, Oregon is the seat of the Multnomah County, Oregon (see Figure 11). Portland is located in the Willamette Valley Region of the Pacific Northwest.

The city of Portland has an area of 145 square miles and had a recorded population of 609,456 people in 2013 (U.S. Census Bureau, 2016). It is projected that the area will see an increase in population between 56 and 74 percent by 2035 U.S. Census Bureau, 2016). The city is situated between a mountain rage and a major river, with an additional major river effectively cutting the city into two physical halves. The northwest edge of Portland abuts the Tualatin Mountains, with the Willamette River running north.
to south, dividing the city in half. The Columbia River runs west to east, making up the north edge of the city. Portland is home to 19 four-year universities and colleges, varying in enrollment from 84 up to 25,959. Portland’s economy is based primarily on steel, technology and business.

According to the Oregon Department of Environmental Quality (2014), Oregon emitted 60.1 million metric tons of carbon dioxide equivalent (Million MTCO₂E) into the atmosphere in 2014. 36.8% or 22.1 Million MTCO₂E of that was produced by transportation (see Figure 12).

According to the U.S. State of Obesity Report (2015), Oregon has an adult obesity rate of 27.5% (according to 2014 data). The report rated Oregon 34 out of the 51 states in the U.S. in terms of adult obesity. From 2013-2014, the rate of adult obesity in Oregon increased from 26.5% to 27.5%.

**The state of active transportation in Portland, Oregon.** Portland is considered active transportation friendly. According to the 2010-2014 U.S. Census American

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<td>Total Emissions</td>
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*Figure 11. Oregon emissions by sector (Oregon Department of Environmental Quality, 2014).*
Community Survey, 23.8% of all trips to a workplace were made utilizing active transportation (bicycling, walking, public transportation) with 58% of all trips to work being single occupancy vehicle trips (drove alone). Of that 23.8% using active transportation 5.7% walked, 6.3% bicycled, and 11.8% used public transportation (bus, metro or light rail).

**Bicycling as a modal split in Portland, OR.** As of January 2016, Portland Oregon was named a “platinum” bicycle friendly community by the League of American Bicyclists—its second highest rating. Portland boasts 350 miles of bikeways. 77 miles of those 350 miles are considered Neighborhood Greenways, 188 miles are bike lanes, 85 miles are paths, and 17 miles are separate bicycle facilities, including 6 cycle tracks and 17 buffered bike lanes. 19 signaled intersections in Portland have bicycle-specific timing in increase cycling efficiency. There are over 6,500 bike racks including 134 bike corrals throughout the city.

Portland has a comprehensive Safe Routes to School Program, which services 40 schools. The program aims to educate the students on bicycle safely, emphasizing how to ride properly and what safety equipment to wear. The walking and bicycling modal split for participating Portland schools increased from 31% in fall 2006 to 44% in spring 2014 for K-5 student trips (Oregon Metro, 2016). Spring 2014 data show that students living within a mile of school were walking, biking, or rolling (roller blading or skate boarding) for 58% of trips, and those within 0.5 miles were using an active mode for 73% of trips (Portland Vision Zero Action Plan, 2016). The Safe Routes to School program also assists schools design pick-up and drop-off areas that are more efficient and do not
encourage unnecessary idling.

Portland, OR has undergone three iterative bicycle planning efforts which have helped shape cycling in the city over the past 40 years. The three separate plans were adopted by the City Council in 1973, 1996 and 2010, respectively. Overarching goals for the Portland Bicycle Plan for 2030, adopted in 2010, are (see Figure 13):

- Attract new riders
- Strengthen bicycle policies
- Form a denser bikeway network
- Increase bicycle parking
- Expand programs to support bicycling
- Increase funding for bicycle facilities

Portland will be launching a bike share program in July 2016. Known as BIKETOWN, the bike share program will service the downtown Portland area, as well as the surrounding neighborhoods. Ideally, BIKETOWN will attract many new people to Figure 13. Portland bicycle plan (Portland Bureau of Transportation, 2010).
cycling by providing easily accessible bicycles at stations near major attractions, population centers, universities, and metro stops. A study and survey conducted in Minnesota discovered that 76% of respondents rode a bicycle one a week or more after they joined the local bike share program, compared the 39% that road one a week or more before joining (Nice Ride Minnesota, 2014). BIKETOWN will have an annual membership cost that has yet to be determined.

The BIKETOWN program in Portland is partnering with Motivate, a national bike share bicycle supplier. It will also be using Social Bicycle (SoBi) technology, a “smart-bike” approach that integrates the locking mechanisms on the bike, instead of on the docking rack, reducing cost and needed space at the racks. Portland’s BIKETOWN will be rolled out with 1,000 bicycles accessible at 100 stations throughout the city (see Figure 14).

**Walking as a modal split in Portland, OR.** Walking as a form of urban transportation is a viable option for people of downtown Portland. The high-density
building patterns and compact, 200-feet-long city blocks make walking feasible for those living and working in the downtown region. Portland supports a rather extensive and comprehensive sidewalk network in the downtown area and the neighborhoods surrounding downtown. However, the sidewalk connectivity in the neighborhoods to the east and west of downtown is less comprehensive and could be improved.

Portland has embraced the 20-minute neighborhood concept, which has helped the city towards becoming more walkable. 20-minute neighborhoods are characterized as having a vibrant mix of commercial and residential establishments within a 1-mile walking distance (Initiative for a Competitive Inner City). By putting amenities within a 1-mile radius of most community members, they are more likely to walk and bike simply because it is more convenient. The mayor of Portland, Sam Adams, stated, Portland is:

“Working to make every section of Portland a complete 20-minute neighborhood to strengthen our local economy. Two-thirds of all trips in Portland and in most American cities are not about getting to and from work. So, if I can offer quality, affordable goods and services, eliminate food deserts, have neighborhoods with schools and parks and amenities—if I can create these 20-minute neighborhoods all over Portland—it strengthens our local economy. (S. Adams, personal communication, June 18, 2010)

In addition to having a comprehensive sidewalk network within the urban area, Portland is also continually expanding its interurban and nature trail system. Although studying walking for the soul purpose of recreating is outside the scope of this thesis, these trails enhance the connectivity of areas within the city while increasing walkability in general. To date Portland has over 152 miles of completed regional trails that circumnavigate the surrounding mountains, follow riparian corridors, and provide access to the urban centers (see Figure 15). All of the trails in Portland are considered multi-use
Figure 13. Map of trails in Portland (Portland Bureau of Transportation, 2016).

trails, meaning they are designed for active transportation use, including walking and bicycling.

The Springwater Corridor is an example of a multi-use path that increases active transportation connectivity in Portland. It is an uninterrupted 21.5-mile multi-use trail that consists of both paved and unpaved sections. It connects the southeast neighborhood quadrant to the downtown core, completely separated from vehicular traffic. Certain parts of the trail parallel the Willamette River, making the route tranquil and enjoyable. The right-of-way for the trail was acquired by the city of Portland from the railroad company in the 1990s. Before it became a trail, it existed as a rail easement (see Figure 16 and 17).

Using public transportation as a modal split in Portland, OR. In Portland 11.8% of all trips to a work place are done using public transportation. Out of the three
Figure 14. Cyclist riding the Springwater corridor trail.

Figure 15. Pedestrians on the Springwater Corridor trail.
modes of active transportation, public transportation modal split is the greatest. Portland is served by the Tri-County Metropolitan Transportation District of Oregon, identified as TriMet, as well as the Portland Streetcar.

TriMet was created in 1969 by the Oregon legislature and operates the Portland region’s bus system, light rail lines, WES Commuter Rail and LIFT paratransit service. TriMet provides transportation public transportation options for thousands of Portland-area residents every day. According to TriMet, it operates more than 649 buses on 79 bus routes, with 7,000 bus stops. The MAX Light Rail system stretches 52 miles and serves 85 stations with 127 light rail vehicles. TriMet provides 11,200 parking spaces in 31 Park & Ride lots around the region (see Figure 18).

As of 2015, TriMet reported that it has a total operating budget of over $530,000,000. Over half of that funding comes from local payroll taxes, a quarter comes from passenger revenue, with additional funding needs being met through federal grants and other sources.

The Portland Streetcar is the second public transportation entity that services the Portland region. The Streetcar is a partnership between TriMet and the city of Portland and is considered a non-profit organization. The Streetcar has two lines and in 2014 it serviced 5.6 million people.

According to a recent TriMet survey, 78% of TriMet riders are considered “choice” riders, meaning they own a car but opt to use transit. TriMet is responding to this by increasing accessibility and creating more options servicing high-demand areas. Future goals of the TriMet and Portland Streetcar system include the following.
Figure 16. TriMet transit routes.
• Making it easier to pay for a transit pass. TriMet will be introducing a Hop Fastpass in 2017. Hop Fastpass is a new tap-on, tap-off electronic fare system that will work with a fare card, smartphone (using services like Apple Pay, Android Pay, and Samsung Pay)

• Introducing a Bus Rapid Transit (BRT) system. Powell-Division Corridor is considered one of the regions busiest and most congested corridors—A BRT system is proposed to be installed on this corridor as early as 2020. The proposed system will streamline mobility throughout this corridor.

Addressing the needs on the Southwest Corridor. Light rail and Bus Rapid Transit are two options being considered to improve the transportation system in the corridor that runs north-south from Downtown Portland to Tualatin and east-west from Lake Oswego to Beaverton.

**Boulder, Colorado Overview**

Boulder City is the most populous municipality located within Boulder County Colorado (see Figure 19).

In 2010 Boulder had a reported population of 97,385 people, within the 25.68-mile area of the city. The city is expected to experience a one percent annual growth rate over the next several years (U.S. Census Bureau, 2010). Boulder is located at 5,430 feet,
in the foothills of the Flat Iron Mountains of the Rocky Mountain range. Boulder has five major perennial creeks that meander through the city: Fourmile Canyon Creek, Wonderland Creek, Boulder Creek, Skunk Creek, and Bear Creek. All of their headwaters originate west of the city in the Rocky Mountain range. South Boulder Creek parallels the eastern edge of the city and runs south.

Boulder City has a 27,000-acre dedicated greenbelt that creates and open-space buffer zone surrounding the city that will remain unbuilt. The city purchased the land using revenue from some dedicated open space sales taxes. To date, the city has acquired approximately 6,100 acres of Mountain Parks lands, approximately 2,700 acres of other park lands, approximately 29,000 acres of Open Space, approximately 480 acres of utility lands, for a total of 38,500 acres. The Boulder County Open Space Program now owns over 54,000 acres of open space land.

Denver, the capital of Colorado, is located 25 miles northwest of Boulder. There are 5 colleges and universities in Boulder, including University of Colorado Boulder—Colorado’s largest University. Boulder supports an array of industries that bolster the local economy, including: aerospace industry, bioscience, natural product development and outdoor recreation.

According to the Colorado Department of Public Health and the Environment, Colorado emitted 130 million metric tons of carbon dioxide equivalent (Million MTC02E) into the atmosphere in 2010. 23% or 30 Million MTC02E of that was produced by the transportation sector (see Figure 20).

According to the U.S. State of Obesity Report, Colorado has an adult obesity rate
of 21.3% (according to 2014 data). Colorado has the lowest obesity rate in the nation for adult obesity. From 2013-2014 the rate of adult obesity remained consistent in the state of Colorado.

The state of active transportation in Boulder, Colorado. According to the 2010-2014 U.S. Census American Community Survey, 29.1% of all trips to a workplace were made utilizing active transportation (bicycling, walking, public transportation), with 52% of all trips to work being single occupancy vehicle trips (drove alone). Of that 29.1% using active transportation 10.1% walked, 10.1% bicycled, and 8.9% used public transportation (bus, metro or light rail).

Bicycling as a modal split in Boulder, CO. Boulder has been named a Platinum rated city for bicycling according to the League of American Bicyclists, and its bicycle usage numbers have been steadily increasing throughout the years. According to a Home Travel survey completed by National Research Center, Inc. The number of Boulder residents who rode their bicycle at least once a day increased by 11% from 1990 to 2012 (National Research Center Inc., 2012), see Figure 21.
To date, Boulder has over 159 center-line miles of bicycle facilities that are well connected and heavily used. These facilities include on street bike lanes, contra-flow bike lanes, designated bike routes, dedicated paved shoulders, multi-use paths and soft-surface paths. A unique element of Boulder’s cycling infrastructure is the active transportation underpasses. Boulder just completed its 80th multi-use path underpass this year. The underpasses are a critical component of the cycling infrastructure because they allow cyclists to completely avoid major vehicular intersections by going under them, using active transportation tunnels. The underpasses also functioning as flood hazard mitigation (see Figure 22).

Boulder has worked to become a national leader in innovative bicycling infrastructure and facilities. One way the city is doing this is through their Living Lab program. This program makes the city streets of Boulder the laboratory for new street designs that prioritize active transportation. The Living Lab program facilitates the implementation of new active transportation amenities throughout the city on a trial basis. User feedback and input are sought in order to improve the design based on relevant,
place specific data. The program was introduced in 2014 and since its inception seven projects have been completed as Living Lab projects, six of which were cycling specific.

Because of the expansive, 8-mile greenbelt that surrounds the city, Boulder relies heavily on trains and buses to bring people into the city. The city realized that this might create a barrier to cycling. Therefore, in order to help alleviate that barrier, the city has constructed four Bus-Bike Shelters at major transit hubs throughout the city. These shelters are designed to provide long-term, secure, bicycle storage conveniently located at the bus and train stations. These shelters serve as important “first-last-mile” solutions. By providing secure bicycle storage the city is encouraging citizens to ride to transit nodes, take the bus to final destination, then repeat that process in reverse at the end of the day.
Since 2005 Boulder has been a recipient of federal Safe Route to school funds. The Boulder Valley School District has received close to $200,000 for cycling education and outreach. Throughout the Boulder Valley there are over 31 schools that leverage the federal funding to encourage and education students on walking and biking to school.

Boulder is home to Boulder B-cycle, the local bike share program. The program was implemented in 2011 with over 20 active sponsors. Boulder B-cycle is designed to be flexible, users can choose the membership that is right for them based on their projected use. There are 40 stations dispersed throughout the city with over 300 bicycles for rent (see Figure 23). In 2014 43,143 trips by 7,374 riders were logged, an increase of 43% over 2013 figures. 82% of the trips were under 30 minutes, and 85% of passes sold were of the 24-hour variety (Boulder B-cycle 2014 annual report).

![Figure 21. Man using the Boulder B-cycle program.](image)
Goals to continue improving cycling in Boulder include the following (derived from the 2016 Boulder Transportation Report on Progress).

- Continue planning East Arapahoe, Canyon Boulevard, 30th Street and Colorado Boulevard corridors, including opportunities to develop the Bicycle 2.0 Low Stress Network.

- Complete construction of current capital projects such as the Diagonal Highway, 28th Street and Baseline multimodal projects as well as new projects such as North Broadway.

- Bicycle 2.0 Low Stress Network: in coordination with corridor plans, identify opportunities to enhance local bikeways for cyclists of all ages and riding abilities.

**Walking as a modal split in Boulder, CO.** In April 2014, the city of Boulder was recognized as a Gold-level Walk Friendly Community by the Walk Friendly Communities group. 10 percent of commuters walk to work in Boulder, which is a very high modal split for the intermountain west.

Boulder has a very rigid urban growth boundary which was established in the 1960s. This boundary has caused the city to become very dense, virtually eliminating sprawl within the city limits. The population density was most recently reported at 3,900 people per square mile. This density has benefited the walkability of Boulder; the 20-minute neighborhood concept is a reality in many parts of the city.

As was stated previously, Boulder has an extensive multi-use path network, with over 58 miles of path complete. These paths have been designed to link employment opportunities to transportation hubs, to more residential areas (see Figure 24). In addition to paths, Boulder has roughly 145 miles of natural hiking trails that crisscross the open space and mountains surrounding the city.

Boulder officials work to engage citizens in letting them know what work needs
Figure 22. Boulder active transportation paths and trails.
to be done to complete missing links in the sidewalk network. This engagement process is orchestrated through the Missing Sidewalk Links program. This program identifies and prioritizes funds to construct missing sidewalk segments in order to complete the network. Community members are the voice in the Missing Sidewalk Links program and to date they have identified over 74 missing connections.

Future goals to encourage more walking in the city of Boulder include (derived from the Boulder Transportation Master Plan).

- Providing a continuous sidewalk and multi-use path network so that pedestrians never stranded or forced to walk in dangerous areas.
- Ensuring a safe walking environment through adequate maintenance, snow removal, vegetation trimming and lighting.
- Providing routine education and enforcement on the rights and responsibilities of pedestrians, bicyclists and vehicle drivers.

**Using public transportation as a modal split in Boulder, CO.** The Boulder community transit network is a partnership between the Colorado Regional Transportation District and Go Boulder (Boulder’s active transportation division). The Regional Transportation District provide routes connecting passengers to Boulder from surrounding urban centers such as, Fort Collins and Denver. Go Boulder provides a robust transit system within the city of Boulder. Ridership on Boulder’s local transit routes has grown 300% since 1990 (Boulder Transportation Report of Progress, 2016).

Boulder city’s transit system consists of a comprehensive selection of routes. The routes are known as the Hop, the Skip, the Jump, the Bound, the Dash, the Stampede and the Bolt. Wait time for any specific bus is usually less than 20 minutes at any point throughout the day. The cost of a fare varies between $2.60 for a one-way local trip to
$1,089 for an annual pass. In an attempt to subsidize the cost of an annual transit pass on the local transit network Go Boulder provides EcoPass to interested businesses and organizations in the city. EcoPasses are available to business and sold at a discounted rate when they are purchased in bulk (i.e., they are purchased by the participating business for all the full-time equivalent [FTE] employees at the business). There is also a Neighborhood EcoPass (NECO) program that provides discounted annual passes to participating neighborhoods, again, only if all households opt in.

In 2014, Boundary County conducted a feasibility study to examine potential options for offering the discounted EcoPass to members of the entire county. Several strategies were examined based on their cost, estimated ridership increase, revenue, and resulting benefits. The feasibility study will be incorporated into the City of Boulder’s Transportation Master Plan update as staff identifies future transit scenarios and investment strategies. As city staff and consultants analyze different future transit scenarios, options in which a community-wide Eco Pass program can be implemented will be explored (Countywide EcoPass Feasibility Study, 2014).

As has been mentioned previously, the city of Boulder is surrounded by an expansive greenbelt. This greenbelt in conjunction with the urban growth boundary have had some unintended consequences for the active transportation modal split. The urban growth boundary has created a developable land shortage in the city, which has resulted in extremely high property values. Although there are many recorded benefits to the growth boundary and greenbelt, they also have been cited as a cause of the affordable housing disparity. A majority of people who work in Boulder cannot afford to live in
Boulder. According to a 2008 study conducted by the Boulder Economic Council, only 32% of the Boulder workforce lives within Boulder city limits (Boulder Economic Council, 2008).

This data draw attention to the need for regional transit options in Boulder. A large majority of those commuting to Boulder are doing so on the I-36 corridor. I-36 connects Boulder with Denver, as well as many other, smaller urban centers in the area. In spring 2016, the Colorado Department of Transportation and Regional Transportation District completed a $317 million joint project that widened the I-36 corridor in order to accommodate a dedicated Bus Rapid Transit (BRT) and high-occupancy vehicle/toll lanes (HOT). This project was part of the FasTracks expansion program, which is a multi-billion-dollar public transportation expansion program, voted on by the eight Colorado counties currently being served by Regional Transportation District.

This BRT system is branded as the Flatiron Flyer and consists 59 buses scheduled on 18 miles of newly constructed dedicated BRT lanes arriving and departing the Boulder and Denver metro areas. The Flatiron Flyer project also enabled the construction of park-n-ride lots, totaling 4,200 parking spaces in six parking lots (see Figure 25).

As reported in the Boulder Transportation Report on Progress (2016), transit goals for Boulder include:

- Expansion of the I-36 BRT program to offer additional service times.
- Employ an evaluation process that recognizes the value of a “complete system” approach to transit development in Boulder and its surrounding communities.

Establish an ongoing collaborative process with transit partners to improve decision-making in service change implementation and enhance public involvement.
Figure 23. Flatiron Flyer route map.
Case Study Site Visits

Observations from Portland, Oregon
April 2013

I went to Portland in 2013 for a 2-week visit during the month of April. I was participating in a 2-week intensive course in bicycle mechanics at the United Bicycle Institute. During my 2-week visit, I lived with friends who graciously offered me a bicycle to use as transportation. This scenario was a perfect “test” to see how I could function for 2 weeks with a bicycle, walking and public transportation as my only available mobility options.

The first part of this test began with getting from my friend’s house to the United Bicycle Institute on the first day. I used Google Maps to map out a route. By using the “bike” transportation mode option, the recommended route (see Figure 26) took me through quiet neighborhoods, on bike lanes and on multi-use paths.

Upon first glance of the route I was surprised to see that, according to the map, my entire 9.9-mile trip was to take place on some type of bicycle facility. When I left on the first morning I gave myself an hour and a half to complete the stated hour-long trip. I was certain I would encounter difficulty of some type along the route, whether it be vehicle congestion on the roads, difficulty navigating, or traffic lights that were not timed to accommodate a bicycle.

The first part of the trip took me through a string of neighborhoods. The ride was very pleasant, I meandered along tree-lined streets, all budding and flowering in the cool spring morning. The city had designated this route as a neighborhood Greenway,
meaning vehicular traffic speeds were posted at under 25 mph; the large painted bike 
“sharrows” on the roads alerted drivers that bicycles (legally) had the right-of-way (see 
Figure 27). I noticed strategically placed wayfinding signs positioned at the bicycle scale 
(eye level with me as I was riding), indicating distances and times to major destinations. 

The next portion of my journey took me along the Springwater corridor multi-use 
path. The multi-use path was roughly 12-feet wide with a center strip to delineate the 
transportation directions. Most of the path was paved with asphalt, with a few short 
sections that transitioned to compacted, crushed gravel. Once I merged onto the path I 
was immediately surprised with the number of fellow riders sharing the path, all of which 
were adorned from head to foot with bicycle commuting attire. Their bikes were
equipped with fenders, racks and lights, it was very apparent that these people were commuting to work on their bike. Once on the path I quickly picked up the pace and was able to hold that pace for nearly four and a half miles. There were few, if any, interruptions to the path and everyone was moving efficiently and orderly.

The most enjoyable aspect of the ride, however, was not the speed at which I was traveling, it was the scenery all around me. The Springwater corridor hugs the bank of the Willamette River for a nearly four miles, giving the trail user sunning views of lush forests, the river, and downtown Portland.

The next portion of my ride transitioned from riparian active transportation corridor to urban riding, but never once did I feel like I was forced to fend for myself amidst vehicular traffic. The Springwater corridor transitioned into an inter-urban active transportation bike path that, again, followed the Willamette River. At this point there
were many more pedestrians sharing the 12-foot path. The trail became the Eastbank Esplanade and skirted around the Oregon Museum of Science and Industry and found itself on the west side of the I-5 Freeway. At this point in the journey downtown Portland was a bridge crossing away, therefore, there were places for cyclists to ride up in a circular “on-ramp” fashion and join the bridge to then cross over into downtown - the way was always marked with signs and arrows.

I continued on the Esplanade until the Moda Center (what was then known as the Rose Center), which is a large sporting complex for a few of the professional teams in the area. This area was a large vehicular interchange with four to eight lanes of traffic converging and turning in different directions. This was the only part of the ride where I felt nervous. As I continued along the route, I realized that my fears were unwarranted because there were still bicycle facilities there to use. Where there was no longer a dedicated path, there was a roomy, buffered bicycle land and bicycle left hand turn boxes, making the navigation of the interchange simple (see Figure 28).

The final portion of my ride consisted of a buffered bike lane paralleling a busier, 35 mph street. I rode through some interesting mixed-use developments, all of which had dedicated bike parking out front. Although it was not my favorite portion of the ride, it was functional and unintimidating. When I arrived at United Bicycle Institute I was surprised to discover that journey had taken me less than 52 minutes. My predictions about delays had been inaccurate, and I had actually completed the trip in less time than Google Maps predicted it would take me.

The rest of the 2-week trip on a bike was similar to the first ride—pleasant and
comfortable. I found that bike routes were ubiquitous throughout the city, and they were well marked, easy to find, and usually full of riders. There were certain roads that did not have cycling infrastructure, but they were easy to avoid, and did not fragment the system as a whole. My trip to Portland seemed to have been timed perfectly, as I only encountered 1 day of rain during the whole 2 weeks. To my surprise, on that day of rain, the bike facilities did not seem vacated, I noticed little difference in the number of cyclists on the rainy day than I did on the sunny days.

I also did a significant amount of walking while I was in Portland and felt a similar level of comfort as I did on the bike. Over the weekend I walked around
downtown for hours and felt comfortable in the urban landscape. Many of the
streetscapes were pedestrian friendly with wide sidewalks, and interesting things to
observe. I often felt surprised by what I found just around the corner, whether it be shops
or food trucks or small urban parks.

On the last day of my trip I experienced the public transportation system. I was
scheduled to leave from class and go directly to the airport, which meant I would not be
able to take the bicycle that day. I was able to catch one bus right down the street from
the house where I was staying. The bus stop was well marked and had a bench and
protective awning. The bus ride took me along the river and across a bridge into
downtown Portland, where I had to transfer and take a different bus to my ultimate
destination. The wait time between transfers was approximately 10 minutes, and it was
relatively easy to find the second bus. The whole trip from door to door took about one
hour and 15 minutes and cost me roughly $2.50.

At the end of the day I utilized the MAX (Portland’s light rail) to get out to the
airport. It was about a half an hour walk to the MAX station from the school (it should be
noted that I could have taken a bus to the MAX station, I chose not to). The station was
open-air and above ground with three sets of tracks converging. It took 30 minutes and 11
stops to go from the Rose Quarter Transit Center to the airport.

This extended site visit gave me an opportunity to experience the active
transportation network in Portland, Oregon. I took advantage of the comprehensive
bicycle network during my 20-mile, round trip commute to and from the school I was
attending. Over the weekend I locked up my bike and took to the streets on foot to
observe the wide sidewalks, short blocks, and pedestrian friendly streetscapes of Portland. On my last day in town I took a bus and the light rail out the Portland international airport. I would describe my experiences as mostly positive. When I was on a bike I never felt as though a bike lane ended abruptly - changes in the bicycle lane treatment were consistently well marked. When I was walking around the city I was able to interact with the city as pedestrian. There were interesting urban parks and plenty of mixed-use developments with shops and restaurants to experience (and spend money in). The bus system was relatively efficient and cost effective. It took me just 10 minutes more to ride the bus to my school as it did to ride there. The light rail to the airport was quick, inexpensive and heavily used.

**Observations from Boulder, Colorado**

**May 2015**

I conducted an intensive, 1-day active transportation site visit to Boulder Colorado in May 2015. The visit was part of a planning effort going on in Logan, UT; therefore, I was with a small group of Logan representatives, planning professionals, and city officials. The site visit involved utilizing all modes of active transportation, hearing from local transportation planning experts and having the opportunity to ask them specific questions about active transportation in Boulder.

We started the day on foot, walking around in the downtown area. One of the most noticeable and prominent pedestrian features in Boulder is Pearl Street, a four-block pedestrian mall in the heart of downtown (see Figure 29). Pearl Street was a pedestrian spectacle. The clean brick road, blooming trees, public seating, street musicians, flower
planters and lively store fronts made it easy to forget about time and stroll. Cycling is not allowed on Pearl Street, and that rule seemed to be well respected. We observed multiple cyclists dismount upon entering Pearl Street and walk. The street was inviting and full of life, even at 9AM.

We made our way one block south onto Walnut Street and observed the Downtown Boulder Station (see Figure 30). The large brick building took up one full city block and was bustling with activity. As we crossed the street to the station I looked down and noticed that the crosswalk was red and was a different material than the asphalt of the road. I realized that this was to help make the cross walk more visible, and therefore, the people in the cross walk more visible to the drivers of the vehicles. I also noticed a traffic signal for bicycles. The bicycle traffic light was timed to have cyclist
proceed through the intersection on their own right-of-way, avoiding a collision with right turning traffic.

Once across the road we made our way into the bus station. It was clean and inviting. We all boarded a “SKIP” bus and were on our way within moments. Our journey on the bus was quick, we exited just a few minutes later on Arapahoe street.

Next we made our way over to one of the 80 active transportation underpasses in the city of Boulder. All of these underpasses were installed with the intent of making biking and walking a very low stress option. Users of these tunnels go under major roads or interchanges, instead of having to negotiate them (see Figure 31). Because these underpasses could take on water during flood events, they were constructed with Boulder city funding, leveraged with FEMA funding. This partnership has been extremely
beneficial for the city and has provided the resources needed to complete the underpasses throughout the city.

Next, we headed over the University Bike Shop to rent bicycles to ride around the city. Once on our bikes we began pedaling around to take a look at some of the bicycle improvements the city has been working on. As we were riding I noticed how much attention to detail the city had placed in the cycling infrastructure. Wayfinding signs were present along all the interurban trails, and buffered bike lanes often were constructed with planter boxes to make them visually appealing, while providing the cyclist with a physical barrier between him/her and the vehicle. The city seemed to prefer installing separated or buffered bicycle facilities whenever possible, which made the riding much more relaxed.

One of the cycling (and walking) features I was most impressed with was the
cities use of the riparian corridors as active transportation facilities (see Figure 32). We rode along the Boulder Creek Path which extends from the Flatirons east along the Boulder creek for 5.5 miles. Most of the trail is paved, with a few portions consisting of crushed gravel. In addition to the Boulder Creek Path, the city had similar paths paralleling a few of the other 15 perennial creeks in the valley. These paths benefited the citizens by providing them with beautiful places to walk and bike, while also preserving the integrity of the watersheds.

Another notable cycling feature that I was able to experience first-hand in Boulder was the Living Lab buffered bike lane along 30th Street. Thirtieth Street is a two-lane 45 mph arterial thoroughfare, which mean that there was heavy traffic to contend with. Because of the high traffic volume along this arterial, the Living Lab program had facilitated the implementation of a buffered bike lane. The bike lane was buffered with

Figure 30. Boulder Creek path.
soft-hit delineator posts (see Appendix A) in order to add visual as well as physical protection. Even with the heavy traffic, all the riders in our group reported feeling comfortable riding in the buffered lane.

The Boulder visit was concise and as a group we were only able to visit the highlights of the city. However, in one day we were able to travel in the city using all three active transportation modes. The walking facilities in and around downtown Boulder were well connected, and it was obvious that much of the infrastructure designed to make walking comfortable was carefully planned, and well implemented—there was an apparent attention to detail. The cycling facilities were expansive and prioritized cycling and walking by utilizing the riparian corridors and underpasses which created strong linkages between all components of the city. The transit component of the active transportation system seemed to compliment the other modes very well. It provided the necessary long-distance links while encouraging users to walk or bike to the transit stations.

Case Study Working Profession Interviews

Greg Raisman—Portland, Oregon

In March 2015, I interviewed Greg Raisman, Traffic Safety Specialist for the city of Portland in the Bureau of Transportation. Raisman was a key contributor in the development, creation and implementation of the Portland Greenways program, as well as the Portland Bike Master Plan 2030, and other safe cycling road treatments. According to a news article about Raisman, he is known for being a strong advocate for safe and
equitable pedestrian and cycling infrastructure both in his role at the Bureau and as a citizen of Portland.

The questions I asked Raisman were aimed at compiling a chronological list of important historical events that occurred which shaped the active transportation network present in Portland today. This is a planning technique is known as backcasting. The questions I asked are as follows.

- Your city has a relatively high active transportation mode-share split. What were the historical decisions, legislation, grassroots movements and champions that were critical in making this happen?
- Were there specific decisions made that had a greater impact than others?
- Were there decisions or ideas that were not effective in promoting active transportation?
- Were there people in government that advocated for active transportation infrastructure, or did the momentum generate from grassroots movements?
- What is the city’s annual budget for active transportation (infrastructure construction and maintenance, education, advocacy)?

Raisman began by alluding to the fact that Portland citizens have embraced cycling as a means of transportation for many years, in fact one report by the Portland Police Bureau in 1970 estimated there to be roughly 180,000 bicycles within the city (based on the population in 1970 that estimation meant that there was approximately one bike for every two people). But it was not until the 1970s the cyclist’s needs began being voiced and vehemently advocated for. Raisman described the 70s as the beginning of a paradigm shift in the Oregon state transportation sector away from the previously held belief that transportation planning is about building infrastructure for vehicular movement exclusively. Portland city officials began working to merge transportation
planning with land use planning—an idea that had not be practiced widely at the time. This merging forced planners to begin thinking about the transportation system as a component of city design and development, and about how active transportation fit into that city design.

In the late 1960s and early 1970s, a group of cycling advocates in Portland, known as the Bike Lobby began lobbying state officials for bicycle infrastructure funding. A bill, later to be known as the “Bike Bill,” was an outcome of this lobbying effort. The “Bike Bill” outlined a plan to set aside a portion of state highway funding for bicycle path development, and during the 1971 Oregon legislative session it was brought before congress. It passed by one vote. The bill called upon cities and counties receiving state highway funds to expend a minimum of 1% of those funds on all of the following: construction of new bike and pedestrian pathways, retrofitting existing roadways to accommodate bicycles and foot traffic, and accommodating bicycle and foot traffic in new construction.

Raisman explained that the Bike Bill was a powerful catalyst for cycling in Portland. The city responded to the bill by conducting a study to assess the feasibility of bicycling and pedestrian infrastructure on Portland roads. The study resulted in a plan that called for the construction of 75 miles of recreational trails and the dedication of 105 miles of city streets as recommended bike routes for commuters. This study laid the foundation for Portland’s first Bicycle Plan, completed in 1973.

The next event that Raisman told me about, pushed active transportation forward and distinguished Portland as different from other developing, western U.S. cities during
that time. The event was the dismantling of the Mount Hood Freeway project.

Throughout the 1950s and 60s, Portland planners and engineers designed a series of freeways that would connect existing freeways with downtown Portland. It was believed that these proposed freeways would make it easier to access downtown in a vehicle, thus alleviating traffic congestion and speeding up commute times. The city put the designs for these freeways in the comprehensive plan and secured over $500 million in federal funding to support their construction.

There was strong opposition to these freeways, and in the late 60’s, early 70’s that opposition became louder and harder to ignore. Opponents to the freeway projects were concerned about the large number of neighborhoods that would be displaced in order to make way for all of the new roads. Thousands of families would have to be relocated, and the freeways would partition Portland into disconnected fragments (see Figure 33).

The Mount Hood Freeway project was so polarizing that it was used as a candidate platform in the 1974 mayoral election. Neil Goldschmidt was the candidate opposed to the project and he campaigned vigorously against it, demonstrating how it would disrupt neighborhoods and diminish the unique city character located in the demolition path.

Goldschmidt won the election and got to work blocking the freeway project. Although by this time there was a strong and legitimate opposition to the project, the city was having a difficult time abandoning it altogether because it was believed that that would mean losing the $500 million in federal funding approved for the project. A pivotal point in the fate of the freeway came in 1973 when an environmental impact
statement was released, showing that the freeway would not alleviate traffic congestion as previously believed. This statement coupled with the strong citizen opposition caused the City Council to take another look at the project, and in the summer of 1974 the Council voted 4-1 in favor of killing the freeway project.

Later that same year the Mount Hood Freeway project block got an even bigger
boost. Goldschmidt worked with federal representatives and was successfully able to divert the federal funding allocated for the Mount Hood project to the MAX light rail, transit-oriented development projects, and other open space and revitalization projects in that area. This was a huge victory for active transportation in the city of Portland. The Portland administration had successfully reallocated federal dollars promised to vehicular centric development towards active transportation projects.

The last historical event that shaped the active transportation system that Portland has today, which Raisman pointed out to me, was the establishing of the Portland urban growth boundary. Oregon Governor Tom McCall (1967-1975) convinced the Oregon Legislature in 1973 to adopt the nation's first set of statewide land use planning laws. With a coalition of farmers and environmentalists, McCall persuaded the Legislature that the state's natural beauty and easy access to nature would be lost in a rising tide of urban sprawl. On May 29, 1973, Senate Bill 100 was signed into law by Gov. McCall. The bill created the Land Conservation and Development Commission and the Department of Land Conservation and Development (Oregon Metro, 2016). As a product of this bill cities and metropolitan areas were required to establish urban growth boundaries in order to protect the natural resources of the state.

In 1977, the Columbia Region Association of Governments proposed an urban growth boundary for the Portland metro area. The initial proposed boundary incorporated 24 cities and over 60 special service districts (Oregon Metro, 2016). It was agreed upon and since the initial boundary was drawn, it has gone through several updates and iterations.
The reason the urban growth boundary has helped active transportation in Portland is that it disincentivized and discouraged low density development within the Portland metro area. As a result, the metro areas densified, a concept that was unpopular in the west, at that time. Compact, urbanized cities are more easily serviced by transit, they are much more walkable and bicycle friendly and do not result in car centric city designs.

The most prominent historical backcasting outcomes I gleaned from Raisman’s interview were as follows.

- The powerful pro-cycling grassroots movement in the early 1970’s galvanized the drafting and passage of the 1971 Bike Bill which allocated state transportation funds to be used for cycling and pedestrian infrastructure.
- The unraveling and destruction of the Mount Hood Freeway project in 1974 demonstrated the unwillingness of the Portland people to allow a massive, car centric transportation project to marginalize portions of the population and stymie active transportation initiatives.
- The Portland metro urban growth boundary of 1977 went against the “pro-suburb” mantra of the time period and encouraged dense, easy to service, development while preserving natural landscapes.

**Chris Hagelin—Boulder, Colorado**

Chris Hagelin is a senior transportation planner with Go Boulder/City of Boulder. He specializes in multi-modal transportation planning, developing Transportation Demand Management (TDM) strategies and has played an integral role in developing the active transportation portions of the 2013-2014 Transportation Master Plan updates. Among other things, he has also worked on establishing Trip Reduction Ordinances (TROs) within Boulder city limits.

I asked Hagelin the same questions as Raisman, which were aimed at compiling a
chronological list of important historical events that occurred which shaped the active transportation network present in Boulder today. This is a planning technique is known as backcasting. The questions I asked were as follows.

- Your city has a relatively high active transportation mode-share split. What were the historical decisions, legislation, grassroots movements and champions that were critical in making this happen?
- Were there specific decisions made that had a greater impact than others?
- Were there decisions or ideas that were not effective in promoting active transportation?
- Were there people in government that advocated for active transportation infrastructure, or did the momentum generate from grassroots movements?
- What is the city’s annual budget for active transportation (infrastructure construction and maintenance, education, advocacy)?

Hagelin began by talking about the establishment of the Boulder Blue Line in 1959. The Blue Line is a charter amendment that establishes a building boundary extending to 5,750 feet up the Flatiron Mountain range, above which, utilities will not be provided by the city of Boulder (see Figure 34). This amendment was the product of citizen engagement and lobbying. Albert Bartlett and Robert McKelvey, two University of Boulder professors, noticed the astonishing and unbounded growth Boulder was experiencing from 1940-1950. They were concerned about the natural beauty of Boulder being trampled by the suburban growth that was happening in Boulder, as well as other metro areas all over the western U.S. In 1959 they formed an organization PLAN-Boulder to campaign for planned growth. That same year they drafted, proposed and encouraged the passing of the Blue Line (Belford, 2013). On July 21, 1959, the voters approved the Blue Line.
The Blue Line set a precedent in Boulder—the city was not going to let population growth extend city limits in an unplanned manner, it was going to be proactive about controlling expansion.

Some have described the Blue Line as “one of Boulder’s most important grassroots efforts to preserve the city and its environment from degradation that comes from uncontrolled growth” (Blue Line). Although this amendment was not directly related to active transportation, it had implications for the future of active transportation in the region. The Blue Line acted as an urban growth boundary along the mountains for the city. It strictly regulated the growth, allowing for Boulder to densify its development and promote active modes of transportation.

The next major historical event that Hagelin told me about was the open space sales tax increase. The establishment of the Blue Line was a huge step for Boulder with regards to open space and active transportation. However, it was only a matter of a few years after the Blue Line was put in place that it was in danger of becoming a distant
memory in Boulder city planning. There were proposals to build hotels above the Blue Line which were threatening the Blue Line’s legitimacy. Again, advocates for open space and PLAN-Boulder got to work drafting legislation to prevent this building from happening. They worked together with the city manager, Ted Tedesco and the City Council to put a one-cent sales tax on the upcoming ballot, 40% of which being allocated for open space preservation and management and the other 60% going to transportation. The measure passed in 1967 with a 61% voter approval (Livable Boulder, 2016).

The passing of this sales tax was critical to preserving open space and catalyzing active transportation. Once the sales tax passed, the city acted swiftly and issued a charter amendment that allowed City Council to issue bonds for the acquisition of open space. Initially the city focused on purchasing some of the iconic Boulder view sheds: The Flatirons, the foothills around the Flatirons, the wooded forests and the many rivers in the valley. Once those iconic landscapes were purchased and under protection the city looked outward and began purchasing the valley lands surrounding the city. The reason the city offices began purchasing the lands immediately adjacent to the city was to begin developing a greenbelt surrounding the city. This was another safeguard against unchecked urban sprawl. By 2008 over 40,000 acres of greenbelt/open space land had been purchased and preserved for the enjoyment of the people of Boulder.

With 60% of the revenue from the open space sales tax going to transportation, it did more than just allow for the purchase of large swaths of open space. It provided the means by which Boulder could begin formulating a concerted plan to incorporate active transportation into the city. The city began planning for active transportation, including
the community’s transit network. In 1979 the Regional Transportation District was created. In 1977, Boulder city and Boulder County adopted the Boulder Valley Comprehensive Plan. This plan established a pedagogy about the importance of preserving the rural character of the Boulder Valley by concentrating the urban development in existing cities. It also recommended the Boulder Creek Path and restoration project, including flood mitigation and channel restoration. Additionally, the plan emphasized the importance of an uninterrupted active transportation network. This opened initial discussions about the active transportation underpasses, the first of many more active transportation measures to become an integral component of the transportation network in Boulder.

Hagelin told me that currently the transportation sales tax has been increased to .75 cents. The sales tax and other revenue sources produce an annual budget of over $30 million for active transportation in Boulder. Federal funding contributes $5.15 million, the state highway users tax contributes $2.47 million, other funding sources contribute $2.76 million, the development excise tax contributes $1.42 million and the local sales Tax is the largest contributor at $24.18 million (Boulder Transportation Report on Progress, 2016). It is expected that the budget will increase another $30 million by 2035 to help pay for additional transit oriented developments. In the formative years of the Boulder active transportation network, the 1970s-1990s, most of the transportation budget was used to build new infrastructure. In recent years, according to Hagelin, the network is relatively built out, therefore most of the annual budget goes to maintaining the existing facilities.
With momentum for active transportation moving forward, the city adopted its first transportation master plan in 1996. Hagelin said that this first plan was a citizen led initiative, and the sentiment amongst the citizens was favorable towards creating a multi-modal system. The 1996 plan coalesced around four policy focus areas: Multimodal Corridors, Regional Connections, Transportation Demand Management (TDM) and Funding (City of Boulder Transportation Master Plan, 2003). The plan outlined a complete bicycle network intended to create safe, continuous cycling facilities around the city. The plan also expressed the importance of having robust pedestrian facilities that connect to transit hubs and ensure safe travel throughout the city. The plan also addressed the need for a comprehensive transit plan, stating that the transit network should be incrementally expanded, as funding allows (City of Boulder Transportation Master Plan, 2003). Hagelin summed up the 1996 TMP as active transportation policy discussions. By laying out policies early, the city could then work to build the infrastructure that supported those policies.

The 1996 Transportation Master Plan (TMP) was the first of four plans (plan updates were completed in 2003, 2010 and 2013/2014). Each subsequent plan recalls the four policy focus areas and works to formulate updates that fall into the category of: Multimodal Corridors, Regional Connections, TDM, and Funding. In more recent years the plans have focused on leveraging state funds with federal funds to implement larger transit projects. There is also a policy in Boulder now that limits the addition of additional vehicular lanes, meaning travel lanes are not the first reaction to relieving congestion. New in the most recent TMP is a policy that requires pedestrian mobility to
be the first consideration in transportation projects. All projects must consider the pedestrian first even if the project is not specifically focused around a pedestrian facility or pedestrian improvement.

The most prominent historical backcasting outcomes I gleaned from Hagelin’s interview were as follows.

- The 1959 Blue Line was a citizen led priority that grew out of a visceral desire to preserve the beautiful vistas of the Boulder Valley. This Blue Line is the reason that there is no development amongst the foothills of the Flatirons to this day. It also paved the way for additional, stricter regulations on sprawl and unplanned development.

- The 1967 one-cent sales tax to fund open space and transportation was a pivotal moment for preserving Boulder’s rural character and pristine landscapes. It allowed the city to purchase land around the city, creating a greenbelt of undevelopable land. It also provided the necessary funding for multi-modal transportation planning and construction. This sales tax has been the backbone for active transportation in Boulder since its inception.

- The first transportation master plan drafted in 1996 outlined goals and policies for the future of active transportation in Boulder. It presented those policies and goals in the four major categories of: Multimodal Corridors, Regional Connections, Transportation Demand Management (TDM) and Funding. All of the subsequent plans have maintained and built off of that framework, giving the city concrete ways to move forward with multi-modal transportation.

**Conclusions from Case Study Data Collection**

The case study data collection process yielded valuable insights into the critical components of a robust active transportation network. By approaching the process from many different angles, including, research, a site visit and a local expert interview I was able to distill all the information down and identify salient points. The key take-aways are listed below.
In both Portland and Boulder, the process of prioritizing active transportation infrastructure, policies, and programs over a period of time greater than 30 years. Incremental changes towards more active transportation friendly cities occurred with highly documented and critical “victories.” Examples of “victories” include sales tax increases, champions for the cause of active transportation being elected to positions of influence, and regulations limiting where motor vehicles could be use. For both of the case study cities, change did not happen overnight.

Active transportation champions played and continue to play an important role in furthering the active transportation agenda. Champions could be advocates or politicians but are often both throughout their careers.

Both Portland and Boulder have dedicated funding sources for creating and maintaining active transportation facilities.

Both Portland and Boulder have transportation master plans that reference active transportation modal split targets.

Efforts to confine development and densify urban growth in order to manage travel distances have been undertaken by both Portland and Boulder.

**Document Prerequisites for Active Transportation**

Throughout the entire data collection phase of this research, analysis was contently occurring and documented. The data collection process was iterative and interactive, resulting in a grounded theory detailing prerequisites required for active transportation in cities of the western U.S.

**The Theory of Prerequisites for Active Transportation**

The common themes discovered in this research will henceforth be defined as the “prerequisites” needed for active transportation in cities of the western U.S. These perquisites are listed in Table 1, based on their type—either City Wide Policies, Bicycling, Walking or, Public Transit.
Table 1

*Prerequisites for Active Transportation*

<table>
<thead>
<tr>
<th>Type</th>
<th>Element</th>
<th>Location</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>City-wide policies</td>
<td>1. Urban growth boundary/ “Blue Line”</td>
<td>Both</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>2. City-wide dedicated active transportation funding</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>3. Compact mixed-use development</td>
<td>Both</td>
<td>High</td>
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<td></td>
<td>4. Active transportation city staff/office</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>5. Prioritize network connectivity</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>6. Reroute major arterials away from downtown cores</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>7. Parking restrictions</td>
<td>Both</td>
<td>Medium</td>
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<td></td>
<td>8. Sustainability plan – GHG emission reduction measures</td>
<td>Both</td>
<td>Medium</td>
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<tr>
<td></td>
<td>9. Easements for trail construction along riparian corridors</td>
<td>Both</td>
<td>Medium</td>
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<tr>
<td></td>
<td>10. Formalized complete-street policy</td>
<td>Boulder</td>
<td>Medium</td>
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<tr>
<td></td>
<td>11. Minority population outreach</td>
<td>Portland</td>
<td>Medium</td>
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<tr>
<td></td>
<td>12. Local university research partnership</td>
<td>Portland</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>13. New vehicle lane restrictions</td>
<td>Boulder</td>
<td>Low</td>
</tr>
<tr>
<td>Bicycling</td>
<td>1. Bicycle master plan</td>
<td>Both</td>
<td>High</td>
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<td></td>
<td>2. Grassroots champion</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>3. Prioritization of separated bicycle infrastructure</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>4. Safe Routes to School program</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>5. City Bike Share program</td>
<td>Both</td>
<td>Medium</td>
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<tr>
<td></td>
<td>6. Bike routes mapped and available online</td>
<td>Both</td>
<td>Medium</td>
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<tr>
<td></td>
<td>7. League of American Bicyclists – bicycle friendly community rating, gold or higher</td>
<td>Both</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>8. Bicycle facility maintenance/snow removal</td>
<td>Boulder</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>9. Active bicycle advisory committee</td>
<td>Portland</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>10. Bicycle underpasses</td>
<td>Boulder</td>
<td>Medium/low</td>
</tr>
<tr>
<td>Walking</td>
<td>1. 20-minute neighborhoods</td>
<td>Both</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>2. Pedestrian-friendly intersections and crossings</td>
<td>Both</td>
<td>High</td>
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<tr>
<td></td>
<td>3. Sidewalk snow removal policy</td>
<td>Boulder</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>4. Sidewalk inventory</td>
<td>Portland</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>5. Pedestrian mall</td>
<td>Boulder</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>6. Active pedestrian advisory committee</td>
<td>Portland</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>7. Pedestrian underpasses</td>
<td>Boulder</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>8. Missing sidewalk link app/fix it app</td>
<td>Boulder</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>9. Compact city blocks</td>
<td>Both</td>
<td>Low</td>
</tr>
<tr>
<td>Public transit</td>
<td>1. Regional/city service routes</td>
<td>Both</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>2. Park-n-Ride lots</td>
<td>Both</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>3. Airport connection</td>
<td>Both</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>4. Transit passes available through employers</td>
<td>Boulder</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>5. Bus rapid transit feasibility study</td>
<td>Both</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>6. First-last-mile strategies</td>
<td>Both</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>7. Location tracker app</td>
<td>Both</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>8. Free fare zone</td>
<td>Boulder</td>
<td>Low</td>
</tr>
</tbody>
</table>
The research also made apparent the relative importance in terms of overall impact of each perquisite in comparison to each other. Therefore, the prerequisites are assigned a “priority” based on:

- Whether or not its historical significance shaped the progression of active transportation into the future.
- Whether or not it has the capability of directly influencing subsequent active transportation policy.
- Whether or not it occurred in both the case study cities.

A “High” priority indicates that all three criteria were met, and “Medium” priority means that two out of the three criteria were met and a “Low” priority means that one out of the three criteria were met. Table 1 demonstrates all 41 prerequisites for active transportation in the western U.S. displayed by their type, location (observed in Portland, Boulder or both), and by their priority.

The preceding research demonstrates the importance of each of the prerequisites individually, but also as one part of a whole system of prerequisites happening throughout time. Due to the shear complexity and volatility of such a task as well as the difficulty in reproducing elsewhere, this research does not specify which prerequisite should be implemented at specific points in time. However, it qualitatively assesses and ranks the prerequisites in order of their proven importance, while acknowledging that each prerequisite functions as part of a whole system on a continuum of time. Put simply, this research and subsequent list of prerequisites is listed in order of importance, but there is no one prerequisite that can independently create a comprehensive active transportation network in a city or town looking to prioritize active transportation. Each prerequisite listed plays a role in the overall network.
The subsequent section provides a detailed description of each type of prerequisite, as well as each prerequisite within the different types. While the consequent prerequisites were likely referenced at various levels of detail in the Data Collection chapter of this research, this section aims to present those conceptual ideas as a formalized theory of Prerequisites for Active Transportation.

A fundamental component of each prerequisite is how it was achieved over time. This research acknowledges that each prerequisite can take varying amounts of time to achieve. However, the exact amount of time is difficult to understand with any degree of precision, and different locations may make progress towards the prerequisites at different rates. This research explores the relationship between time and each prerequisite in more depth within the Alternative Future for Cache Valley, UT, where current progress can be qualitatively assessed.

**City-Wide Policy Elements**

It became evident during the case study analysis phase how important it is to have specific, city wide policies in place that encourage, promote and enable active transportation. These policy elements are rooted not in one particular mode of active transportation, but in the whole system of the city. The important city-wide policies that are critical for active transportation are:

**Urban growth boundaries.** Urban growth boundaries set the stage of active transportation systems. They encourage compact growth, mixed-use development and if development is dense enough the city will not accommodate a 1:1 ratio of vehicles to people—thus restricting ease in car ownership. Both Boulder and Portland have urban
growth boundaries that were established in the 1970s and earlier.

**City-wide dedicated active transportation funding.** If cities are going to promote active transportation they must have the infrastructure and facilities to support it. Dedicated funding is a necessary component of active transportation. In Portland, the funding for active transportation is an independent part of the transportation department budget. In Boulder, there is an independent organization/office that manages the active transportation budget. Both cities have dedicated staff members working on active transportation projects.

**Compact mixed-use development.** Compact mixed-use development goes hand in hand with a strict urban growth boundary. A growth boundary will encourage mixed-use development, making active transportation much more feasible and personal vehicle trips costly and unnecessary. Both Portland and Boulder have zoning ordinances that require mixed-use residential and commercial in portions of the downtown.

**Inter-urban trails network.** Inter-urban trails allow citizens to walk or cycle throughout the city away from vehicular traffic. There are many benefits citizens experience when there are city trails nearby: an increase in property value, lower rates of obesity, and higher reported rates of overall happiness (American Trails).

**Parking restrictions.** Driving a car is convenient when there is parking readily available and inexpensive at destination centers. By making parking expensive or limited, people may be in the position to reconsider their transportation choices to a mode that is more convenient. Both Boulder and Portland have strict parking restrictions, high parking prices and parking enforcement in their downtown areas.
New vehicle lane restrictions. By limiting the number of new travel lanes, cities are committing to managing the existing a future travel demand. Boulder implemented a “no new vehicle lanes” policy. The city has nearly 250 miles of vehicle travel lanes and they have made the commitment not to add any additional lanes. The city suggests there are many health, and safety benefits to this policy but the most persuasive argument is that it saves the city annually by reducing the required capital to create and maintain the roadways.

Sustainability plan—GHG emission reduction measures. Transportation makes up 26% of emissions produced throughout the U.S. annually (Environmental Protection Agency [EPA], 2016). Cities that have demonstrated a commitment to lowering their emissions impact have a comprehensive sustainability (or emissions) plan that outlines benchmarks for lowering their transportation greenhouse gas emissions. By committing to limiting the carbon footprint, the city will make strides towards enhancing active transportation.

Easements for trail construction along riparian corridors. Coupling inter-urban trails with riparian corridors have the added benefit of preserving the rivers while providing serene active transportation networks. Boulder established its Boulder Creek Path which is a 5-mile trail running along the Boulder Creek. Portland used a rail easement to establish the Springwater Corridor which parallels the Willamette River.

Formalized complete-street policy. A complete-streets policy can have the effect of legitimizing active transportation along streets, while requiring roads be equipped with travel lanes for the different modes. Recently, the western U.S. has
prioritized vehicles on street rights-of-way, often leaving relatively little space for active transportation facilities. Complete-streets policies can vary in how stringent they are, but they are intended to encourage or require those designing roadways to consider active transportation users when conceptualizing and creating roadways. Both Portland and Boulder have a complete streets policy in their cities. They also work with their local Department of Transportation and have assisted them in creating a complete-streets policy at the state level.

**Minority population outreach.** All citizens of a city should have access to active transportation. Educational materials, public outreach events and data gathering sessions should all be inclusive and equitable. Cities should also consider translating active transportation information into commonly spoken languages to encourage and promote their use. Portland has most of its cycling materials printed in Spanish and widely available.

**Local university research partnership.** Many larger metropolitan areas have a university within their city limits. The university provides unique opportunities to have research conducted locally, resulting in place-based recommendations, while giving students the opportunity to have practical, experience learning. Portland State University has the Initiative for Bicycle and Pedestrian Innovation—a research center dedicated to bicycle and pedestrian learning and education.

**Active transportation city staff/office.** Similar to having a dedicated budget for active transportation, it is critical to have dedicated staff to actuate the active transportation goals of the city. The number of active transportation staff can vary in size
depending on the rigor of the city’s goals and the size of the budget. Boulder has “Go Boulder,” an office dedicated to active transportation. It works closely with the other areas of the government.

**Prioritize network connectivity.** Ideally, active transportation networks should connect, not only with themselves, but to the other two networks. Bike lanes and sidewalks should connect users with transit stations. Metro stations should be a destination in and of itself. New developments should demonstrate how they intend to complete the active transportation network if they are along one. Active transportation choices should be intuitive, easy to follow, and not leave a user stranded half way through a commute. Potential network segment additions should be constructed in accordance to their connection to the greater network. Both Portland and Boulder have worked to complete the networks.

**Reroute major arterials away from downtown cores.** Similar to the historical cities of Europe, the downtown cores in urban cities in the western U.S. should be accessible by foot, on bike or by bus. This will help preserve the quality of the space, while creating a stress-free place for people to congregate. Routing major arterials through downtown cores demonstrates that vehicles have priority in that space, instead of people. Perimeter parking is recommended with nothing larger than minor collectors throughout the downtown area. It would be best to create a pedestrian mall throughout the area, but if that is not possible, pedestrian facilities should be the most prominent feature. Portland blocked a project that would have added a freeway coming into the downtown area in the 1950s, thus preserving the character of downtown in addition to
saving hundreds of homes. Boulder has located the majority of its downtown parking on the perimeter of the core and has the Pearl Street pedestrian mall.

**Bicycling Elements**

Bicycling policies are those that improve and enhance the bicycling experience in the city.

**Bicycle master plan.** A bicycle master plan is the first, and most important, step in creating a comprehensive bicycle network. Creating the master plan should include the various stakeholders who are involved in the network at any level (e.g., professionals, advocates, residents, and city officials) should all have the opportunity to contribute. The master plan should call on best practices in order to find creative solutions for placed-based challenges. The master plan should be a living, dynamic document that is readily available to the public and is referenced by city officials often. Boulder has worked to make their Transportation Master Plan updates available to the public through an interactive website platform, engaging the user more than a static PDF document. Portland has asked for the public’s help in selecting the locations for the 100 BIKETOWN bike share program. An interactive map allows citizens to select locations based on a set of given criteria.

**Grassroots champions.** In an age when Americans are habituated to driving their vehicles, changes in the transportation system that deemphasizes vehicles might be considered drastic and outlandish. The push for policies and legislation that incorporate active transportation needs champions. Local politicians are direct representatives of the constituents they serve. If citizens work with their politicians to draft bills and rally other
supporters, their cause is much more likely to be considered. In both the case study cities there were easily identifiable champions of the active transportation movement. These people worked tirelessly to promote active transportation. In Portland there was a professor at Portland State University by the name of Sam Oakland who organized bicycle rallies and was integral in the passing of the Bike Bill. In Boulder there were two University of Colorado at Boulder professors, Albert Bartlett and Robert McKelvey, who developed the idea of the Boulder Blue Line, through which subsequent urban growth boundaries and active transportation initiatives were conceived.

**Safe routes to school programs.** The key to active transportation in the future is working with children today. By working with kids during their formative years to show them how to ride bicycles, ride the bus and walk to school, they are more likely to continue those habits into the future. Another reason to help kids integrate active transportation into their lives is because research suggests children are not getting enough exercise on a regular basis. According to the CDC, in 2012 more than one third of children and adolescents were overweight or obese (Centers for Disease Control and Prevention, 2012). Both Portland and Boulder have Safe Routes to School programs working with hundreds of students in multiple school districts.

**City bike share program.** City bike shares are gaining popularity among many major metropolitan areas. The goals of bike share programs are to encourage cycling within downtown areas, to and from attractions, restaurants and other amenities, while eliminating barriers to accessing a bicycle. Bike shares are designed for short trips, most programs have established 30-minute payment increments with multiple docking stations
within a 30-minute ride. While bike share does not necessarily promote longer trips by bike, they expose people to cycling by providing bicycles that are convenient to access without the required maintenance. They also promote cycling simply by being visible throughout the city. Portland is launching their 100 station (300 bicycle) system in July 2016, and Boulder has a 300 bicycle program that has been in place since 2011.

**Bike routes mapped and available online.** In an era of smart phones and mapping apps, paper maps are becoming obsolete. Cities should make information available online and quickly accessible, including information on bike routes. Recommended cycling routes should be readily available when someone opens a mapping app. There is room for innovation in presenting bike routes online in a dynamic fashion. Both Boulder and Portland have bike maps accessible online, but they are static PDF’s that do not give a rider a prospective based on their current location.

**League of American Bicyclists—Bicycle friendly community rating, gold or higher.** The League of American Bicyclists is a resource for bicycle advocacy and education. The criteria they have set for the Bicycle Friendly Community Rating has been thoroughly vetted for effectiveness and overall contributions to the community by a board of experts (see Appendix B). This rating recognizes communities that have exceptional cycling infrastructure, policies and advocacy programs. A gold, platinum or diamond rating suggest that the city has placed a strong emphasis on cycling and has the systems in place to support that claim. The ranking itself is less important than the policies and infrastructure in place to achieve that ranking. Boulder and Portland have both achieved Platinum ratings.
**Prioritization of separated bicycle infrastructure.** In looking at our European city counterparts, it is apparent that building efficient separated bicycle facilities results in a higher percentage of riders. Cities like Copenhagen and Amsterdam have bicycle modal splits of over 25%, and their cycling network is almost exclusively separated from the vehicle travel lanes (see Appendix A). A similar result can be gleaned from, the Portland study: Four Types of Transportation Cyclist in Portland (Geller, 2009). The study results suggest that, “the number one reason people do not ride bicycles is because they are afraid to be in the roadway on a bicycle. When they say they are “afraid” it is a fear of people driving automobiles” (Geller, 2009, p. 3). The study goes on to suggest that separated cycling facilities will encourage roughly 60% of people to try cycling, because they feel safer in those facilities (Geller, 2009). Portland works to implement separate facilities whenever possible and Boulder has over half its cycling infrastructure protected or separated.

**Active bicycle advisory committee.** The development of good cycling network should include input from the people who cycle on a daily basis. An active bicycle advisory committee can be an excellent sounding board for concepts, designs and activities a city is looking to implement or host. Often the advisory committee is a part of bicycle planning efforts, design reviews and volunteers at annual events. Portland has a dedicated cycling advisory committee, while Boulder has a transportation advisory committee which is tasked with advising on bicycling project as well as other projects.

**Bicycle underpasses.** Bicycle underpasses are a high impact facility for establishing and maintaining bicycle transportation network connectivity. They provide a
stress-free alternative to negotiating a busy vehicular interchange, which is the place, studies suggest, can be highly dangerous for cyclists (Wachtel, A. & Lewiston, D., 1994; Wang, Y. & Nihan, N., 2004). The underpasses in Boulder are an integral part of the whole active transportation system, and the city has invested in them by leveraging federal flood mitigation funds with city funds.

**Bicycle facility maintenance/snow removal.** Vehicular roads are plowed throughout the winter in any metropolitan areas that receive snow on a consistent basis. It is a well-known fact that the transportation network would not function in the winter if it were not maintained, and this would not be acceptable considering its use. A city with an active transportation network should be diligent about maintaining it during and after storm events so that people can rely on it with the same predictability guaranteed in vehicular travel network snow clearing. Boulder has multiple snow removal machines that are sized to clear the bicycle facilities throughout the city. Cities should also be sure to maintain the bicycle facilities they have in place. This includes filling pot holes, sweeping, repainting the lane markings and maintaining the lighting along the facilities. Boulder and Portland have structures in place to accept fix-it requests.

**Walking Elements**

Cities can achieve higher walking modal splits if their officials invest in some key elements that promote pedestrian activity, making it safe, convenient and an enjoyable experience.

**Twenty-minute neighborhoods.** If walking is a viable mode of transportation and there are places people can go within a 20-minute walk from their home, they will be
much more likely to walk. The concept of a 20-minute neighborhood is not only about making a community *walkable* it is perhaps more importantly about making a community *livable*. If amenities are accessible within a 20-minute walk from most residential areas, that entire area will benefit from having a thriving economy and happy residents. Cities can achieve greater walkability by examining their zoning ordinances and insuring there are plenty of opportunities for mixed-use residential and commercial developments. These opportunities should be grouped together whenever possible and linked together through active transportation networks. Portland has a 20-minute neighborhood policy that encourages walkable communities and developments.

**Sidewalk inventory.** Sidewalks that end unexpectedly can render the whole sidewalk network useless. If a sidewalk ends and a citizen must proceed on the road right-of-way, they are in an uncomfortable and potentially life-threatening situation. A sidewalk inventory should be conducted in every city so that transportation offices understand where the crucial missing links are located and can develop a plan to reconnect them. Portland has completed a thorough sidewalk inventory that is available on their website. Though that processes they were able to identify trends in sidewalk gaps, and work to mitigate those gaps.

**Compact city blocks.** City blocks provide important structure to a functioning city. In most cases, the length of particular cities bocks was established long ago, and there is little that can be done to change the lengths. However, whenever possible, cities should strive to make their city blocks more short and compact. If city planners have the ability to shorten blocks in their city by connecting a street that currently only goes
halfway through a block, they should do so. Both Portland and Boulder downtowns have short city blocks, although there was no evidence that they are working to connect streets whenever possible.

**Pedestrian mall.** A pedestrian mall is a street or corridor that is open to walking only. Typically, these streets are retail centers with restaurants and shopping. Studies show that pedestrian activity correlates with business growth (Stangler, 2013). While not all streets should be pedestrian only, cities should examine if there are areas where a pedestrian corridor could be implemented. The initial implementation could always be done as a pilot project at first, with planters to demonstrate the closure, then if it is successful it could be made more permanent. Boulder has Pearl Street, which has been a dedicated pedestrian mall since 1977.

**Active pedestrian advisory committee.** Similar to a bicycle advisory committee, there should be a group that is tasked with advising governing offices on pedestrian related issues and projects. Typically, these types of groups meet monthly or quarterly to discuss projects, work on outreach and assist with events. Portland has an active pedestrian advisory board that reports to the Bureau of Transportation.

**Pedestrian underpasses.** In Boulder the underpasses are for both cyclists and pedestrians, and pedestrians enjoy similar benefits when using them as cyclists do. Intersections are dangerous places for pedestrians who are considered vulnerable roadway users. Therefore, if there is an opportunity to give them a dedicated and separated intersection facility that, it should be taken.

**Sidewalk snow removal policy.** Sidewalks should be cleared of snow in a timely
fashion. One method cities have used for sidewalk clearing is delegating the task to the homeowners where the sidewalks are located. This is a logical approach and is relatively effective. However, it should be stated that this type of policy only works if it is enforced. People will be dissuaded to walk if they believe they are at risk of falling on ice along their route. The city of Boulder has a strict sidewalk policy that states a homeowner who neglects to shovel their sidewalk within 24 hours after it stops snowing will be fined $100 on their first offence and up to $1,000 and 90 days in jail as the maximum fine.

**Missing sidewalk link app/fix-it app.** Cities could benefit from crowdsourcing information regarding damaged or dangerous sidewalks, and there are apps available to streamline the process. Creating, and disseminating information about an app that allows people to map the problem area on a sidewalk will take a tremendous amount of work out of maintaining the sidewalk system. Cities should articulate a method for determining which sidewalks are repaired or constructed. A plan for pedestrian activity in a city could assist in creating that that method. Boulder has a missing link program that assesses links based on their cost and works to build and repair as the budget allows.

**Pedestrian friendly intersections and crossings.** Having a good pedestrian network is more than the sidewalks, it is also about people crossing from one side of the street to another. If city officials are limited in their ability to create a separated pedestrian underpass (or overpass) to avoid a particularly problematic intersection, every other precaution should be taken to ensure that pedestrians can safely cross the street. City officials should ensure pedestrian crossing times at lighted intersections and curb ramps comply with the Americans with Disabilities Act (ADA) requirements. This will
benefit disabled users as well as the general public. City planners should also observe the “desire lines” crisscrossing throughout the city (see Figure 35). These lines can be helpful in understanding where people want to go from specific locations. An effort should be made to legitimize desire lines whenever possible.

**Public Transit Elements**

Cities can achieve higher transit modal splits if officials invest in some key elements that promote quick, efficient transit trips at an affordable cost.

**Regional/city service routes.** Perhaps the most important aspect of a comprehensive public transit network is insuring that there are sufficient routes on both the city scale and the regional scale. Local transit authorities should reach out to their constituents often to ensure that the routes they are scheduling continue to be relevant and desired. There will be limitations to service, however, a transit authority that is adaptable
and dynamic will be the best suited to meet the needs of the community while balancing the books. Regional services, connecting people to the larger metropolitan areas, are a vital component to creating a holistic system. Rail or metro lines may have the ability to serve this need to the greatest capacity, but with the greatest cost. Bus Rapid Transit (BRT) systems may be a viable alternative for longer distance, regional service. They require much less space, upfront investment, and are not permanent like rail systems are. Both Portland and Boulder have comprehensive transit systems. In Boulder the city has teamed up with the regional transit authority to provide the local service, a unique and functioning partnership.

Transit passes available through employers. Many people may say that cost is a barrier to using a transit system. A potential solution for this dilemma could be offering annual passes to major employers in the region at a discounted rate. These “bulk” passes can then be offered to the employees as a benefit. This program could even be offered on a neighborhood level, requiring a certain number of households buying in to receive a discounted rate. The city of Boulder has an Ecopass program that provides employers the option of buying a specific number of passes to receive a discount. Currently Boulder is considering expanding this program to the entire city, a feasibility study was completed to understand the options for this type of expansion.

Bus rapid transit feasibility study. As previously stated, BRT systems tout many of the benefits of a rail system at a lower cost. They do require a dedicated lane on major arterial roads and freeways. They also require metro-like entry and exit platforms in order to insure they are fast, efficient and accessible. A feasibility study should be
conducted in metropolitan areas to see if a BRT could increase the level of service within a given region. BRT systems may be useful in providing a transit option between metropolitan areas. Both Boulder and Portland have conducted BRT feasibility studies along a select number of major thoroughfares within the city and in the surrounding region. Boulder has implemented the construction of a BRT system that serves the Denver area.

**Park-n-ride lots.** Often people who are using transit (especially on a regional scale) are using their personal vehicle to get to that transit station. While the study is aimed at encouraging active transportation at every stage of an assumed commute, it is understood that a personal vehicle may help a citizen access an active transportation network. Therefore, if someone chooses to drive to a transit station only to find there is no place for her to leave her car while using the transit system, she may be discouraged from using the system in the first place. A park-n-ride lot is a solution in that scenario. The lot could also be equipped with bicycle lockers to encourage people to ride their bike there. Boulder’s new BRT system has multiple park-n-ride lots along the route.

**First-last mile strategies.** Similar in concept to the park-n-ride lots, first-last mile strategies address the question of how someone is going to access a transit facility. An intuitive approach to finding the solutions to this question is to ensure the active transportation networks connect and overlap. Bike lanes that connect to transit hubs, which are equipped with bicycle lockers, will increase the number of people who arrive to the hubs by bicycle. Transit hubs that are strategically located near retail centers and businesses will experience frequent visits from those looking to shop and dine. The
potential to implement first-last mile strategies should encourage those working for transit agencies to study the demographics of people surrounding a new potential hub location. Understanding demographics can lead to more effective first-last-mile marketing strategies, resulting in more people walking or biking to the new hub. Portland has transit stations that are positioned in high visibility, destination locations. Many of these locations also converge with bicycle facilities (the Rose Quarter station is located along a bike lane and is within walking distance of a stadium). Boulder’s major transit centers have secured covered bicycle parking within the building.

**Airport connection.** Major international airports should be considered when cities are looking to create or expand transit service. Airports charge more for parking than the cost of a ticket to get there by train. Therefore, a transit line to the airport provides a much more cost-effective way to get to the airport, with the additional benefit of being able to leave the car at home. Additionally, service to the airport may allow city visitors to have a car free vacation—they would be more likely to rent a car if they knew they had to have one just to leave the airport in the first place. Portland has a very efficient metro line that goes directly from the Rose Quarter District to the airport. Boulder, while it does not have a dedicated bus or train service to the airport, it does have services to Denver, which then provide service to the airport.

**Location tracker app.** Smart devices enable people to be connected at any time. Transit authorities have the ability to use that connection to their benefit, by creating and provide apps that allow people to access a bus location, real time. With these types of apps people can understand wait times and plan accordingly. They can also use the app to
make instantaneous decisions about taking transit. By simply accessing the app, potential riders could realize that a bus was mere moments away and decide to take it. While apps like this do not guarantee ridership, they make it more convenient for people to use the transit service. Both Portland and Boulder have apps that give people real time bus location information.

**Free fare zones.** A free fare zone is a specific area, route, or section on a route that does not cost anything to use. Typically, free fare zones are located within a few blocks of a downtown area. They encourage people to take transit instead of driving to busy urban cores. They can also give people who may not have used the system before, a free trial on transit. They can be an added benefit to a transit system if they are not cost prohibitive for the transit agency. Portland had a free fare zone in their downtown area up until 2013, at which point it was discontinued. Boulder still has a small area that is fare free within their downtown.

**Expert Validation**

An important phase of this research was having the prerequisites vetted by planning professionals. The planning professionals from both of the case study cities evaluated each active transportation element and were given the opportunity to make suggestions. The list of prerequisites was also given to a transportation planner in Cache Valley to provide a Utah perspective.

**Case Study Expert Validation**

Both Raisman and Hagelin of Portland and Boulder respectively were given the
list of prerequisites and asked to provide feedback or validation. Both Raisman and Hagelin confirmed that the list was a thorough and comprehensive examination of the prerequisites for active transportation. Both stated that if they had more time they would like to delve into the list with a more critical eye, but stated they were comfortable with its current state.

**Local Expert Validation**

Jeff Gilbert, the transportation planner for the Cache Metropolitan Planning Organization (CMPO), spoke with me about the list of prerequisites. Gilbert provided professional insight on the elements and spoke to their priority and feasibility in Cache Valley, UT (CMPO, 2012). This was a valuable perspective to obtain, it shed light on the priority active transportation has within the Cache Valley.

Gilbert started out by saying that establishing an urban growth boundary in Cache Valley would help the growth of active transportation. However, he said it is a difficult concept to sell in Cache Valley. He recalled a time in the mid-2000s when Logan City attempted to set a strict boundary, and the measure failed at the executive level. He said that there is support for the type of development a growth boundary encourages, but both citizens and politicians alike, do not enjoy the idea of a strict line that cannot be altered. He rated an urban growth boundary as a high impact element, but low priority in Cache Valley at the time this research was conducted.

When asked about establishing dedicated active transportation funding, Gilbert explained that Cache Valley currently receives $80,000 annually from the federal government for Transportation Alternative Projects (TAP). He stated that this is a very
small amount of money, but leveraged with other funds, has the ability to have a greater impact. He agreed that is a high priority, and doable in the long term.

Gilbert agreed that compact mixed-use development would have a high impact for active transportation. He stated that it is relatively achievable in Cache Valley because the current land-use plan calls for a greater proportion of this type of development. He did, however, state that there has been some push back from residents because they have seen some poor examples built in neighboring vicinities.

Gilbert spoke very positively about the concept of inter urban trails and acquiring rights-of-way along riparian corridors to extend trails whenever possible. He expressed that there is difficulty in acquiring the necessary easements, but stated it was a reality and the County was versed in handling those types of situations.

When the subject of rerouting major arterials out of the downtown, Gilbert commented that he understood the potential value in making a decision like that, but that it would need to be done strategically. Gilbert stated that in the studies that have been done in the past, most of the traffic on Main Street in Logan is localized traffic, meaning it is people moving around inside the valley. He questioned how much sense it would make to divert traffic five blocks west to then proceed on a north south route if the original destination of the citizen was east of main street and only 10 blocks north of downtown Logan. We discussed a BRT option on Main Street and Gilbert stated that is idea has been brought up within the CMPO board, but it has encountered a few roadblocks in recent years. Hopefully, it will be reevaluated in the next few years when the political climate is conducive to that discussion.
Gilbert agreed that a complete streets policy is an important component of actualizing active transportation infrastructure. He said that the CMPO works to ensure that many of the new projects have considered active transportation in the design phase but said that more needs to be done on the state level to prioritize active transportation.

Gilbert agreed that having dedicated active transportation city staff makes a massive difference in prioritizing active transportation projects. He believes that while Cache Valley has made some effort in making that happen, he is unsure if there is long-term dedication to prioritizing funding.

**Cache Valley, UT: Existing Condition**

**Context**

Cache County is a semirural county located in the north corner of Utah. The reported population as of 2013 was 116,909. The county has an area of 1,173 miles and the county seat and largest city in Cache Valley is the city of Logan. Logan is unique to other metropolitan cities in Utah in that it is not serviced by a freeway. Cache County is home to three colleges and Universities with Utah State University being the largest. There are 19 cities and towns within Cache County, all of which are located in a geographic bowl, with the Wellsville mountain range on the west side and the Bear River range on the east side. The population is expected to double in Cache Valley by 2050 (Envision Utah, 2014). The main economic sectors are agriculture and service.

Historically, most of the cities in Cache Valley were established in the late 1800’s as Mormon settlements. The cities of Cache Valley, like many Mormon settlements were
based on the “City of Zion” plat, which is a uniform grid system (see Figure 36).

This gridded city design was convenient and easy to navigate with wide transportation corridors and identifiable landmarks. Today, Cache Valley boasts very wide street rights-of-way and still has strong ties to the original grid system (see Figure 36).

According to the U.S. Energy Information Administration (2016), Utah produced 66.4 million metric tons of CO$_2$ into the atmosphere in 2013—16.5 million metric tons of that was produced within the transportation sector.

Because of the topographic bowl that makes up Cache Valley, the area suffers from poor air quality during certain times of the year. During the colder winter months an atmospheric inversion occurs, which is a trapping of colder air near the valley floor below a warmer layer of air at higher altitudes. This inversion phenomenon prevents

*Figure 34. Plat of Zion grid system (urbanplanning.cornell.edu).*
atmospheric mixing, which traps particulate pollutants (some of which are produced through tailpipe emissions) and pollute the air shed. NOX and VOC’s are harmful particulate pollutes caused by vehicles that are trapped in our air shed during inversions.

As of 2014 Utah had the 45 lowest adult obesity rates in the country at 25.7%. In 2013 the adult obesity rate was 24.1%. The state has also reported a low childhood obesity rate, 11.6%.

Logan, the County seat has a modal split of 70.9% of people driving to work alone, in a personal vehicle. 3.4% take public transportation, 2.9% bicycle, and 7% walk (U.S. Census). According to the Utah Travel Study conducted in 2013, 67% of the trips taken in Cache valley are under three miles. There is a local transit system in Cache County, Cache Valley Transit District (CVTD) which is supported by a local sales tax and multiple federal grants. The system is free to use, but according to the Utah Travel Study roughly 68% of Cache residents reported that they have never used the transit system (Utah Travel Study, 2013).

Figure 37 demonstrates the current active transportation system in Cache Valley.

Existing Transportation Plans

In order to provide sufficient context for the Alternative Future for Active Transportation in Cache Valley, UT it is important to draw attention to some of the major plans that have been completed within the realm of transportation. It is also important to discuss if/how these plans support certain active transportation prerequisites because it indicates where there is momentum building for certain aspects of active transportation,
Figure 37. Existing active transportation networks in Cache Valley, UT.
and where it would be reasonable to expect future prioritization. These plans include the:

- Utah Department of Transportation (UDOT) Long Range Plan;
- Cache Metropolitan Planning Organization (CMPO) Long Range Transportation Plan;
- The Cache Valley Transit District Short Range Transit Plan;
- The Logan Transportation Master Plan;
- The Logan Bicycle and Pedestrian Master Plan
- Other plans

Each of these plans will be described briefly as they relate to this research.

**Utah Department of Transportation Long-Range Plan, 2015-2040.** The Utah Department of Transportation compiles long range plans every four years to identify projects for implementation by UDOT throughout the state. Projects prioritized in the Long Range Plan are those that fall on roads within UDOT jurisdiction. UDOT is organized by Regions, and Region 1 includes Cache County along with several other counties in the northern part of the state. The 2015-2040 plan outlined the following projects for Cache that may be relevant to active transportation:

- Add one additional travel lane in each direction to State Route 30.
  - *How can cycling be incorporated into this lane expansion?*
  - *Could a bus route be added here?*

- Widen US-89 northbound from mile post 486—489 to accommodate slow uphill traffic.
  - *Is there an opportunity/need for a BRT system on this canyon road?*

**CMPO Long Range Transportation Plan, 2040.** This document was produced in cooperation with the Utah Department of Transportation, Cache Valley Transit District, Cache County, and other stakeholders in the Cache Valley area. Identified priority areas that could affect active transportation include:
• Future capacity improvements on the Main Street corridor, including transit investments
• Commuter transit service between Logan and Ogden
• Circulator shuttles for communities in the Cache Valley
• Future expansion of express routes to bus rapid transit (BRT)
• Sidewalk connectivity improvements
• Snow removal enforcement for sidewalk routes
• Improved pedestrian crossings on major roadways
• Bicycle storage facilities near transit routes
• Bicycle racks, including covered facilities
• Selected shoulder widening throughout Cache Valley to accommodate bicycle

**Cache Valley Transit District Short Range Transit Plan, 2012.** As outlined in
the Short Range Transit Plan, Cache Valley Transit District (CVTD) operates 16 routes in
the Cache Valley. Ridership on CVTD has generally trended upwards from 2006-2010,
despite a small dip in 2008 during the recession. Recent public outreach efforts through
the plan identified several issues and needs associated with transit access in Cache
Valley.

• The span of service during the day needs to be longer
• More frequent service is needed
• More direct service and competitive travel times are desirable

**Logan City Transportation Master Plan, 2008.** The Logan City Transportation
Master Plan analyzed future roadway needs throughout the city and identified several
active transportation initiatives.
• A Pedestrian-Friendly Streetscape Plan, outlining design elements and sidewalk standards.

• Work to provide bicycle friendly street treatments in the downtown area.

• A new form based code was implemented, which encourages dense, multi-use development.

**Logan City Bicycle and Pedestrian Master Plan, 2015.** The Logan City bicycle and pedestrian master plan examined potential programs and facilities that would help improve the walking and bicycling conditions in the city of Logan. General proposed improvements include:

• Sidewalk improvements and completing network gaps (a sidewalk inventory was completed as a part of this effort)

• Crossing improvements

• Bike network facilities

• Shared use path and side path projects

**Alternative Future for Active Transportation in Cache Valley, UT**

The following section describes each of the prerequisites in a Cache Valley, UT context, and outlines the progress made towards each prerequisite. Acknowledging that progress towards achieving any given prerequisite takes time and that at the time this research was conducted, a static image of progression was taken, Table 2 diagrams a qualitative assessment of the progress made. The asterisk (*) symbol denotes an element that will be reproduced on the Alternative Future for Active Transportation in Cache Valley, UT map.
**City-Wide Policy Elements**

**Urban Growth Boundaries / “Blue Line.”** Cache Valley is a semi-rural community in a geographic bowl. Strict urban growth boundaries should be established around existing cities and towns. Urban growth boundaries will promote active transportation while also preventing development from encroaching on the agricultural and natural areas. A Blue Line should be established in Cache Valley at roughly 5,200 feet to preserve important view sheds, while making active transportation more viable. Currently, there are multiple municipal boundaries that cross that threshold and should be redrawn below the Blue Line. Existing buildings should be “grandfathered” in, but no new development over 5,200 feet should be permitted. An urban growth boundary could be achieved in Cache Valley by working with local politicians and creating a base of support around the merits and benefits of it. Such a boundary would have to be adopted within a general plan in order to be implemented.

**City-wide dedicated active transportation funding.** Cache Valley should continue to use the $80,000\(^3\) TAP funding for active transportation initiatives. Additional funds should be leveraged to bolster and increase this amount. Cache Valley should call on the Boulder example and leverage federal funds with local funds. A potential option for funding includes Congestion Mitigation and Air Quality (CMAQ) federal grant which is a substantial pool of monies, available to communities in nonattainment air quality areas, as established by the EPA. Currently, Cache Valley qualifies for this grant. Other sources of revenue should be explored.

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\(^3\) It is noted that in 2016 this amount was closer to $200,000. The exact amount may vary year to year, based on how much is allowed to Cache Valley by the Federal Government.
Compact mixed-use development. Cache Valley should reexamine its land use plan and determine whether there are opportunities to increase suitable areas for multi-use commercial and residential development. A form based code already exists in the city of Logan, which is a significant, positive step forward. This form based code should be referenced often, and other communities in Cache Valley should be encouraged to adopt a similar code. Additionally, parking requirements should be decreased on all new developments, while bicycle parking and pedestrian facilities should be required. By doing this, active transportation modes are encouraged, while motor vehicle use is discouraged, creating a built environment that prioritizes active transportation. It would be beneficial for Cache Valley to also do an inventory of existing commercial areas to see if there are opportunities for more mixed-use developments. It could also be enlightening to do an investigation of existing commercial structure parking facilities on the north end of Cache Valley, along Main Street, to see how often they are at or near capability (see Figure 38). Those parking lots that do not meet a minimum parking occupancy should be reconsidered for commercial development.

Figure 35. Parking lot in Logan, UT.
Inter-urban trails network. With its impressive mountain views and active community, Cache Valley is a prime location for an intricate inter-urban trails network. Progress towards an interurban trail network has already been made and should continue moving forward. For example, Logan City is examining certain canals and riparian corridors to determine where they can be converted to trails. An additional measure that could be explored is assessing the feasibility of a Valley “belt” trail circumnavigating the entire region and then connecting with the Bonneville Shoreline trail to the east. Such a trail could serve as an active transportation “spine.”

Parking restrictions. As Jeff Gilbert pointed out, in addition to James Nye (Utah State University Parking and Transportation Services Director), there is plenty of parking throughout the Valley, it is just not what might be considered “convenient” parking. Existing parking should be evaluated and potentially eliminated if the space could serve a different purpose, or if it is determined it is unnecessary. As Cache Valley continues to increase in population, space will continue to become a valuable commodity. Assessments of space allocation trade-offs could help cities determine where they are willing to give up parking space for other community amenities. It is also recommended that new building construction convert their parking minimums to parking maximums, while making secured, covered, bicycle parking easily accessible, and abundant.

New vehicle lane restrictions. Often, vehicle congestion can be mitigated by making the existing network more efficient, instead of building more vehicle lanes (which is costly and may make congestion worse due to induced demand). Cities in Cache Valley should continue to identify critical locations where roadway Level of
Service is failing and should work with engineering departments or UDOT to determine whether there are opportunities to increase efficiency through operation management techniques, such as, signal timing optimization, lane reconfiguration, etc. Any instance where there is consideration of building new travel lanes, a careful examination should be done. In the future Cache Valley should examine the feasibility of establishing a Boulder type policy, disallowing the construction of new roads.

**Sustainability plan—GHG emission reduction measures.** Cache Valley has a strong case for promoting active transportation due to the amount of air pollution conventional transportation produces and then gets trapped during inversions. In 2013 Cache Valley began requiring emission testing on personal vehicles. This was a positive step for air quality, however, it should be made more stringent. There should be a larger emissions reduction plan established, that includes active transportation as a key component.

**Easements for trail construction along riparian corridors.** Trails should become a component of the many, beautiful, riparian corridors in the Valley. Many of the rivers have been piped within city boundaries, a measure that should be reversed, if possible, in order to restore the river to its natural state and provide active transportation opportunities. Most of the rivers flow east to west, and if there were trails near them, they would provide important east/west connections, while preserving the rivers for habitat connectivity.

**Formalized complete-street policy.** All roads in Cache Valley should consider all modes of transportation whenever possible. A complete-streets policy would help to
insure vehicular traffic movement is not the only condition considered in new road projects or restriping projects. Both Boulder and Portland planners claimed that a complete-street policy has helped them deflect any controversy around a specific active transportation project that was not popular amongst city officials. This type policy would need a local champion to help draft and gather needed support. The local city councils would be required to vote on such a measure and approve it.

**Minority population outreach.** Cache Valley has a relatively high immigrant and refugee population. These populations should be considered when promoting and educating the public about transportation options in the valley. These populations should be educated on safe bicycle riding techniques and should have educational resources translated for them to ensure they understand the materials. Cache Valley can look to Portland for examples of how to make resources available online. City staff time to create materials, translate them, and push them out to the local communities would be required to make this initiative work.

**Local university research partnership.** Cache Valley has an excellent resource at its disposal, Utah State University. In the past, there have been efforts to contract research out to the university. However, it may be beneficial to establish a more formalized partnership and agreement on certain projects to set clear guidelines and outcome requirements. Cache Valley could draw on the example of Portland and Portland State University and determine whether a center for research may be beneficial.

**Active transportation city staff/office.** In 2016 Cache Valley hired a trails planner to spearhead the effort of establishing more trails throughout Cache Valley. This
is an important step and should serve as a catalyst for additional positions being created that are dedicated to active transportation. Both Portland and Boulder have offices for active transportation, which are funded through dedicated sales taxes and auxiliary funding sources. Cache Valley should consider these two cities as examples and determine the feasibility of establishing a dedicated sales tax to support active transportation.

**Prioritize Network Connectivity** Jeff Gilbert stated that active transportation network connectivity is an aspect of the system that is lacking in Cache Valley. The city of Logan contracted out a bicycle and pedestrian master plan, which helped identify those missing bicycle and pedestrian connections within the city limits. Unfortunately, the plan ends at the jurisdictional boundaries, leaving the other cities without a vision for bicycle and pedestrian planning. The same planning effort should be completed for the entire valley to avoid fragmenting the network. Once a regional plan is in place, it should be referenced when opportunities arise to complete part of the network. This is a difficult, yet critical component of building out the network. Often times cities will incorporate a bike lane or other facility only when they are undergoing a different roadway project on that segment. Having someone being aware of the regional plan and advocating for its implementation when opportunities arise is critical.

**Reroute major arterials away from downtown cores.** The most prevalent example of where this should happen is in the city of Logan. Main Street Logan is a five-lane major arterial that bisects the city into two distinct parts. This road is often congested and is a major barrier for those on bike or foot attempting to cross it. The historic
downtown has its frontage on this road with beautiful building façades, shops and restaurants. The vibrancy of this historic downtown is severely diminished due to the high volume of traffic one experiences as a pedestrian along the road (see Figure 39). The main arterial should be relocated off of Main Street Logan in order to revitalize that area.

Focusing vehicular traffic away from the downtown core would transform the feel of this road. A BRT system could be installed in one of the existing lanes to continue the movement of people along this corridor while downgrading the number of vehicular traffic lanes.

**Bicycling Elements**

**Bicycle master plan.** Logan City completed a bicycle and pedestrian master plan in 2015, which is a very positive move for cycling and walking in the City. This master plan, completed by Alta Planning + Design, identified many of the missing links in the

*Figure 36. Main Street, Logan, UT.*
current bicycle and pedestrian network and designed and prioritized new infrastructure projects based on their potential to make crucial links. As this plan is built out, the City will become more comfortable for cycling. However, it is important to note that this plan only considered the city of Logan. Because bicycle lanes should not end at an arbitrary jurisdiction boundary, a county wide plan should be developed with the goal of continuing the recommendations from the Logan plan on a county scale.

**Grassroots champion.** Residents of Cache Valley need to make a concerted effort to express their support for cycling infrastructure and education. This could happen through advocacy groups or cycling clubs. As was evident in the case in both Boulder and Portland, these important initiatives must have support from the grassroots level. The communities of Cache Valley are small enough that opinions voiced by the public will be heard and should be a part of the decision-making process.

**Safe routes to school program.** Currently, Cache Valley does not have a Safe Routes to School program. A program should be implemented in order to begin formally educating the students of Cache Valley about the benefits of cycling, while showing them how to ride in a safe and courteous fashion. Just as young people need to be educated on how to drive a vehicle safely, they need to be trained on proper cycling etiquette. Once students are educated on cycling, a bicycle suddenly becomes more than a toy and instead, a legitimate form of transportation. There is federal money available for Safe Routes to School programs, Cache Valley need only to apply for the funds through the local UDOT. Portland and Boulder have implemented Safe Routes to School programs and state that they are invaluable components of their cycling advocacy toolboxes.
**City bike share program.** A city bike share program enables short trips to be taken on a bicycle. Bike shares make cycling an option from those who express that their biggest barrier to cycling is not owning a bike. In Cache Valley, according to the 2012 Home Travel Survey, nearly 60% of residents site “not owning a bicycle” as the reason they do not bike consistently. A bike share program would target and empower that precise population of potential riders. Giving residents access to bicycles they are not required to maintain, do not have to store, and could use easily, would lower the burden of entry, significantly. Cache Valley should seek public participation in locating the stations, just as Portland did. This exercise would give community members the opportunity to participate in the planning process and insure that their opinions were collected and considered.

**Bike routes mapped and available online.** Recently Cache Valley just launched the “Trails Cache” which is a website that serves as a clearing house for outdoor recreation information, opportunities, and maps. The user-friendly interface, relevant content, and mobile app friendly design make this website a great place to house active transportation maps and information. This website is dynamic and could also allow for people to see events happening in the area that pertain to active transportation. The maps should be in addition to wayfinding signage throughout the city. Branding the routes with unique imaging and consistent nomenclature would make them easily identifiable and simple to follow.

**League of American bicyclists—bicycle friendly community rating, gold or higher.** It would be a laudable achievement for Cache Valley to receive a gold ranking.
This ranking is less about the award than it is about the improvements the city had to make in order to receive the award. Cache Valley should start by implementing many of the bicycle infrastructure improvements detailed in the Logan City Bicycle and Pedestrian Master Plan, then expand these efforts to the surrounding cities. Once this is achieved it should consider applying as a Bicycle Friendly Community. This recommendation should be considered a final step for Cache Valley, UT, but an important one, nonetheless.

**Prioritization of separated bicycle infrastructure.** Cache Valley benefits from wide roadways, which could accommodate above curb separated bicycle facilities or on-road separated bicycle facilities. These facilities are considered low stress because they delineate, with a physical barrier, the travel locations for vehicles and cyclists. Recent best practices identify separated cycling facilities as preferred by people who may not feel comfortable riding in a conventional bike lane. Typically identified as the “60%” (see Literature Review), this portion of the population indicates that they would consider riding if there were high comfort facilities for them to use. Cache Valley has many young families and separated cycling facilities could encourage them to ride together. Both Portland and Boulder have great examples of separated cycling facilities that are heavily used by people in every stage in life. In terms of implementation, a separated cycling facility could be installed on a roadway that warrants a greater level of protection. Then, counts could be completed on that segment of cycling facility to determine if it has increased usage.

**Active bicycle advisory committee.** Cache Valley has a Bicycle and Pedestrian
Advisory Committee that went through a visioning and goal setting process in early 2016. This process allowed the group to define their role as an advisory body in the Valley for all bicycle and pedestrian related topics. This group should strive to become a legitimate board of voting members that acts as a sounding board for cycling and pedestrian ideas presented to them by county officials. This group could become an invaluable source of information for the community if the energy is harnessed and members are delegated tasks.

**Bicycle underpasses.** If Main Street in Logan does not transition away from being a major arterial, consideration should be given to implementing bicycle and pedestrian underpasses along that corridor. Currently, it is a huge physical and conceptual barrier for those wishing to walk or ride a bicycle. There are only a select few intersections along Main Street with a traffic light where pedestrians can cross Main Street. Additionally, there are even fewer locations where there are cyclists have detection, meaning, they can prompt a light change. At least one underpass should be constructed in a strategic location for the safety and comfort of active transportation users. Underpasses should also be considered along many of the riparian corridors in order to ensure the preservation of the river systems, while making critical active transportation links. Boulder provides examples of such underpasses.

**Bicycle facility maintenance/snow removal.** Cache Valley should establish a plan for bicycle infrastructure maintenance. This should include lane re-striping and facility sweeping. While there is often a restriping plan for vehicle lanes, a similar plan should be put in place for bike lanes. There is potential to organize citizen volunteers to do some annual larger cleaning events on an as-needed basis (an example of this is in Salt
Lake City where locals help with noxious thorn barring weed removal on an annual basis). During inclement weather events, the existing bike lanes should not be used for snow storage of the motor vehicle lanes, whenever possible. This will require coordination with the Public Works department to establish a plowing schedule that includes snow removal in the bike lanes and multi-use pathways. Currently there is an ordinance that requires residents to clear the sidewalk in front of their home. The ordinance is relatively weak in comparison to its counterpart in Boulder. The fine is small and many “warnings” are issued before any fine levied.

**Walking Elements**

**Twenty-minute neighborhood.** The majority of residential areas in Cache Valley are single family dwellings that are not densely clustered together. The Valley has large amounts of space with farm lands that have slowly been subdivided over time as historically farming families have decided to sell their land to developers. This selling of agriculture land is causing the Valley to lose the important semi-rural, agriculture, sense-of-place that many residents cherish, because development is continuing to encroach farther out from developed cores. It would be difficult to completely change the layout of the Valley to high density, multi-use developments in a short amount of time, but there are techniques that would help with land lose over time. The Valley should incentivize infill development inside existing jurisdictional boundaries while identifying existing urban nodes that could be expanded to create more 20-minute neighborhoods. Streets should be walkable, which according to Strong Towns means:

- Walkable streets do not have swoops, slip lanes, pork chops, and other features that encourage drivers to make fast turns;
• Walkable streets have narrow lanes, typically 10 feet wide—even for buses;
• Walkable streets place continuous shade trees in any medians;
• Walkable streets have parallel parking along every curb, to protect pedestrians (and potentially bikes) from moving traffic; and
• Walkable streets are lined by buildings that give them life, and in urban locations these buildings are tall and sit directly against the sidewalk. (Strong Towns, 2016)

**Sidewalk inventory.** Before Cache Valley can begin filling in the sidewalk gaps, and missing links an inventory must be completed to understand where those gaps are. Completing in the sidewalk network throughout Cache Valley should be a high priority for the cities. The ability to walk within your community is a basic commodity that all residents should have access to. It is unsafe to divert pedestrians out into roadways because there is no sidewalk available (see Figure 40). In 2014 over 30 pedestrians in Utah were killed due to motor vehicle crashes, and another 785 are hospitalized for the same reason, and this figure has been increasing every year over the past 10 years (Utah Department of Public Safety, 2016). As part of the 2016 Logan City Bicycle and Pedestrian Master Plan, sidewalk gaps were identified. Again, while this is an important step, a similar audit should be completed for the rest of the valley, to ensure all sidewalk gaps are eliminated over time.

**Compact city blocks.** Cache Valley cities have relatively long city blocks, which is a disincentive for walking due to the overall distances required for travel being greater. Cache Valley also has many cul de sac type development that require a circuitous route to arrive at a destination that is geographically close. Any opportunity the Cache cities have to shorten block lengths by connecting non-through streets should be taken in order to
encourage short walking trips. There are many examples of this being done only for pedestrians. Streets do not have to be through streets for vehicles, it is possible to create sidewalk connections in key locations to encourage walking without allowing vehicular through movement. There are locations in Logan City where this has been done.

**Pedestrian mall.** If the major arterial was moved off of the main streets in Cache Valley, there could be an opportunity to convert those thoroughfares into pedestrian promenades. Although it would be very unlikely for Main Streets in Cache Valley to be closed to vehicular traffic completely, the historic buildings, trees and wide sidewalks would make for beautiful pedestrian areas if the roads had less traffic and slower speed limits. Dedicated pedestrian-only malls could be implemented on other streets that currently have little vehicular traffic and amenities available to people. Pearl Street in Boulder is an example of this.

**Active pedestrian advisory committee.** See *Active Bicycle Advisory Committee.*

**Pedestrian underpass.** See *Bicycle Underpass.*
Sidewalk snow removal policy. See *Bicycle Facility Maintenance/Snow Removal*.

**Missing sidewalk link app/fix-it app.** Citizens of Cache Valley could assist local officials in identifying the missing sidewalks, or the sidewalks that are in need of repair. Boulder has a program that encourages its citizens to actively participate in the ongoing sidewalk inventory through an online crowd sourcing phone app. Based on the collective gathering of information through the phone app, the city then prioritizes funding to install sidewalks or repair existing ones.

**Pedestrian friendly intersections and crossings.** There are examples of innovative pedestrian crossing treatments in the city of Logan. Certain streets have color delineated crossings with bulb-outs to make crossing distances shorter. Despite having relatively long blocks throughout the cities of Cache, mid-block crossings are prohibited due to liability reasons. Should Logan and other cities of Cache Valley find a solution to the mid-block crossing liability issue, there are many examples of ways to make it safe for pedestrians to cross the street in the middle of a block. HAWK Beacons, pedestrian refuges at mid crossing, rectangular rapid flash beacons, and flagged intersections, are a few examples of mid-block treatments that will support research—proving their safety.

Existing, lighted intersections should be examined for pedestrian safety. Lighted right turn signals for vehicles may help prevent injures to pedestrians within crosswalks. Additionally, the ADA has specific requirements for feet per seconds at lighted intersections. Cache Valley should insure that all its lighted intersections comply with ADA regulations.
Public Transit Elements

Regional/city service. As previously stated, Cache Valley is served by the CVTD, which is a fare-free system. CVTD has routes throughout the valley, although the most routes are concentrated in and around the city of Logan, because it has the greatest population and greatest concentration of employers. As of 2016 CVTD did not offer a connection between Cache Valley and Salt Lake City (80 miles), the capital of Utah and largest economic hub in the state.

CVTD and its fare free system is a great asset to Cache Valley but could be improved to make a greater impact. All CVTD routes must make a mid-route stop at the transit center, located in central Logan. This mid-route exchange is necessary for many transfers but causes overall trip times to be significantly higher. An analysis should be completed to understand how service routes could function without the mid-route exchange at the transit center. There may be a more efficient way to conduct the routes that does not involve stopping at the transit center.

Many of the smaller cities throughout the Valley are underserved by CVTD, which is encouraging personal vehicle use within those areas. More routes need to be added to the smaller cities in the Valley. Funding for those route additions could be shared by CVTD and the smaller communities.

CVTD should also provide Cache residents with a connection to the Wasatch Front. Currently there is a private shuttled service that goes from Preston, ID to the Salt Lake City International Airport, but due to its cost and schedule, it may not be sufficient for the growing Cache population. A CVTD Ogden connection route should be
implemented for a fare. This route could service the FrontRunner transit hub in Ogden, which would then connect people to the airport and the entire Utah Transit Authority (UTA) system.

**Transit passes available through employers.** All CVTD routes and services are free, therefore this prerequisite has already been met.

**Bus rapid transit feasibility study.** Jeff Gilbert suggested that much of the traffic along Main Street in Logan, North Logan, Smithfield, and Richmond is local traffic, meaning it consists of people who live and work within the valley. A BRT system along Main Street in Cache Valley that extends from Preston, Idaho to Wellsville, Utah could yield a significant reduction to Main Street Traffic, while doing so in a relatively cost-effective way. The system would have to be systematically linked to other routes in order to accommodate an entire trip for residents. It could also be linked to a bike share system to encourage a multi-modal trip.

**Park-n-ride lots.** Cache Valley has a park-n-ride lot on the south end of the valley. Once a more comprehensive transit system is established with a BRT system in place and a connection to the Wasatch Front, more park-n-ride lots should be installed. Similar to Boulder, park-n-ride lots could be added along the Bus Rapid Transit route to encourage people to carpool to the stations.

**First-last-mile strategies.** CVTD has been working to encourage first and last miles of transit trips to be done with a bicycle. By installing high quality, covered, and secured bicycle cages at their transit center, they have made it easier to ride a bicycle as a component of the whole trip. Additional measures that could be taken include, insuring
that bus stops are located along bicycle routes, installing bus shelters at bus stops, and working with local cities to make sure bus stop locations have adequate pedestrian facilities near them. Funding for these types of facilities is available through federal pools of money, as well as state funding.

**Airport connection.** See *Regional/City Service Routes.*

**Location tracker app.** CVTD recently teamed up with a third-party app to provide bus tracking services. This service helps system users know bus timeliness and plan accordingly. By having real-time bus location information available, system users and potential system users have a better understanding of system reliability.

**Free fare zone.** CVTD is a fare free system, therefore this prerequisite has already been met.

As discussed previously in this chapter, the consideration of time, and how each of these prerequisites have progresses through time, is an important consideration. Cache Valley has made progress towards creating a transportation system promotes the use of active transportation, but there are still many opportunities moving forward for the region. Figure 41 outlines the progress that Cache Valley has made towards the active transportation prerequisites at the time of this study. This qualitative assessment of progress provides a basis for Cache Valley moving forward, highlighting areas that need work and investments, and areas where significant progress has been achieved.

Figures 42 and 43 are the maps for the Alternative Future for Active Transportation in Cache Valley.
## Prerequisites

### City Wide Policy Elements

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<tr>
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<td>2 City Wide Dedicated Active Transportation Funding</td>
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<tr>
<td>3 Compact Mixed-Use Development</td>
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<td>4 Inter-Urban Trails Network</td>
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<td>5 Parking Restrictions</td>
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<td>7 Sustainability Plan - GHG Emission Reduction Measures</td>
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<td>8 Easements for Trail Construction along Riparian Corridors</td>
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<td>9 Formalized Complete-Street Policy</td>
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<td>11 Local University Research Partnership</td>
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<td>13 Prioritize Network Connectivity</td>
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<td>14 Reroute Major Arterials Away from Downtown Cores</td>
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### Bicycling Elements

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### Walking Elements

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<td>3 Bus Rapid Transit Feasibility Study</td>
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**Figure 4.1.** Current progress of active transportation prerequisites in Cache Valley, UT.
Figure 42. Proposed bike + walk transportation networks in Cache Valley, UT.
Figure 43. Proposed transit transportation networks in Cache Valley, UT.
CHAPTER V
CONCLUSIONS

Implications of this Study

In our modern era this country is faced with many urban transportation and mobility challenges. The western U.S. has a particularly large transportation challenge with its existing car-centric urban design, and large amounts of open space. How will the western U.S. accommodate the transportation needs of the growing population without relying on single occupancy vehicle trips? Can the west combat climate change, obesity, and a failing transportation infrastructure while preserving iconic landscapes with active transportation? Although there is no perfect solution to these questions, active transportation can make a positive impact. If western cities disincentivized the private automobile while providing active transportation choices that are safe, convenient and enjoyable to use, they would experience cleaner air, healthier citizens and less road maintenance to be responsible for.

This research focused on demonstrating the benefits of active transportation while providing other western cities a detailed framework of the elements needed to bolster and expand active transportation networks. The grounded theory produced in this study is aimed at outlining how to make active transportation a reality in the cities of the west. Key legislation, policies, programs, plans, and paradigm shifts in the initial research and in both case study cities were documented and compiled in chronological order to demonstrate the changes made to create the framework for active transportation. The
elements were then assigned a priority based on their overall contribution to active transportation. The goal for this information is that it be used as a guide to help other cities understand the prerequisites to creating a more comprehensive active transportation network. By learning through precedents set, other cities may determine that active transportation can become a viable mobility option.

Several key take-aways can be gleaned from this research. An overarching object of this research was to look holistically at active transportation in the west and answer the question of why some areas or cities seem to be some much more active transportation friendly than others. There are many examples of research that explores one element of active transportation, with quantitative data to support the effectiveness of that element at shifting the modal split. The uniqueness of this research is its attempt to understand the many active transportation elements in concert that make up the whole system. Throughout this research, connections to active transportation were made between policies and infrastructure that many not seem outwardly related. For example, this research made evident the connection between a strict urban growth boundary and a robust active transportation network. While intuitively this connection may have been apparent to some, this research attempted be overt about the connection, with grounded examples and evidence. Put simply, this research provided evidence for the many policies, programs, and infrastructure that are related and tangentially related to active transportation.

This research also drew attention to the importance of progress over time. Each of the prerequisites take time to complete, some take longer than others. While this research
did not specify exactly how long each prerequisite takes to complete, it did acknowledge the process can take years. Even after everything on the list is completed, facility upkeep and maintenance are required, and political support for active transportation may ebb and flow depending on elected officials, public support and available resources.

Taking this one step further, having a list of the crucial active transportation prerequisites provides readers with the simplest way to comprehend the information. This was intentional. A one-page list is a format intended to be readily understood by the vast majority of readers. The list can also be used and a stand-alone document with the rest of the research supporting it. From a practical standpoint, one list is much more likely to be used and referenced by public and private sector planners than long, text-heavy report.

**Limitations of this Study and Opportunities for Additional Research**

The scope of this research was focused on the western U.S. because of its unique geography, topography and climate. The case study cities examined for this study were also located in the western U.S. in order to be sensitive to the unique mobility challenges the western U.S. faces. Future research should be done to compare and contrast the active transportation history in eastern U.S. cities, as well as international cities. Valuable lessons could be learned from conducting a nation-wide audit of active transportation history, facilities and best practices.

This research considered active transportation to be bicycling, walking and utilizing public transportation. This study did not examine other mobility choices, such as ridesharing, peer-to-peer ridesharing (such as Uber, Lyft, etc.), car sharing, and
carpooling. Future research might examine the relationship between active transportation and these expanding ride-share alternatives. It will be important to understand how active transportation complements or competes with these other forms of transportation.

The automated, or, self-driving vehicle is a technology that is not readily available to public at the time this thesis was written, however, it is on the horizon. The self-driving vehicle may change the way cities plan for transportation. It will greatly increase the carrying capacity of roads, especially large arterials, and have the potential to reduce motor accidents. Further research on the implications self-driving vehicles could have on active transportation should be conducted.

This study did not considered walking and cycling within the context of recreation, it only examined them as transportation choices. Therefore, interurban trails and other multi-use recreation and transportation paths were only considered for their transportation value. This is not to assert that they are not valuable for recreation, it is only to say that their recreational benefit was considered outside the scope of this thesis.

This study aimed at providing thoroughly researched and professionally vetted recommendations, it did not explicitly outline how any city in the western U.S. should implement them. Every city it unique, therefore the implementation approach should also be unique and completed on a place by place basis. The chapter of this research on Cache Valley provided various recommendations on how that area could continue implementing active transportation facilities. However, creating an implementation plan for each prerequisite was beyond the scope of this work.

The mapping exercise conducted in the final stage of this research was a basic
demonstration of how the prerequisites can be replicated in a real context. An official plan should be developed for all the mapped recommendations as that detail of planning was outside the scope of this research.
REFERENCES


APPENDICES
Appendix A

Bicycle Infrastructure Design Standards
# 14 Ways to Make Bike Lanes Better

A quick guide to the ways to protect a bike lane.

Developed from research by Nathan Wilkes, City of Austin

## Striped Buffer

<table>
<thead>
<tr>
<th>Feature</th>
<th>Protection Level</th>
<th>Installation Cost</th>
<th>Durability</th>
<th>Aesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
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<td>$8k-$16k per lane-mile</td>
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## Delineator Posts

<table>
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<th>Durability</th>
<th>Aesthetics</th>
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</thead>
<tbody>
<tr>
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## Turtle Bumps

<table>
<thead>
<tr>
<th>Feature</th>
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<th>Aesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
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<tr>
<td>Feature</td>
<td>Description</td>
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<tr>
<td><strong>LARGE BUMPS</strong></td>
<td>1.5 ft. additional width; $15k-$30k per lane-mile</td>
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<td>$ $ $ $ $</td>
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<tr>
<td><strong>OBLONG LOW BUMPS</strong></td>
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<td>☺☺☺☺☺</td>
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<tr>
<td><strong>PARKING STOPS</strong></td>
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</tr>
<tr>
<td><strong>LINEAR BARRIERS</strong></td>
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<tr>
<td><strong>PARKED CARS</strong></td>
<td>11 ft. for parking + buffer; $5k-$16k per lane-mile</td>
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<tr>
<td><strong>JERSEY BARRIERS</strong></td>
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<td><strong>PROTECTION LEVEL</strong></td>
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<tr>
<td><strong>INSTALLATION COST</strong></td>
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<td><strong>AESTHETICS</strong></td>
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<table>
<thead>
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<tr>
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<td><strong>DURABILITY</strong></td>
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<table>
<thead>
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<tbody>
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<tr>
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<td><strong>DURABILITY</strong></td>
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<td><strong>AESTHETICS</strong></td>
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</table>
### 12" Precast Curb
1.5 ft additional width; $400k-$600k per lane-mile

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<td>Installation Cost</td>
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<tr>
<td>Aesthetics</td>
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</table>

### Raised Bikeway
No additional width; $8m-$26m per lane-mile

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<td>Installation Cost</td>
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</table>

The ratings for aesthetics are subjective, based on full life-cycles. For details on all ratings, visit bit.ly/14bikelanue.
Appendix B

League of American Bicyclists—Bicycle Friendly Community Criteria