

Downtown Parks Connectivity Analysis with Geographic Information Systems (GIS)

Fall 2010 • Planning, Public Policy and Management

Trafton Bean • Planning, Public Policy and Management

Marc Schlossberg • Associate Professor • Planning, Public Policy and Management



Sustainable Cities Initiative

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About SCI

The Sustainable Cities Initiative (SCI) is a cross-disciplinary organization at the University of Oregon that seeks to promote education, service, public outreach, and research on the design and development of sustainable cities. We are redefining higher education for the public good and catalyzing community change toward sustainability. Our work addresses sustainability at multiple scales and emerges from the conviction that creating the sustainable city cannot happen within any single discipline. SCI is grounded in cross-disciplinary engagement as the key strategy for solving community sustainability issues. We serve as a catalyst for expanded research and teaching, and market this expertise to scholars, policymakers, community leaders, and project partners. Our work connects student energy, faculty experience, and community needs to produce innovative, tangible solutions for the creation of a sustainable society.

About SCY

The Sustainable City Year (SCY) program is a year-long partnership between SCI and one city in Oregon, in which students and faculty in courses from across the university collaborate with the partner city on sustainability and livability projects. SCY faculty and students work in collaboration with staff from the partner city through a variety of studio projects and service-learning courses to provide students with real-world projects to investigate. Students bring energy, enthusiasm, and innovative approaches to difficult, persistent problems. SCY's primary value derives from collaborations resulting in on-the-ground impact and forward movement for a community ready to transition to a more sustainable and livable future. SCY 2010-11 includes courses in Architecture; Arts and Administration; Business Management; Interior Architecture; Journalism; Landscape Architecture; Law; Planning, Public Policy, and Management; Product Design; and Civil Engineering (at Portland State University).

About Salem, Oregon

Salem, the capital city of Oregon and its third largest city (population 157,000, with 383,000 residents in the metropolitan area), lies in the center of the lush Willamette River valley, 47 miles from Portland. Salem is located an hour from the Cascade mountains to the east and ocean beaches to the west. Thriving businesses abound in Salem and benefit from economic diversity. The downtown has been recognized as one of the region's most vital retail centers for a community of its size. Salem has retained its vital core and continues to be supported by strong and vibrant historic neighborhoods, the campus-like Capitol Mall, Salem Regional Hospital, and Willamette University. Salem offers a wide array of restaurants, hotels, and tourist attractions, ranging from historic sites and museums to events that appeal to a wide variety of interests. 1,869 acres of park land invite residents and visitors alike to enjoy the outdoors.

Course Participants

Social Planning with Geographic Information Systems (GIS)

Marc Schlossberg, Associate Professor, Planning, Public Policy and Management

Steven Abbot, Community and Regional Planning Graduate

Trafton Bean, Planning, Public Policy and Management Undergraduate,
Environmental Studies Undergraduate

Kevin Belanger, Community and Regional Planning Graduate, Environmental
Studies Graduate

Alyssa Diamond, Planning, Public Policy and Management Undergraduate,
Geography Undergraduate

Michael Duncan, Planning, Public Policy and Management Undergraduate

Elena Fracchia, Public Administration Graduate

Nick Garcia, Community and Regional Planning Graduate

Rithy Khut, Community and Regional Planning Graduate

Kory Northrop, Environmental Studies Graduate

Daniel Ronan, Planning, Public Policy and Management Undergraduate

Ben Reder, Community and Regional Planning Graduate

Matt Remer, Public Administration Graduate

Emma Silverman, Planning, Public Policy and Management Undergraduate,
Interior Architecture Undergraduate

Ted Sweeney, Planning, Public Policy and Management Undergraduate

Tanner Semerad, Geography Undergraduate

Eric Stipe, Geography Undergraduate

SCI Directors and Staff

Robert Liberty, Executive Director

Nico Larco, SCI Associate Director, and Assistant Professor of Architecture

Marc Schlossberg, SCI Associate Director, and Associate Professor of Planning,
Public Policy, and Management

Chris Jones, SCI Program Manager

Amy Hause, SCI Program Manager

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Executive Summary

The following report documents the ideas, proposals, and methodologies produced by the Sustainable City Year (SCY) Downtown Parks Connectivity project for the City of Salem. The Downtown Parks Connectivity project members included students in the University of Oregon's department of Planning, Public Policy and Management enrolled in the academic course PPPM 436/536: Social Planning with Geographic Information Systems (GIS).

Project members were given the task of connecting Salem's core area parks by proposing a system of urban pedestrian trails and bicycle routes. The City of Salem hopes to improve pedestrian and bicycle accessibility to enhance the recreational potential of the parks system and the enjoyment of park patrons.

Research was primarily conducted using GIS, however this comprehensive report puts an emphasis on ideas for improving transportation connectivity and connecting Salem's downtown communities rather than the technical GIS methodologies. Note that GIS is still addressed in the final sections of the report and in the appendices, but this is due to the innovative nature of select projects that require a technical understanding of GIS.

Each section is divided into brief summaries of individual projects. Policy and planning recommendations are included on a case-by-case basis. The conclusion section includes an overall summary of recommendations generated by these reports. The structure of the report is as follows.

Introduction and Background

These sections briefly explain more about the class and project scope, and recognize the City of Salem's interest in connecting community members with downtown parks. The two sections also identify several policies that will shape the discussion for future bicycle and pedestrian planning in Salem.

Transportation Planning

This section emphasizes connecting people to Salem's downtown parks by means other than personal automobile, including pedestrian, bicycle, and public transit. Project recommendations include using proposed pedestrian and bicycle networks, removing key barriers to bicycle and pedestrian transportation, creating strategic bicycle and pedestrian thruways, and increasing bus route activity. Technical GIS methodologies and GIS metadata for select projects are located in the Appendix. These recommendations will be most applicable for city staff, such as transportation planners and traffic engineers, and for residents engaged in public issues related to transportation.

Economic Development Proposals

This section highlights opportunities to build community, increase livability, and fund development in downtown Salem. Recommendations for increasing economic development include targeting the tourism industry, focusing on connecting low-income housing developments, and engaging community members in the planning process to create a livable community. These sections will be applicable for community planners and developers as well as concerned citizens.

Community Engagement in Planning

This section offers a new tool using Mobile GIS that allows participants to accurately measure bicycle and pedestrian mobility with in-the-field data collection devices. Recommendations include developing this tool to allow community members to submit their opinions about transportation issues and engage in the planning process. This section will be applicable for community planners, transportation planners, and outreach coordinators.

Conclusion

This section includes a final summary of students' policy, planning, and urban development recommendations and their implications within the larger context of the Sustainable City Year.

Introduction

The City of Salem's goal for this project is to connect Salem's core area parks using a system of urban trails and bicycle routes. This new transportation network could improve pedestrian and bicycle accessibility and enhance the recreational potential of the parks system and enjoyment of parks patrons. Furthermore, the intended product is an integrated set of alternatives for downtown bicycle and pedestrian access that the city can use to initiate community outreach and develop a preferred Parks Connectivity Plan.

The city provided a set of objectives and desired outcomes to guide SCY students in their work. These project ideas included, among others, examining the implementation of a Court Street underpass connection between downtown and Riverfront Park, integrating access to and from Wallace Marine Park with existing development plans for West Salem, and identifying inter-park and intra-park improvements that would enhance recreational opportunities. Given these objectives, project members began addressing these issues of connectivity and community development through classroom discussion and GIS research.

The Social Planning with GIS (PPPM 436/536) course was structured as an application of GIS in urban transportation planning. GIS is a computer-based system that merges geographic locations with statistical analysis and database technology. GIS allows planners and researchers to combine and analyze statistical information with its geographical representation. Project members spent the majority of their work time in the University of Oregon's Social Science Instructional Labs (SSIL) analyzing Salem's infrastructure based on shapefiles, data, and GIS layers provided by city staff.

The strength of this course was its emphasis on using GIS to better understand how planners and community members can create a more welcoming environment and livable community for Salem's residents. Professor Marc Schlossberg stressed the importance of using GIS as a means to an end throughout the academic quarter. Project members were encouraged to be innovative with their ideas and methodologies while using the vision of downtown parks connectivity as a guiding factor for their end product. As a result, this project produced a wide range of ideas spanning the fields of transportation planning, civic engagement, and economic development.

Project topics include bicycle, pedestrian, and transit connectivity, park accessibility, bicycle boulevards, a marathon course, and downtown pedestrian corridors. Some projects targeted specific areas, such as Willamette University and the State Capitol building, while others targeted specific populations, such as elementary school students, tourists, and low-income citizens. Project methodologies ranged from simple spatial analysis of city infrastructure to highly technical GIS data creation and manipulation.

This project aims to create a more livable, sustainable community for Salem residents, and intends to communicate ideas about how to create such a

community to the City of Salem staff members. The students in this course hope that these recommendations will be taken into consideration by city staff members, business owners, and engaged citizens alike in order to address the barriers to creating a more livable community.

Background

The City of Salem has over 4,000 acres of public parks and green spaces, from expansive Minto-Brown Island Park, to smaller city parks like Waldo Park, to public green spaces like the Capitol Mall (see Figure 1). Parks and recreation areas provide a range of opportunities for social gatherings, physical exercise, and relaxation, as well as an environmental balance to the typical urban built environment filled with buildings, streets, and automobiles.

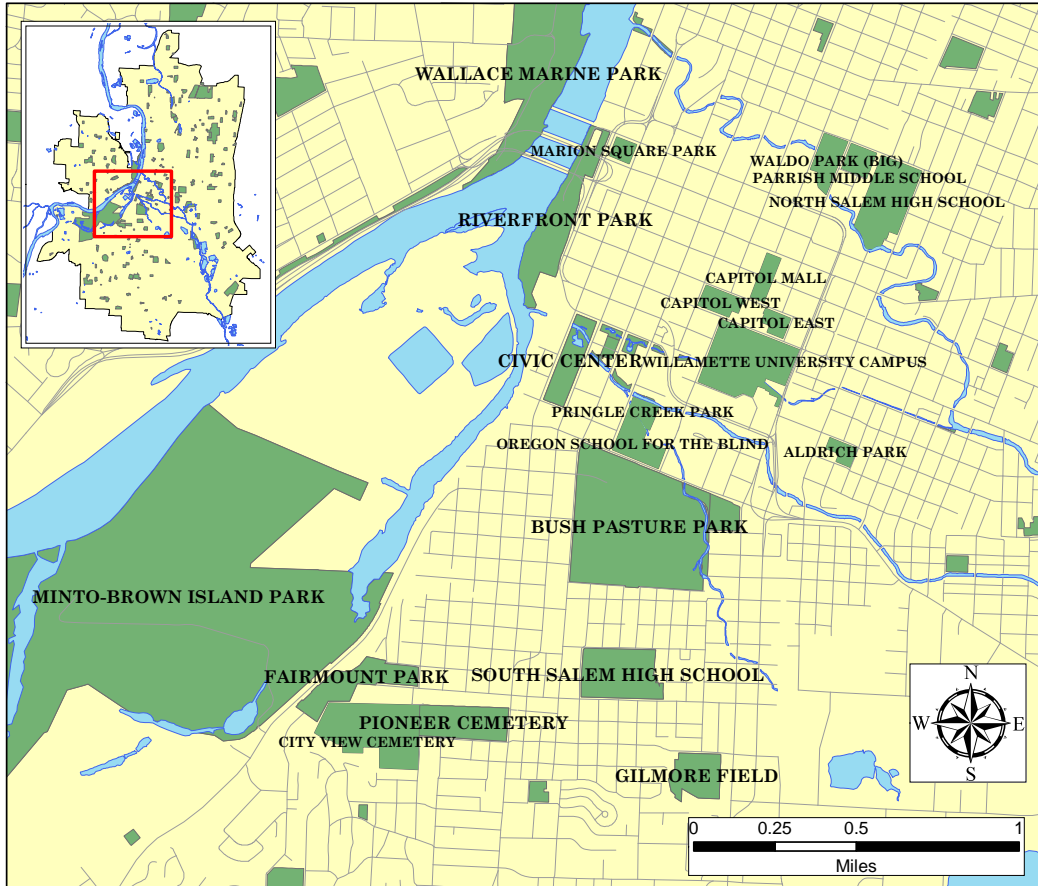


Figure 1: Salem Urban Parks. The map shows all the major parks and green spaces located in downtown Salem.

Connecting these green spaces together into an easily navigable network for pedestrians and bicyclists can encourage social activity, and it also conforms with several planning documents created by the City of Salem to increase and enhance the connection between people and parks.

Updated in 2009, Salem’s Comprehensive Parks and Recreation System Master Plan (CPRSMP) emphasizes the parks and recreation system as a means to “preserve and enhance the quality of life for Salem residents by ensuring ample natural opportunities for leisure, education, and recreation” (City

of Salem, 2008). The CPRSMP also notes that equity among citizens of all ages and ethnic backgrounds is critically important to the city's ideals, and long-term, goal-oriented planning is required to create a successful parks and recreation system (McIntyre, 2007).

The Salem Transportation System Plan (TSP) is the city's master plan to guide transportation policy and planning actions needed to provide safe and efficient transportation in the 21st century. Salem's TSP has goals of providing a "balanced, multimodal, transportation system that supports the efficient movement of goods and people" (City of Salem, 2007). Of particular importance to this SCY project, the city is currently updating the TSP's Bicycle and Pedestrian Elements, which means that Salem is dedicated to upgrading bicycle and pedestrian infrastructure to connect the population and neighborhoods to schools, activity centers, and employment centers.

The City of Salem is planning the future of its downtown core through a process called Vision 2020. Still in development, the plan envisions several districts within and around the downtown core (City of Salem, 2008).

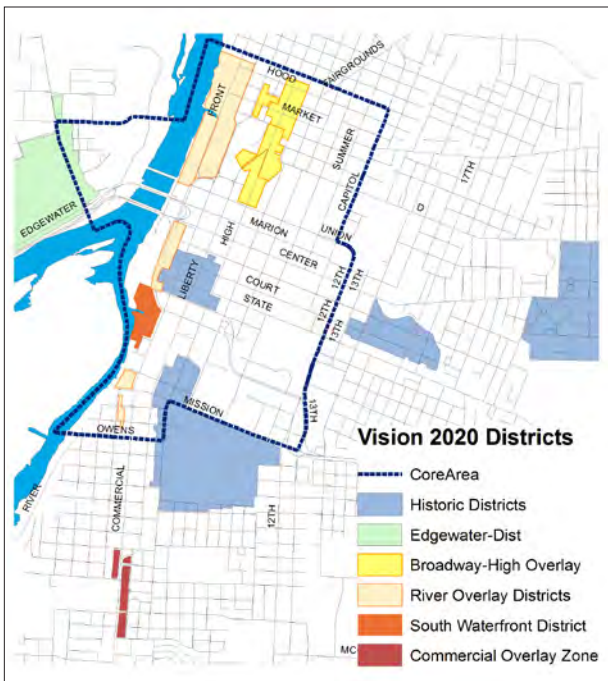


Figure 2: Salem Vision 2020. The City of Salem's Vision 2020 envisions several districts within the city's downtown area.

Historic Districts can preserve the city's unique personality and architectural identity. Buildings in these districts are intended to be close to the street, attractive, and accessible.

The Broadway-High Street District leverages its position just north of the central business district to promote mixed-use development with a Main Street theme. Urban forms in this district will favor pedestrian access, emphasizing connection to a recreational trail along the Mill Creek corridor.

The Riverfront District and Front Street District are combined in Figure 2 as the River Overlay Districts. These will be high-density residential and mixed-use areas that take advantage of their position along the Willamette River to provide access to both leisure and retail activities. Pedestrian facilities will be strongly emphasized. The

Edgewater District, on the west side of the Willamette River, will present a less dense, but complementary, mixed-used development.

Finally, the South Waterfront District takes advantage of its strategic position between the river and the urban core. It will provide a mix of retail services and residential facilities, and provide a connection between Minto-Brown Island and

Riverfront Park.

On a broader geographic scale, the City of Salem is a member of the Mid-Willamette Valley Council of Governments, a voluntary association that promotes cross-jurisdictional collaboration between Salem and the other municipalities within Polk and Marion Counties. In 2007, the Cities of Salem and Keizer developed the 2031 Regional Transportation Systems Plan under the guidance of the Council of Governments and the Salem-Keizer Area Transportation Study (SKATS). The overall goal of the plan is to “provide an adequate level of mobility for area residents and businesses while maintaining or improving the overall quality of the region.” Furthermore, the Plan notes, “one of the main barriers to increased bicycle use in the Salem-Keizer urbanized area is the lack of a direct, continuous, convenient, and safe system of bicycle facilities” (MWVCOG, 2007).

In 2004, the Governor’s Advisory Group on Global Warming proposed a set of goals to reduce greenhouse gas emissions to a level of 10% below 1990 levels by 2020 and 75% below 1990 levels by 2050 in the Oregon Strategy for Greenhouse Reductions. The report recommends encouraging and upgrading infrastructure for non-automobile forms of transportation (Governor’s Advisory Group, 2004).

The aforementioned documents, policies, and goals support the research and analysis of effective bicycle and pedestrian infrastructure. The projects documented in this report are students’ attempts to use research and analysis to recommend tangible improvements for the people of Salem.

Pedestrian Connectivity

Downtown Pedestrian Network and Web Application

Tanner Semerad and Eric Stipe

The City of Salem provided several GIS data layers to aid in students' research, but project members quickly realized this information was more useful for analyzing automobile transportation than pedestrian transportation. This project's aim was to use ArcGIS to create a true pedestrian network of downtown Salem. The project also developed a web-based mapping tool to allow Salem's pedestrians to select walking routes based on time or safety. This web tool was created to make the complex GIS data set easy and useful for the general public and realistic enough for transportation planners to better model pedestrian transportation.

Method

Project members recognized the need to work with detailed data that illustrated real-life attributes of pedestrian routes – sidewalks, driveways, park trails, alleys, parking lots, and street crossings. Because such data did not exist, project members created a new pedestrian network data set. This method involved digitizing pedestrian paths into ArcGIS by tracing them from a high-resolution 2008 aerial photo of Salem. Each section of the route was classified with a specific title and integrated into a GIS attribute table, essentially creating a “hierarchy” of pedestrian transit options based on safety and accessibility. Metadata for this project can be found in Appendix 3. The hierarchy consists of eight discrete classes of pedestrian transit:

- **Primary:** Paths that were on-street sidewalks, paved walks, or protected pathways through parks.
- **Alternate:** Paths that would be logical for a pedestrian to take through a park or green space, assumed to be as safe as a primary path.
- **Painted Crossing:** Marked crosswalks across streets, designated by painted stripes.
- **Driveway:** Segments along paths where there appeared to be a driveway, such as the entrance to a business or a parking lot, going from the street across the line of pedestrian travel.
- **Crossing:** Designated segments for pedestrians to cross a street that are not marked with painted stripes.
- **Alley:** Mid-street public ways where pedestrians might travel.
- **Parking Lot:** Paved open lot for automobile parking.
- **Dangerous Crossing:** Areas with no apparent segment designated for crossing a highly trafficked street.

These designated classes of street segments combine to form a comprehensive, digitized walking network (see Figure 3).

Analysis Applications

Both city planners and pedestrians can utilize this tool. Planners can use this new pedestrian network to assess pedestrian connectivity within downtown Salem. People who regularly commute on foot can use this information to plan their walking route. There are two methods to analyze the pedestrian walking environment with this tool: route-optimized and time-area polygon.

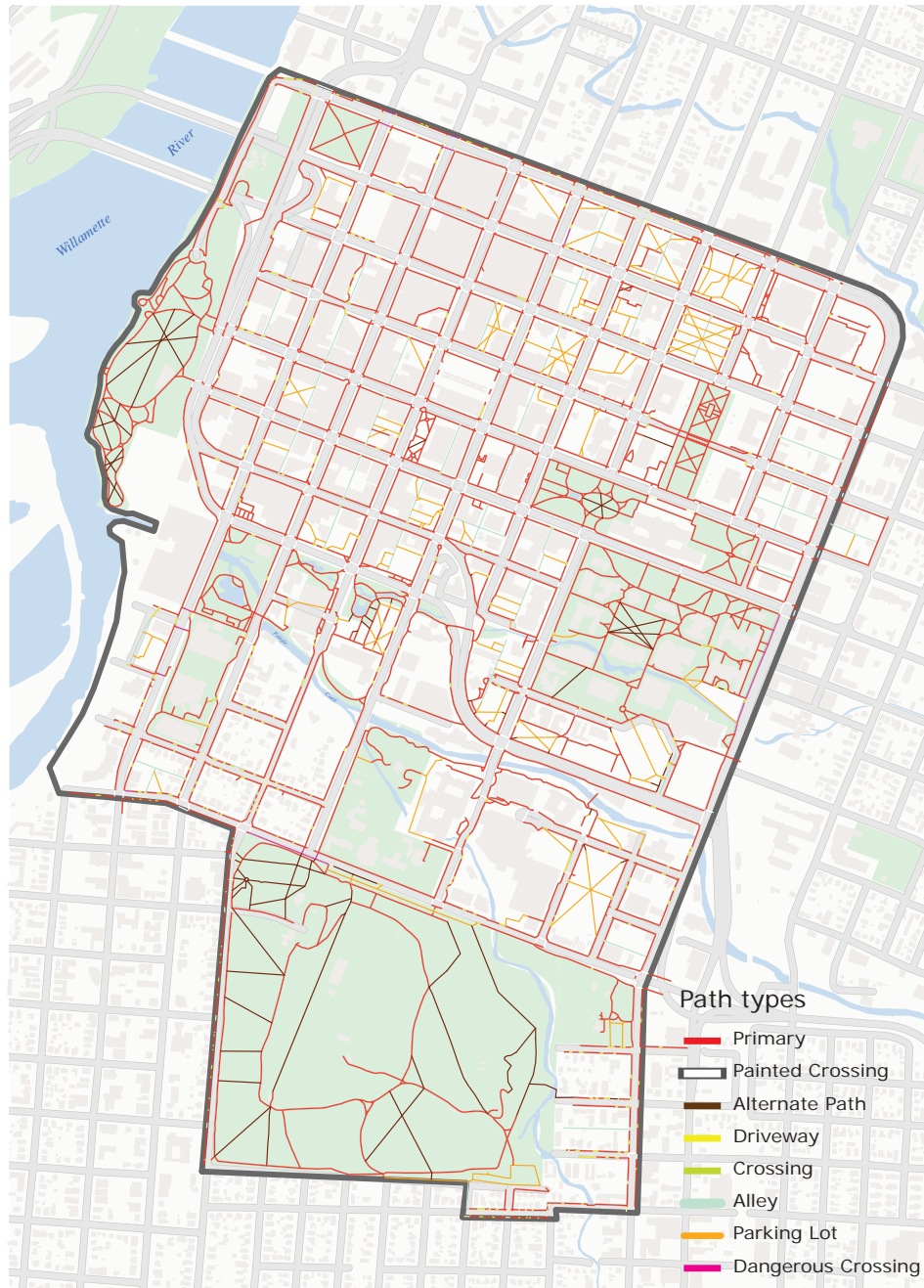


Figure 3: Newly Created Walking Network. The new walking network is color-coded based on eight different path types. Each path type is given an accessibility rating in order to optimize pedestrian routes.

Route-Optimized Analysis

Figure 4 demonstrates pedestrian routes to and from a similar set of points using different variables to calculate each route. The time optimized route (blue) calculates the quickest path between each point, while the accessibility optimized route (pink) calculates the path that would be best suited for pedestrian travel.

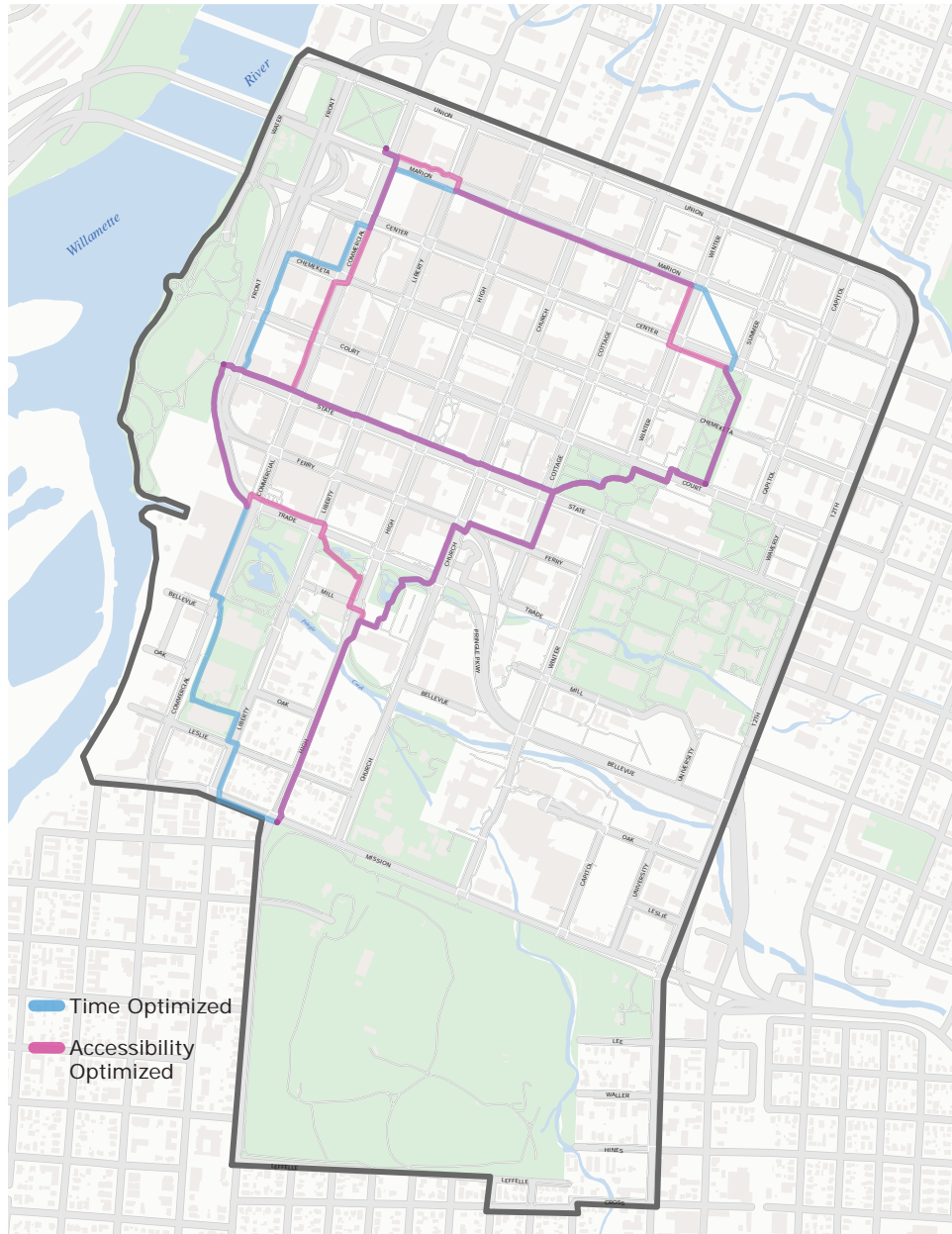


Figure 4: Route-Optimized Analysis. The map above demonstrates pedestrian routes to and from a similar set of points using different variables to calculate each route. The time optimized route (blue) calculates the quickest path between each point, while the accessibility optimized route (pink) calculates the path that would be the best suited for pedestrian travel.

Time-Area Polygon Analysis

Figure 5 demonstrates the functionality of the walking network. The large purple polygons represent the distance one could travel in increments of 3, 5, and 7 minutes from the center.

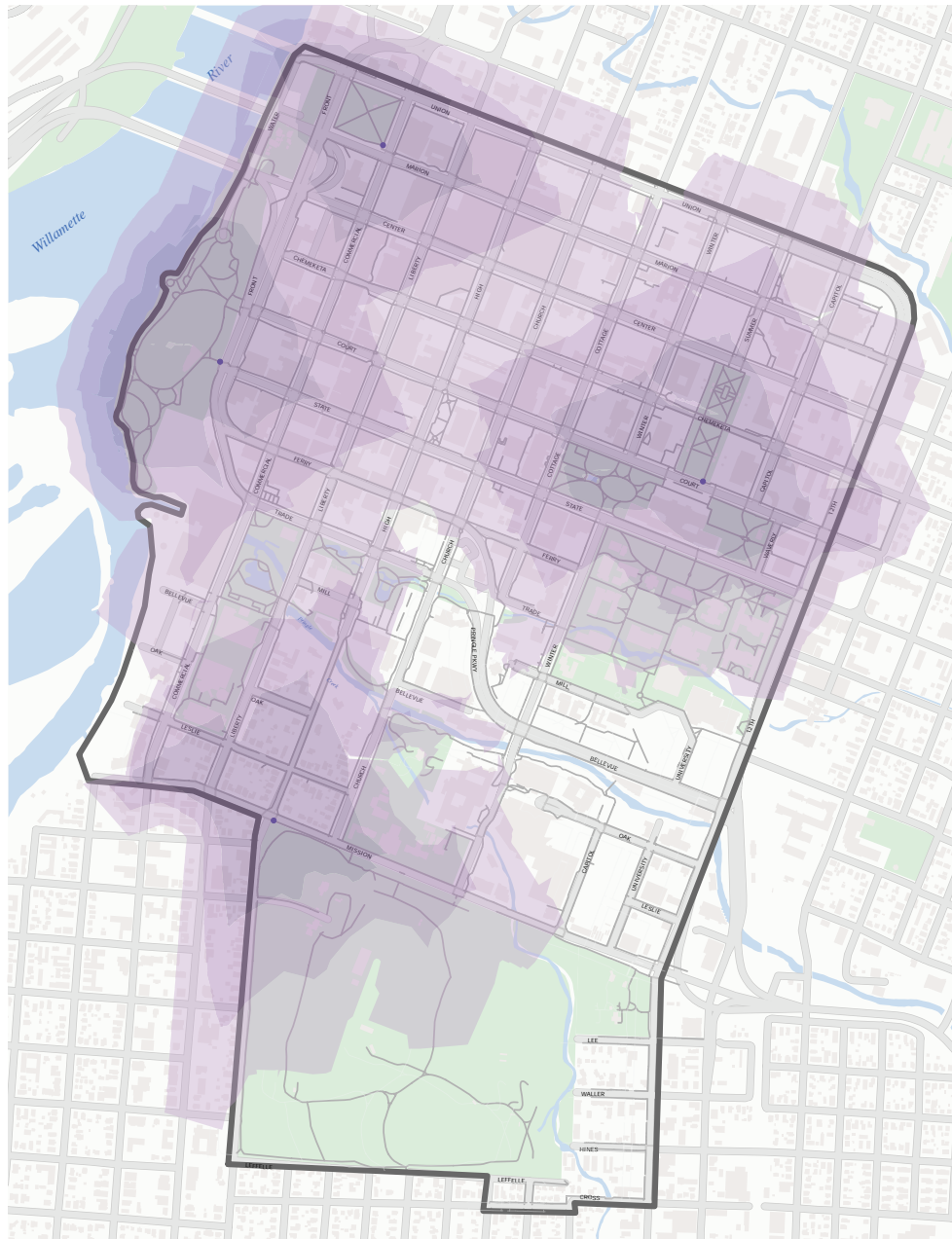


Figure 5: Time-Area Analysis. The map above demonstrates the functionality of the walking network. The large purple polygons represent the distance one could travel in increments of 3, 5, and 7 minutes from the center.

Assumptions

To create a walking network in a limited time frame that yields realistic, believable results, the project team made several assumptions when attributing data to the different streets in the path ‘hierarchy.’

Assumption 1: All paths and sidewalks visible in the 2008 aerial photo used to digitize pedestrian routes are safe and up-to-date.

Assumption 2: Pedestrians travel at an average of 4 miles per hour.

Assumption 3: Different walking paths assume varying speeds of pedestrian commute. The web application designers created a ‘time-impedance multiplier,’ which is the main factor in the application’s ability to calculate a ‘time-optimized’ pedestrian route; see Figure 6 below.

Assumption 4: Different walking paths assume varying levels of safety, accessibility, and convenience for pedestrians commute. The web application designers created an ‘accessibility multiplier,’ which is the main factor in the application’s calculation of an ‘accessibility-optimized’ route; see Figure 6 below.

Path Type	Time Impedance Multiplier	Accessibility Multiplier
Primary	1	1
Painted Crossing	2	1
Alternate Path	1	1.2
Driveway	1.2	1.7
Crossing	1.5	2
Alley	1.2	2.5
Parking Lot	1.2	3
Dangerous Crossing	5	5

Figure 6: Digital Path Hierarchy with Multipliers. These multipliers were integrated into the GIS attribute table with their corresponding path types in order to accurately calculate times and accessibility ratings for the web-based route finder tool.

Web-Application Tool

The web-application tool (see Figure 7) allows people to access the same capabilities of the pedestrian network data without needing any prior GIS experience. The only difference between the GIS tool and the web-application tool is the user interface. Users can customize their walking route in downtown Salem by finding either the quickest or safest paths.

To find a walking route, the user would click either the “Time Route” button (Figure 8-1) to highlight the shortest (Time-Optimized) route or the “Safe Route” button (Figure 8-2) to highlight the safest (Accessibility-Optimized) route. Next,

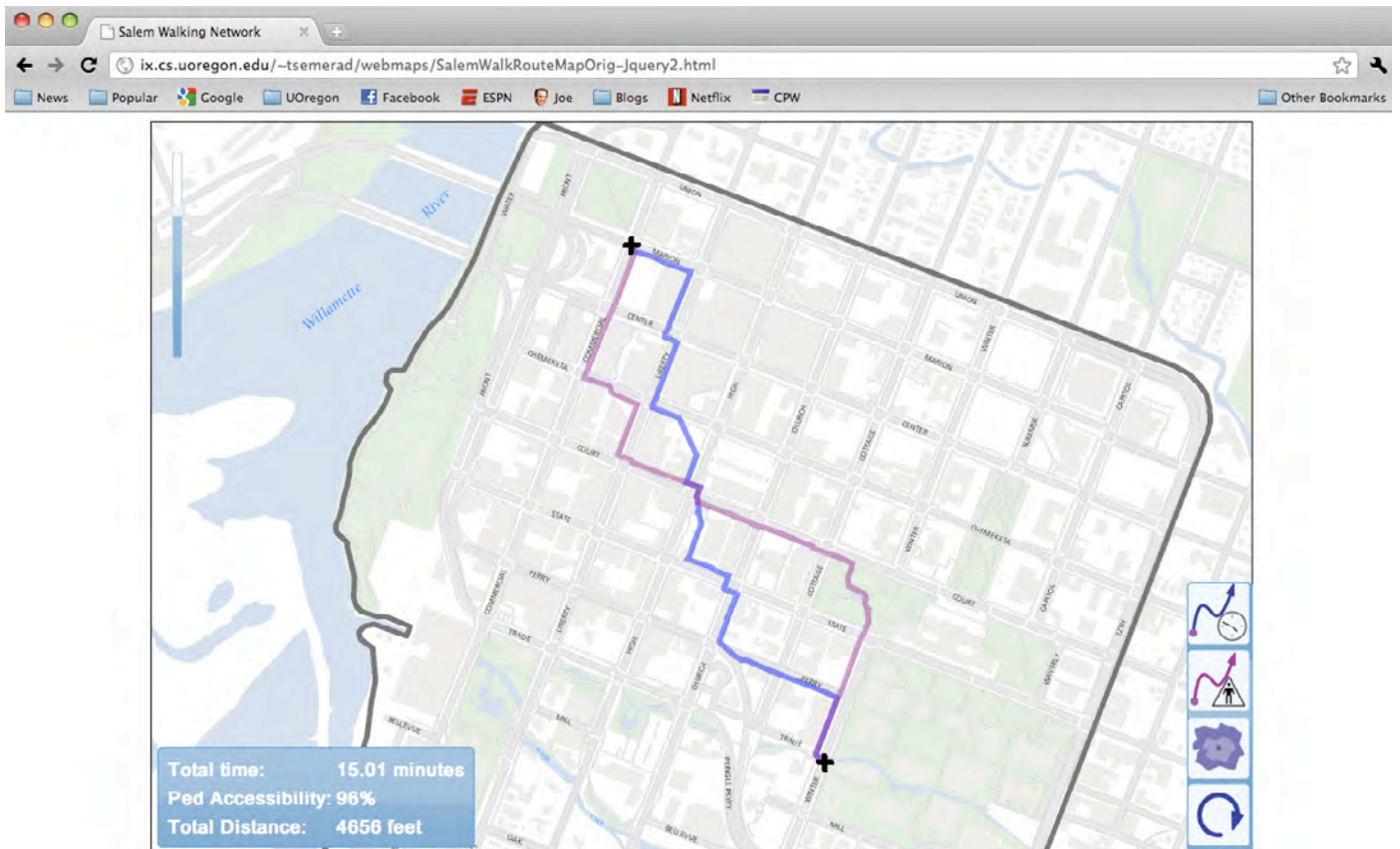


Figure 7: Web-Application Tool. Users can utilize this tool to customize their walking routes in downtown Salem by finding the quickest routes (blue) or safety route (purple).



Figure 8-1 through 8-4: Web-Application Tool buttons

the user would click two different locations on the map that represent a starting point and destination for the user's intended trip.

The user could click the "Time Analysis" button (Figure 8-3) then click a location on the map to perform a time-area analysis. The map would then display shaded polygons representing areas a pedestrian could walk to within 3, 5, and 7 minutes. Finally, the user can clear everything from the map by clicking the "Start Over" button (Figure 8-4).

Recommendations

Planning with New Pedestrian Network

Planners can use this new pedestrian network GIS layer as a tool to assess pedestrian connectivity within downtown Salem. Planners can utilize the "Time

Analysis” tool to focus on improving pedestrian accessibility around a particular intersection or site.

Encourage Use by Salem Residents

Residents, particularly those who regularly travel on foot, can use this information to plan their daily walking routes. City staff can encourage Salem residents to use this new web tool and request feedback on its usability and effectiveness.

Extend the Network Boundaries

This study in the creation of a new pedestrian network was limited to downtown Salem for both time and practicality purposes. Extending the network to the entire City of Salem and the greater Salem-Keizer region should be relatively simple.

Increase Accuracy of the Network

This project was built on several assumptions about time and accessibility of different walking routes to generate the desired results. Further study of time and accessibility would result in more accurate data. For example, a set of field measurements could be taken to generate more realistic values for each adjusted “time multiplier,” which would increase the precision of the route and time-area analysis functions.

Another method for increasing accuracy of the network would be to obtain a set of safety or accessibility values that represent a general consensus. This task could be accomplished by administering a survey to a sample population of Salem. The survey would gather views of relative safety levels on different types of pedestrian paths. The results of this survey could then be incorporated into the “accessibility multiplier.”

Share the Pedestrian Network with Other Cities in Oregon

The methods and applications of the pedestrian network can easily be replicated in other municipalities, regardless of differences in geographic location, pedestrian infrastructure, or population size. Sharing this framework with staff members and GIS specialists from other cities could lead to recognition for the City of Salem as a pioneer in active transportation planning and could create a more effective tool through successful collaboration.

Downtown Pedestrian Corridors

Ben Reder

A pedestrian corridor is an urban trail that has been optimized for pedestrian safety and comfort, as measured by street classification and proximity to parks, waterways, and open spaces. The purpose of the following study is to create a network of pedestrian corridors using existing pedestrian walkways and trails in downtown Salem.

Research

Figure 9 represents a network of pedestrian corridors that meets the best-case condition for pedestrian corridors based on proximity to parks, green spaces, and water features. The diagram utilizes off-street paths through parks in addition to city streets. Almost all roads in the downtown are classified as arterials, collectors, or parkways, so any pedestrian corridor will include some degree of usage along these streets.

The most valuable aspect of the research is that it identifies high-priority roads and paths that should be adopted into a pedestrian-oriented urban network of trails, streets, and other pedestrian passageways. Based on this analysis, several key recommendations can be considered by the City Council as they begin to review short-term infrastructure improvements.

Creating an Official Urban Network System

The city could consider developing an official urban network system that features connected wayfinding signs and trail maps. Figure 10 shows three potential “loops” that could be highlighted as recreational routes. Historical, ecological, and cultural assets along the routes could be highlighted through informational signs. The pedestrian improvement measures outlined in this study could be included in Salem’s updated Comprehensive Parks and Recreation System Master Plan (CPRSMP).



Figure 9: Proposed Pedestrian Corridor Network. The roads shown in brown are the proposed trails that could be integrated into a pedestrian corridor. These roads were chosen based on their high levels of comfort and safety for pedestrians.

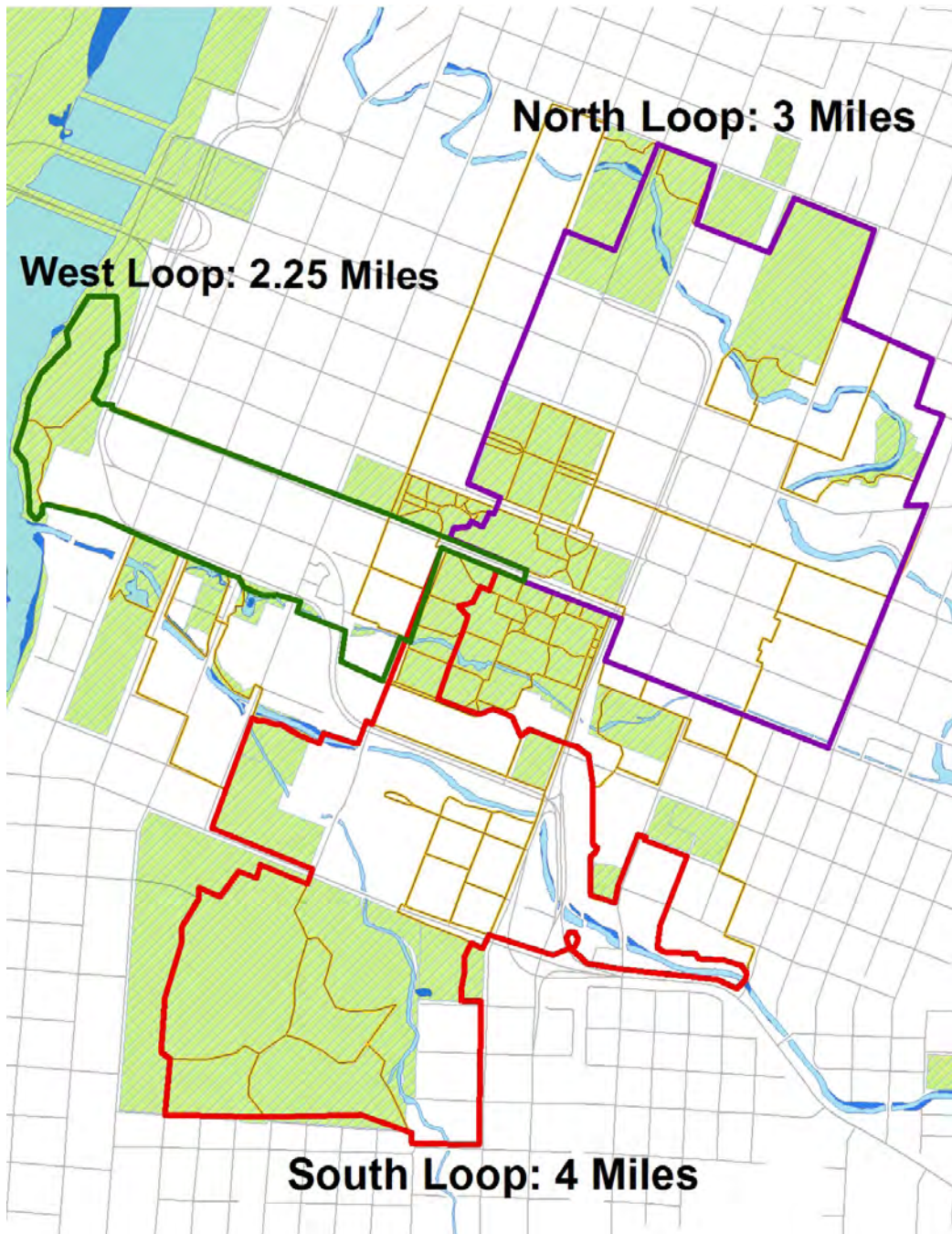


Figure 10: Official Urban Network System. The loops seen in the map represent three potential pedestrian recreation routes within downtown Salem.

Recommendations

Locate High Priority Streets

The first step to developing an integrated urban pedestrian network is the identification of the proposed route, which has been completed in this study.

Further studies will facilitate the implementation of the network. These studies would result in a summary list of structural changes along the proposed route. Figure 11 identifies the key streets that merit further investigation into pedestrian-friendly structural improvements. Common strategies to improve the pedestrian environment include the following:

- Small aesthetic changes like additional plantings, trees, and other landscape improvements
- Increased maintenance
- Speed bumps on neighborhood streets
- Intersection improvements to reduce pedestrian crossing distances
- Signage and policies that clearly designate the area as pedestrian priority zone (e.g. crosswalks, stop signs, and reduced speeds)

Street Name	Street Classification
14th NE/SE	Collector
15th NE/SE	Collector
18th NE/SE	Residential
Chemeketa NE	Residential/Collector
Cottage NE	Residential
Court NE	Arterial/Residential
Ferry SE	Residential
Leffelle SE	Residential
Mill SE	Collector
Winter NE	Residential

Figure 11: High Priority Streets. These key streets merit further investigation for pedestrian friendly improvements.

Adopt Pedestrian Friendly Design Standards

Ultimately, Salem might consider preparing pedestrian friendly design standards for downtown and neighborhood streets. Design standards could specify and illustrate sidewalk and crosswalk configurations, materials and detailing, landscaping placement, lighting, and street furniture. These elements could be incorporated into broader discussions regarding connectivity between downtown, parks, and neighboring communities. Similar aesthetic improvements could be applied to the trail areas. We recommend focusing on increasing safety and mobility by improving lighting, installing signage along trails, and increasing maintenance. All potential pedestrians, including people with disabilities, should be included in the public involvement planning process. Within the parks and surrounding areas, pedestrian facilities can be developed that are safe, attractive, convenient, and easy to use.

Bicycle Connectivity

Downtown Bicycle Network

Michael Duncan, Kory Northrop, and Ted Sweeney

Similar to the analysis of pedestrian connectivity, project members recognized the need for a new digital bicycle network that shows Salem's street network in terms of bicycle travel as opposed to automobile commute. The vision for overcoming that barrier is creating a working model of Salem's bicycle network and adding it to the existing automobile network (see Figure 12).



Figure 12-1. Status Quo Bicycle Route Modeling

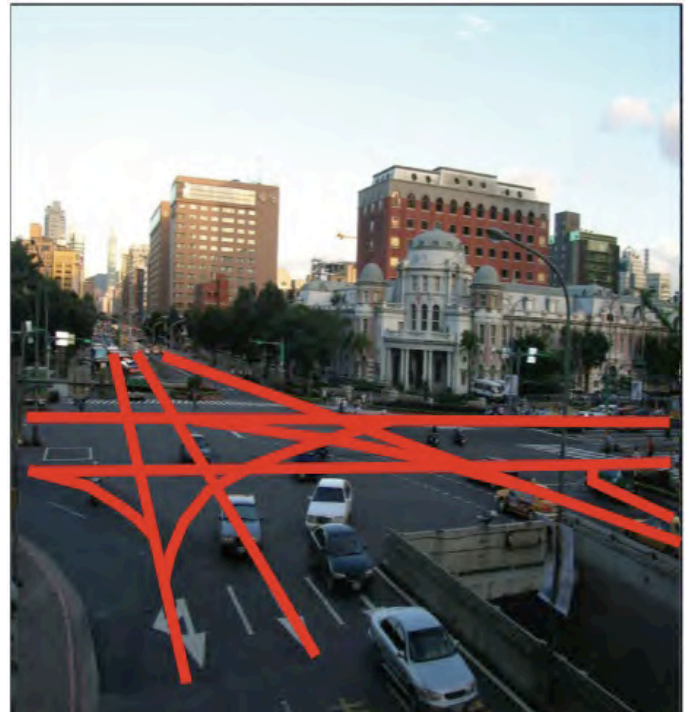


Figure 12-2: Proposed New Bicycle Route Modeling

This new data set includes real-world information showing paths where bicycles actually travel, such as bicycle lanes, road shoulders, multi-use paths, and automobile roadways. The data accurately reflects challenges cyclists face in traveling on an auto-oriented road system, such as moving through intersections that do not have a designated bicycle lane (see Figure 13).

Background

This study and data set is based on the idea that not all bicyclists have the same level of comfort when interacting with automobile traffic. One bicyclist might feel comfortable riding on major arterials, such as Salem's Commercial Street, while others might feel comfortable riding only on local, residential roads



Figure 13: Downtown Bicycle Accessibility. Cyclists of different skill levels have different interpretations of how much of the city core is accessible. Sections of dark red represent areas that only the “Strong and Fearless” bicyclists would ride and thus are potential areas for infrastructure improvement. For more information on the three different types of riders, refer to Figure 14).

where vehicles do not dominate the roadway. Riders’ perceptions of bicycle infrastructure and connectivity depends on rider confidence, see Figure 14 below.

Perception of the bike network depends on rider confidence

Bicyclists can be split, intuitively, into three groups based on their relative levels of confidence and bravery. Each of these groups perceives the bike network differently, based on which roads they feel comfortable using.



The “Interested but Concerned” Cyclist

-At 60%, they represent the majority of residents willing to cycle.*

-Comfortable on multi-use paths or segregated bikeways, they feel unsafe on roadways shared with traffic.

-Perceived level of safety, end of trip facilities, and degree of connectivity heavily influences this group’s decision to ride a bike.



The “Enthusied and Confident” Cyclist

-Comprise about 7% of a city’s population.*

-These riders are excited yet cautious in their approach to cycling.

-Often new to cycling they are enthusiastic about riding, but are reluctant to do so unless it is in the comfort of bike lanes, sharrowed roads, or low volume residential streets.



The “Strong and Fearless” Cyclist

-Make up roughly 1% of a community’s residents.*

-Experienced and Confident, these are seasoned cyclists willing to ride regardless of infrastructure challenges.

-Comfortable with “taking the lane” and riding in traffic, utilizing turn lanes on multi-lane roadways.

* Geller, R. (2009). *Four Types of Transportation Cyclists*. Portland Bureau of Transportation.

Figure 14: Rider Confidence and Perception of Bike Network. Bicyclists can be split into three groups based on their relative levels of confidence and bravery. Each of these groups perceives the bike network differently, based on which roads they feel comfortable using.

Method

The new bicycle data set aims to examine how intimidating it is to travel between any two locations within downtown Salem. Routes are modeled along lines drawn where bicycles legally travel, and each line segment has an associated “Fear Factor” score indicating the level of intimidation felt by a bicyclist riding there.

Fear Factor is a calculation based on four elements:

- **Automobile speed limit:** Sharing the road with fast cars is intimidating.
- **Number of automobile lanes:** Bicyclists feel more vulnerable on wide streets with more automobile lanes.

- **Type of Infrastructure:** Types include bicycle lanes, highway shoulders, and multi-use paths.
- **Cyclists being forced to “take the lane:”** Roads with less developed bicycle infrastructure force cyclists to occupy auto lanes, which is one of the most intimidating aspects of bicycle travel. This barrier is commonly seen in road intersections where “taking the lane” is the best logical or legal option for a cyclist.

These different elements were then combined into a set of equations to calculate a final Fear Factor for each street. More detailed information on the Fear Factor calculations can be found in Appendix 4.

Capabilities of New Bicycle Network

This Fear Factor tool allows planners to identify possible infrastructure improvements and see the effects they might have on the bicycling environment. If a bike lane is proposed on a street, it can be added into the data set to see how it changes routes plotted through the area. Plotting routes based on Fear Factor could also help indicate where new bike routes should be designated through neighborhoods in order to create a bicycle boulevard network. Similar to the Pedestrian Network from the previous section, this data set and its associated calculations can be used to plan out bicycle routes based on lowest Fear Factor or shortest distance (see Figure 15). Also, this bike network could be shared online to help the public choose cycling routes that best meet their comfort levels.

A bicycle route finding tool that provides options based on rider confidence would remove a barrier to cycling for many novices. These riders worry that if they try to use the official bike network, they will encounter places where they feel too intimidated to continue comfortably. A web-based routing tool based on this newly created bicycle network, expanded to include most or all streets in Salem, would give people confidence that the bike route they are embarking on would be one on which they would be comfortable for their entire trip.



Figure 15: Bicycle Route Tool. The bicycle route tool calculates the shortest distance (red) or lowest fear factor (blue) route for bicycle travel in downtown Salem.

Recommendations

Expand the Scope of the Data Set

The data set could be expanded to digitize bicycle travel and formulate a Fear Factor for every street in Salem. Project members digitized the portions of the city's existing bike network, which included only the official bike routes in the city, except for downtown, where every street was fully digitized for bicycle travel. Proposed bicycle routes could be digitized to analyze future bicycle infrastructure plans. The digitization process is relatively simple as outlined above. Completing this new data set for the entire city of Salem would be a good task for a college-level intern with some experience in ArcGIS.

The model would need to include more of the city's low-speed, low-volume neighborhood streets to become more effective for Salem residents. Project members assumed that many of these residential streets would earn a low Fear Factor, making them more attractive to the model as it aims to find the most comfortable bicycle routes. Analysis might reveal that the most comfortable route for the novice bicyclist is one that avoids the city's official bicycle route altogether in favor of neighborhood streets. Such information could help place bicycle way finding signs to create a system of bicycle boulevards.

Customize Fear Factor Formula

The Fear Factor formula was developed through trial and error. Project members tested different ways of mathematically weighting and combining each street's objective factors until the formula made comparative sense, or seemed intuitive for a bicyclist. Street segments the team perceived as dangerous received high scores, and segments considered comfortable scored low. The formula can be easily edited to reflect different values. Vehicle speeds could be weighted to a greater degree than proposed, or bike lanes may do less to mitigate a feeling of safety than the current rankings indicate. The tool is easily tunable to reflect values from academic research or community surveys.

Bicycle Boulevard Network

Rithy Khut

Bicycle boulevards are low-volume and low-speed streets that have been optimized for bicycle travel through treatments such as traffic calming and traffic reduction, signage and pavement markings, and intersection crossing treatments (Bicycle Boulevard Guidebook, 2010). The current bicycle network within East Salem lacks both connectivity and safety. Integrating a network of bicycle boulevards within the current system of bicycle lanes throughout Salem has the potential to increase the level of bicycle ridership.

Method

Three methods were used to analyze the suitability of various roads to create a single logical network:

1. Spatial analysis was conducted in GIS to visualize the quickest routes. In this case the analysis was based on school data. The spatial distribution of schools was helpful in creating a network between various points around town, keeping the routes as linear as possible.

Also, connecting these new routes with the proposed Salem Transportation System Plan (TSP) bicycle network was a high priority.

2. Basic aerial photo analysis was conducted to locate any possible connections that weren't easily seen in GIS.

3. On-site inspection verified the logistics of the GIS model. The concept map in Figure 16 was created to guide the spatial creation of a new bicycle boulevard network.

Proposed Bicycle Boulevard Network

The analysis suggests the creation of one north-south route and two east-west routes. The north-south route connects seven of the schools in East Salem. The southern east-west route connects with the proposed bicycle route on Chemeketa Street that leads to the city center. Both east-west routes would require a bridge to travel over Interstate 5, providing key linkages between East Salem and the city center. Figure 17 shows the proposed bicycle boulevard network.

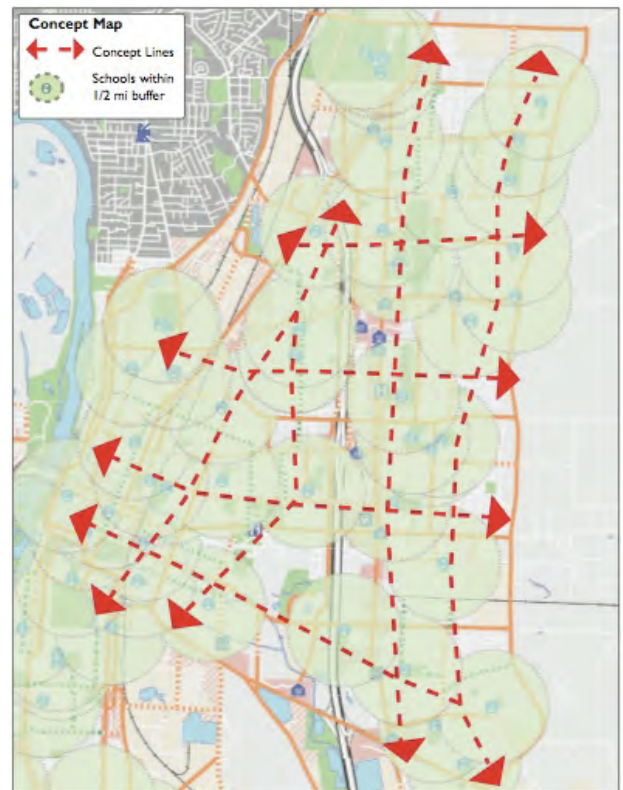


Figure 16: Bicycle Boulevard Concept Map. This map is meant to symbolize the spatial implications of creating a new bicycle boulevard network. The concept lines are roads that provide optimal location for bicycle connectivity.

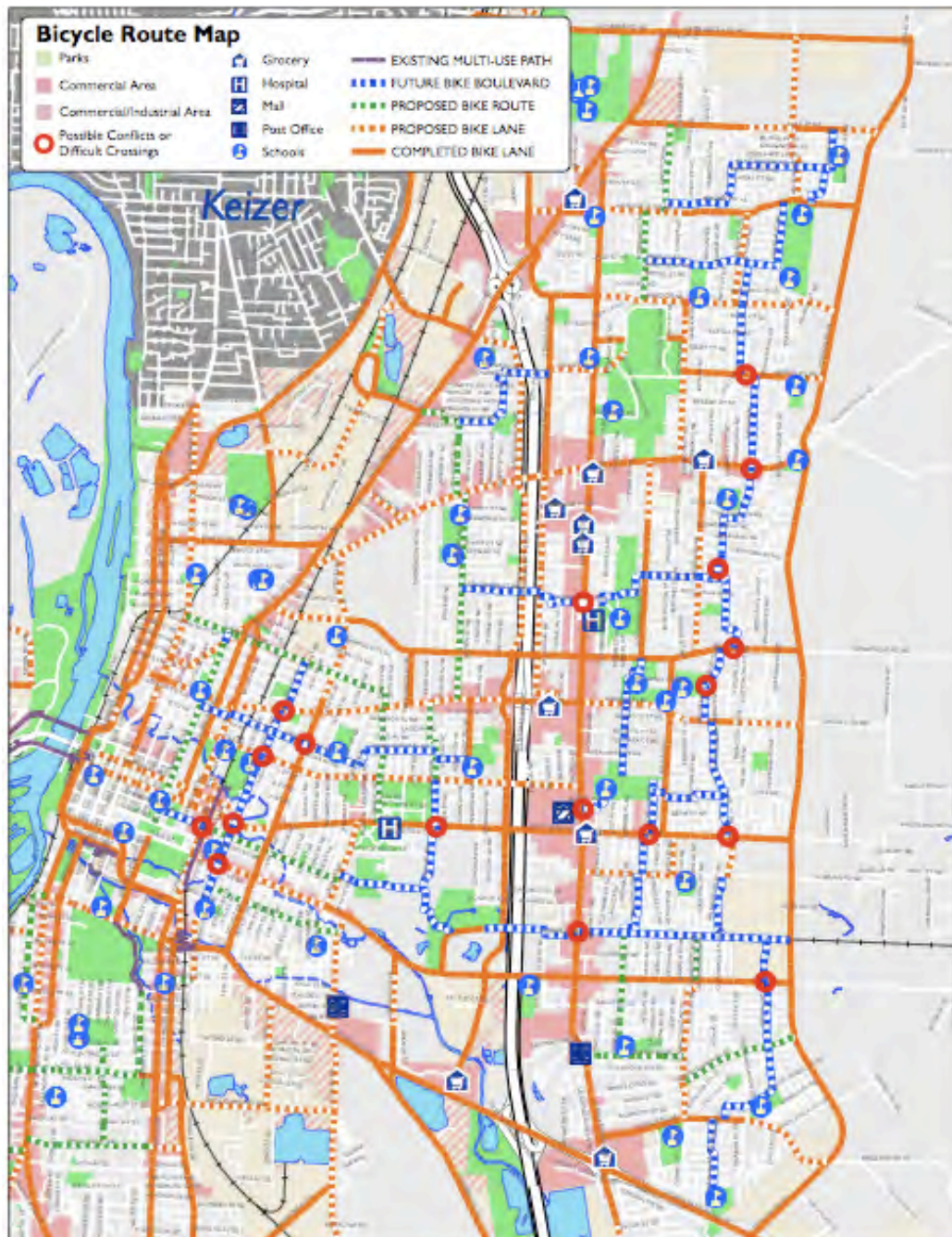


Figure 17: Proposed Bicycle Route Map. This map shows the current proposal for bicycle routes according to the Salem Transportation System Plan (TSP), with added routes for the future bike boulevards (blue) according to research from this study.

Recommendations

Retrofit Current Streets for Bicycle Travel

All of the routes classified as bicycle boulevards utilize streets that are considered “neighborhood” streets, residential streets characterized by less auto traffic and slower traffic speeds. Some streets and properties could be retrofitted to accommodate bicycles. This is especially true near schools where the roads end in a grass field or other similar landscape.

Another important component will be signage. Most of the routes are on neighborhood streets, which can lead to difficulties associated with staying on the intended path. This is especially true for portions of the route that stop at T-junctions or turn from a north-south to an east-west route. We recommend adding wayfinding signs, sharrows, or both, to help guide riders along the designated bicycle boulevards.

Conclusion

The ability to create this bicycle network will depend on many factors. Institutional dedication, the building of community support, leveraging funding sources, and public/private partnerships are all critical components.

There are funding sources available from the Federal Highway Administration and Federal Transit Administration, in addition to State, County, and local sources. Some innovative municipalities have used Safe Routes to School funding to create a safer environment for children around schools. Another innovative use of funds is leveraging stormwater mitigation funds to create the necessary infrastructure to create more bike-friendly streets.

While this network will not happen overnight, the city can take steps to begin the process of creating more bikeable neighborhoods within East Salem. However, it will take a dedicated coalition of the city, community members, and the wider public to keep bicycle transportation on the agenda.

Transit Connectivity

Public Transit Connections to Downtown Parks

Nicholas Garcia

The existence of a high quality, well-connected network of city parks promotes healthy and inexpensive recreation activities, fosters a resilient urban ecosystem, and improves the beauty of the city environment. An extensive, convenient public transit network will encourage people to get out of their cars, decreasing congestion and pollution, and will provide transportation options for members of society who cannot or choose not to drive.

Connecting the transit system with the park system compounds the benefits of both networks, making each more valuable. Parks and public transit are both investments in the public good, with benefits to public health, the environment, accessibility, cost of living, and community aesthetics.

Background

Salem-Keizer's transit system is a network of bus routes called Cherriots, operated by the Salem-Keizer Transit District. Cherriots maintains 25 local bus lines, running at intervals that range from every 15 minutes to every hour. It also runs two longer-distance bus lines—one to Wilsonville and one to Grand Ronde.

All of the Cherriots buses run Monday-Friday, with no service on weekends or holidays. The standard bus fare is \$1.50, although there are variations depending on the type of rider and the route. Daily, monthly, and annual bus passes are available.

Criteria for Analysis

Park Importance

The Salem-Keizer Transit District can prioritize selected parks over others given limited resources in deciding how to extend transit service. Some factors that might make one park more important than another include size, aesthetic qualities, unique assets, and public ownership/accessibility. A detailed assessment of these assets was not in the scope of this project. Park size and best-guess approximation of other attributes were used to identify high-priority areas for transit access.

Convenience of Bus Line Realignment

In addition to prioritizing parks by importance, Cherriots can get the most public benefit from transit service by trying to reconfigure transit routes so that park access is greatly expanded even though minimal changes are made. This can mean finding places where shifting or adding bus stops would improve access to a park, or where a slight route change or extension would increase park access. It can also mean identifying clusters of parks that could all be served by a single transit line.

Findings

As might be expected, the parks that are best served by Salem's transit system are the ones near the downtown, where most of the bus lines come together

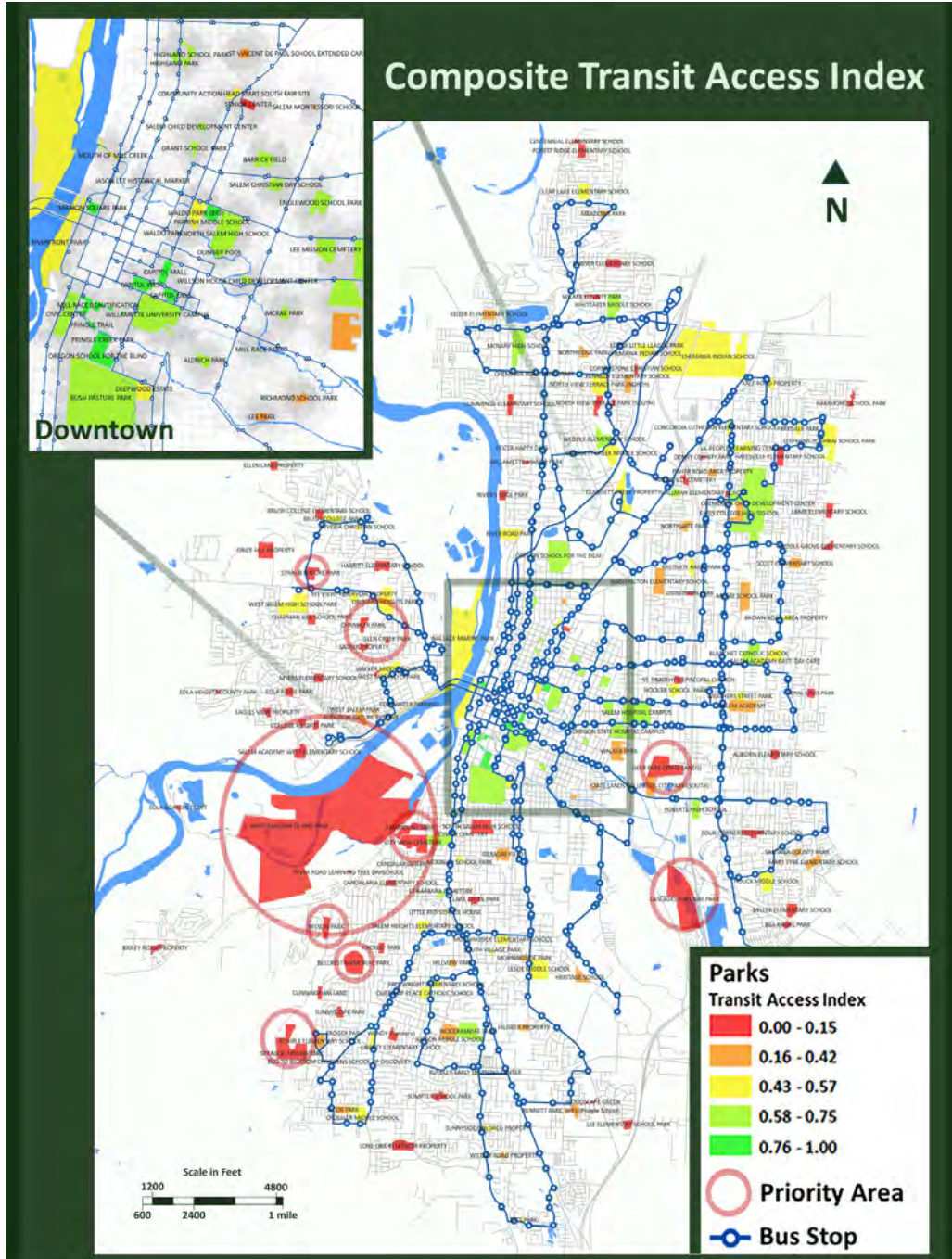


Figure 18: Composite Transit Access Index. This map shows all parks and open spaces within Salem and rates them on accessibility based on several indicators, including proximity to the nearest bus stop, number of bus lines within walking distance, and frequency of bus service to nearest lines. Metadata for GIS layers that went into creating this map are included in Appendix 3.

and there is a high density of bus stops. Outside of the downtown area, parks in the north and east of Salem tend to be better served than parks in the south and west, due to a higher density of bus lines. Figure 18 shows a complete map of Salem's urban parks and associated scores for accessibility via public transit.

High Priority Areas for Connectivity Improvement

The most obvious area for improvement is Minto-Brown Island Park in southwest Salem, by far the largest park in Salem. At 900 acres, it accounts for almost a quarter of the public green space in the city, but it is poorly served by transit.

Other green spaces with poor transit access include Geer Park, Cascades Gateway Park, and the Corban University campus, all in east and southeast Salem. There is also a swath of small and medium-sized parks with poor transit access in south Salem, from Fairmount Park adjacent to Minto-Brown, down through Nelson Park and Belcrest Memorial Park, to Sprague Skyline Park. Finally, there is a scattering of small parks and green spaces in west Salem, almost none of which have good transit access. These include Eola Heights County Park, Eola Ridge Park, Chandler Park, Glen Creek Park, Straub Nature Park, and green spaces at several schools.

Recommendations

Route Realignment and Extensions

There are a few areas where very minor changes would improve parks' transit access: Straub Nature Park lies right on bus route #10, but in between two stops. Adding a Straub Nature Park bus stop would be a cost-effective way of improving access to this park.

Sprague High School and Skyline Park lie near the end of Route #8; a small loop could be added that incorporates Schirle Elementary School, Sprague High School, and Skyline Park.

New or extended routes could also greatly improve transit access to parks. The highest priority area is southwest Salem. A bus route extending down River Road and onto Croisan Creek Road could stop at or nearby a number of high-quality parks, including Minto-Brown Island Park. This route could be a new out-and-back route originating at the city center, or a reconfiguration of Route #8, taking it on a big loop.

To improve access to Cascades Gateway Park, Route #16 could be realigned so that it loops back on Highway 22 and Airport Road rather than on Lancaster Drive. Transit access to Cascades Gateway Park could also be improved by extending Route #7 down Mission Street almost to the I-5 interchange. This would also serve the purpose of acting as a drop-off point for people carpooling north or south via I-5.

Corban University lies over half a mile from the end of Route #11. Extending

this route further down Lancaster Drive would significantly improve access to Corban University.

To improve access to West Salem's parks, Route #12 could be realigned to form a large loop along Eola Drive, Docks Ferry Road, and Glen Creek Road.

General Transit Recommendations

Time spent waiting for the bus significantly decreases the convenience of the service, so improving frequency of service is one of the best ways to improve transit effectiveness. Salem's Cherriots buses do not run on weekends or holidays. If Salem residents desire transit access to parks, weekend bus service is highly recommended. As parks are primarily used for leisure activities, the highest demand for park access likely comes on weekends, when potential bus riders are not at work or school.

In addition, the most frequent routes run every 15 minutes at peak times; many routes run only once an hour. At these levels of frequency, a rider must keep close tabs on bus schedules to avoid being stranded for a long time at a bus stop. In contrast, when service frequencies are improved to every 10 minutes or less, people feel comfortable simply showing up at a bus stop, secure in the knowledge that a bus will be arriving any minute. The more Salem-Keizer Transit District can improve the frequency of its bus service, the more convenient it will be for riders and the more it will be used.

Economic Development Proposals

Salem Marathon

Kevin Belanger

The City of Salem suggested that students explore the viability of creating an entirely off-street marathon route using the city's existing trail system. Although an off-street trail route was not feasible, this project was able to create a mixed on-street and off-street marathon route within Salem. The following report details the proposed marathon course and recommendations to facilitate its development.

Community Benefits

Hosting a Salem Marathon would have significant benefits to the Salem area. Oregon, particularly the Willamette Valley, has a rich history of running in a temperate climate. With marathons in Eugene and Portland, Salem is currently missing the attention and economic benefits of a world-class marathon. The Salem Marathon could be a unifying event for the community as well as an opportunity to generate economic activity within Salem's vibrant downtown area.

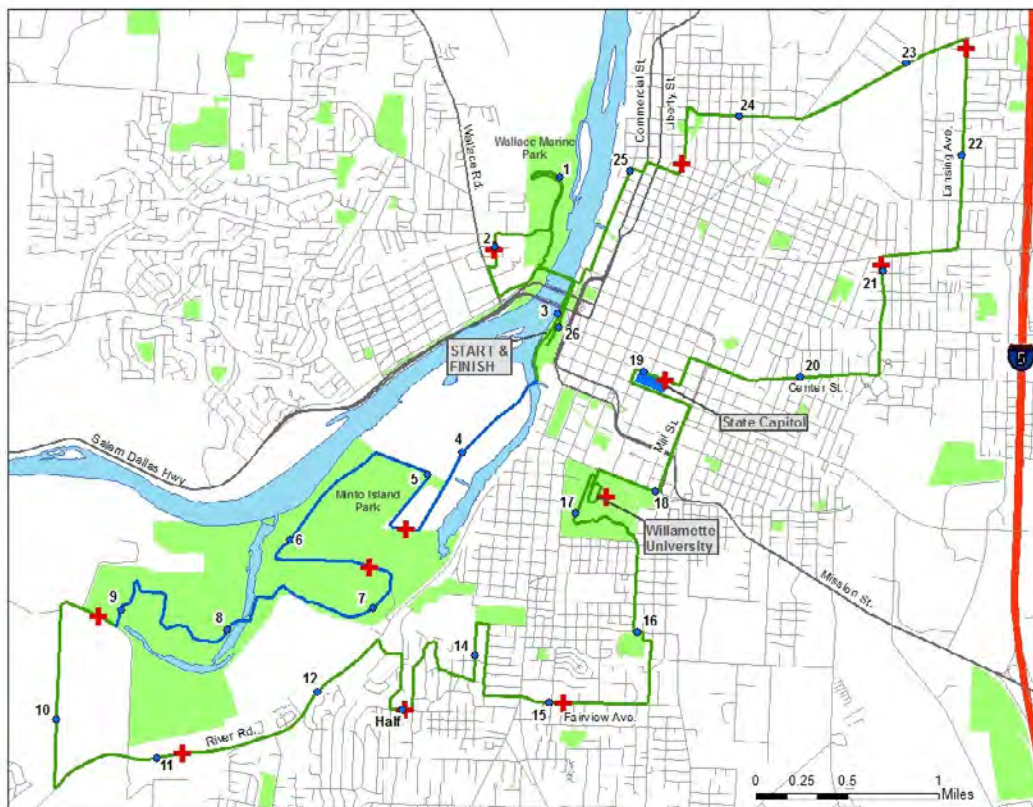


Figure 19: Proposed Salem Marathon Course. This map shows the layout of the full course starting and ending at Riverfront Park in the center of the map. The map includes mile markers and aid stations along the route.

The Salem Marathon could also create an emphasis on physical fitness during a period of increasing obesity rates. While only a small percentage of the Salem community would partake in the marathon, shorter distance events and the local buzz around the marathon would likely stimulate interest in running as a means of exercise for more residents. A healthier Salem population could be more productive, healthy, and active in the community, all of which are important elements in fostering a successful community.

The Salem Marathon would also provide benefits to walking and biking in Salem. In order to implement a world-class marathon, key connections would need to be created and upgraded; residents and visitors could use those connections for the other 364 days of the year.

The Course

The proposed course (see Figure 19) begins in Riverfront Park, heads north into Wallace Marine Park, goes south into Minto-Brown Island Park, and heads back into the city along River Road. The course traverses neighborhoods south of downtown on its way to Willamette University, where the course takes a brief detour along the Willamette University track. The course then circles the State Capitol and meanders through the neighborhoods northwest of downtown on its way back to Riverfront Park to complete the 26.2-mile course.

Recommendations

Minto-Brown Island Pedestrian Bridge

Before the city could adopt this proposed marathon course, the proposed bicycle and pedestrian bridge connecting Riverfront Park to Minto-Brown Island Park would need to be completed. Currently, visitors to Minto-Brown Island Park need to access the park from the south, which often necessitates vehicle use because the entrance is located at a significant distance from downtown. A bicycle and pedestrian bridge would facilitate non-motorized traffic to more easily access the off-street trails within Minto-Brown Island Park.



Figure 20: Minto-Brown Island Park. This maps shows a close-up of the trails throughout Minto-Brown Island Park. These trails would add value to a Salem Marathon course, however, they would likely require significant engineering upgrades to accommodate increased foot traffic.

Minto-Brown Island Trail System

The trails on Minto-Brown Island Park could be upgraded and integrated into a system of trails for the marathon course (see Figure 20). The existing trails are important and useful for those who desire to explore off-street trails, but they are not fully connected and would not be able to accommodate the heavy traffic of marathon runners and an increased volume of training runners. Also, trails may need to be elevated and engineered appropriately on the north end of Minto-Brown Island Park to allow access through the current wetlands on the site. These paths would provide for an improved running experience in the marathon as well as allow more residents and visitors to access Minto-Brown Island Park during the rest of the year.

Salem Bicycle Tour

Matt Remer

Salem possesses several attributes that make it a potential tourist hotspot in the Mid-Willamette Valley. One idea to promote Salem tourism is to create a bicycle tour of the city that would connect various cultural destinations and integrate them into Salem's downtown bicycle network.

Background

Several studies on travelers' motivations have shown that along with rest and recreation, visiting scenic areas and historic sites are among the top reasons why people travel. The value of tourist routes and outdoor recreation areas depend on their visual qualities (Bishop and Gimblett, 2000). There are multiple community attributes to consider when evaluating the suitability of a cultural bike network within a city such as Salem. These include:

- Aspects of natural scenic beauty, such as bodies of water, high quality parks and ecological sites, and an abundance of trees (Meenar, 2001).
- The presence of recreational facilities such as a large waterfront or harbor, museums, cafes, and restaurants.
- The existence of cultural facilities that expose the locality's historic heritage such as notable government and commercial buildings, historic theaters, museums, monuments, and even the homes of celebrated locals who have made a remarkable impact on the region's history.

Salem possesses all of these attributes to some degree.

Existing infrastructure could also be considered in assessing the suitability of a recreational bike network. This includes existing bike paths, either on-road or off-road, the existence of already proposed bike paths, strategically located bike racks, and tracts of land or commercial facilities that are either abandoned or underutilized so that the land can be converted and integrated into a proposed network (Meenar, 2001). How well all of these infrastructure attributes

connect to one another is crucial in visualizing how such a bike network will be formulated when trying to include these features. Potential infrastructure barriers to a highly connected network include the quality of intersections, road lane and shoulder width, speed limits, and traffic density (Bishop and Gimblett, 2000).

Bicycle Tour Route

The proposed bicycle tour route (see Figure 21) is calculated to be 3.8 miles in length, starting from Santiam’s Bike Shop and ending at A.C. Gilbert’s Discovery Village. The following description of each cultural and historical site explains the reasons for including each site as a stop on the tour.

The Oregon State Capitol is perhaps the most popular building in Salem. It hosts daily historical tours.

Located across the street, Willamette University, founded in 1842, is the oldest university on the West Coast. The campus is full of open green spaces and the constant activity of students and professors. As a part of Willamette University, the Hallie Ford Museum of Art is the third largest art museum in Oregon with six galleries that primarily showcase local Oregon artists.

The Mission Hill Museum is an interpretive museum of the Thomas Kay Woolen Mill, a meticulously preserved 19th century wool mill, a preserved church, and Oregon Trail settlers’ housing. The museum sheds light on one of Oregon’s first major industries, the production of wool products.

At the northeast corner of Bush’s Pasture Park, Historic Deepwood Estate is a prime example of Victorian architecture situated on four acres of manicured gardens. Deepwood Estate holds daily tours for tourists who are fond of Queen Anne Victorian architecture, and is listed on the National Register of Historic Homes. The Bush House Museum and Conservatory, located a few blocks west of Deepwood Estate, is another Victorian style building on the National Register of Historic Homes. The Bush House boasts that it possesses the oldest greenhouse west of the Mississippi, which makes it a great stopping point for tourists.

Continuing along the tour, the Elsinore Theatre possesses strong elements of Gothic architecture and hosts many live

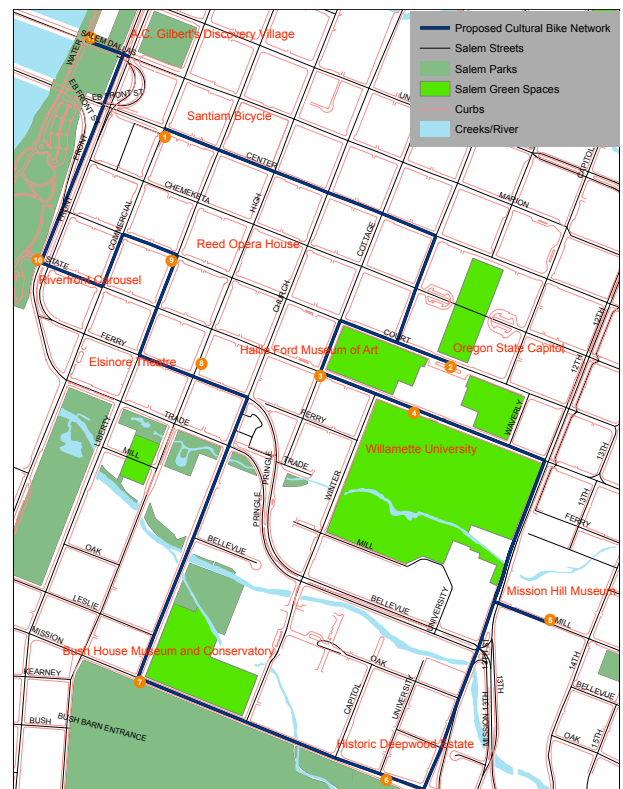


Figure 21: Salem Bicycle Tour. This map shows the bicycle tour through downtown Salem starting at Santiam Bicycle on the top left corner of the map and looping clockwise through Salem.

plays and performances throughout the year. On a similar note, Reed Opera House has been Salem's capital for performing arts since opening its doors in 1870. Both theaters are included on the National Register of Historic Places, and both are located downtown, in close proximity to Salem's cafes and shopping retailers.

The end of the tour brings riders to Salem's Riverfront Park. The park's Riverfront Carousel is a Depression-era style horse carousel that is a great attraction for families. Finally, A.C. Gilbert's Discovery Village, once again listed on the National Register of Historic Places, is an interactive children's museum featuring the inventions of American inventor Alfred Carlton Gilbert. It was also once home to the National Toy Hall of Fame.

Community Benefits

The main benefit from implementing this specific bike network would be an increase in tourism in Salem. Despite the fact that Salem is the capital of Oregon and possesses many cultural assets, it is rarely seen as a cultural hub within the state. The architectural, cultural, and historic sites of a city or town are important economic resources for a municipality. The successful creation of an integrated bike route would allow tourists as well as locals to explore, interact with, and experience Salem's cultural heritage in a meaningful way that is not desensitized or restricted by travel in a car, truck, or large recreational vehicle.

Safe Routes to School Funding

Elena Fracchia

Increasing pedestrian and bicycle connectivity can mean a number of different things for a city official. It could mean improving crosswalk safety, reducing barriers, implementing new paths or bike lanes, or providing alternatives to routes along high-speed roads. However, one challenge in a depressed economy will be funding these initiatives. The following report proposes that federal Safe Routes to School (SRTS) funding be used to increase active transportation connectivity in Salem. The intersection density analysis conducted in this study could be included in an SRTS application if city staff decide to pursue this funding source.

Safe Routes to School

Safe Routes to School (SRTS) is a federal program devoted to improving pedestrian and bicycle connectivity surrounding public elementary schools. The program encourages parents, children, and school officials to use mobile GIS methods to determine which routes to school provide the best access and which routes have significant barriers that need extra support and funding. For the purposes of this Downtown Parks Connectivity project, elementary schools would need to be linked to parks in order to obtain SRTS funding. Public elementary schools are often included in the definition of public parks and seen

as neighborhood recreation areas, with community access for individuals who live nearby. The following research contends that increasing connectivity of public elementary schools will result in increased park connectivity.

Research

In order to receive SRTS funding, the city will need to decide which schools require the most attention. Determining the connectivity of schools will help create focus areas for city officials to proceed further with researching street-level data to present as evidence for grant funding. The method used to prioritize schools is known as intersection density analysis, which involves counting the number of intersections within a half-mile radius of each elementary school.

Intersection density provides strong evidence for bicycle and pedestrian mobility in urban areas. Individuals are more likely to choose active transportation over automobile travel in areas with high concentrations of safe intersections. For this particular study, intersection density analysis was only conducted only on minor arterials and local streets. Major arterials were not included in the GIS analysis because they are considered to be undesirable for pedestrian travel, and particularly unsafe for elementary school students. Figure 22 illustrates this reasoning for not including major arterials.



Figure 22-1: McKinley Elementary. Figure 22-2: Washington Elementary. These maps show two different elementary schools with different intersection densities. McKinley Elementary has a higher intersection density despite the presence of a main arterial (red street) that must be crossed for students walking or biking from the west. For students who live north of Washington Elementary, it is impossible to walk to school without traversing along a main arterial, which significantly lowers the intersection density surrounding the school.

As can be seen in Figure 23, there are only two schools with a high level of connectivity (in dark brown). The two schools are located in a gridded portion of downtown Salem. Those two schools represent 5% of the schools in Salem. Highlighted in yellow are the schools with low levels of intersection density (50-100 good intersections). There are eighteen schools with low levels of intersection

density, the majority on the north and west boundaries of the city. These schools with the lowest connectivity represent 44% of the schools in Salem.

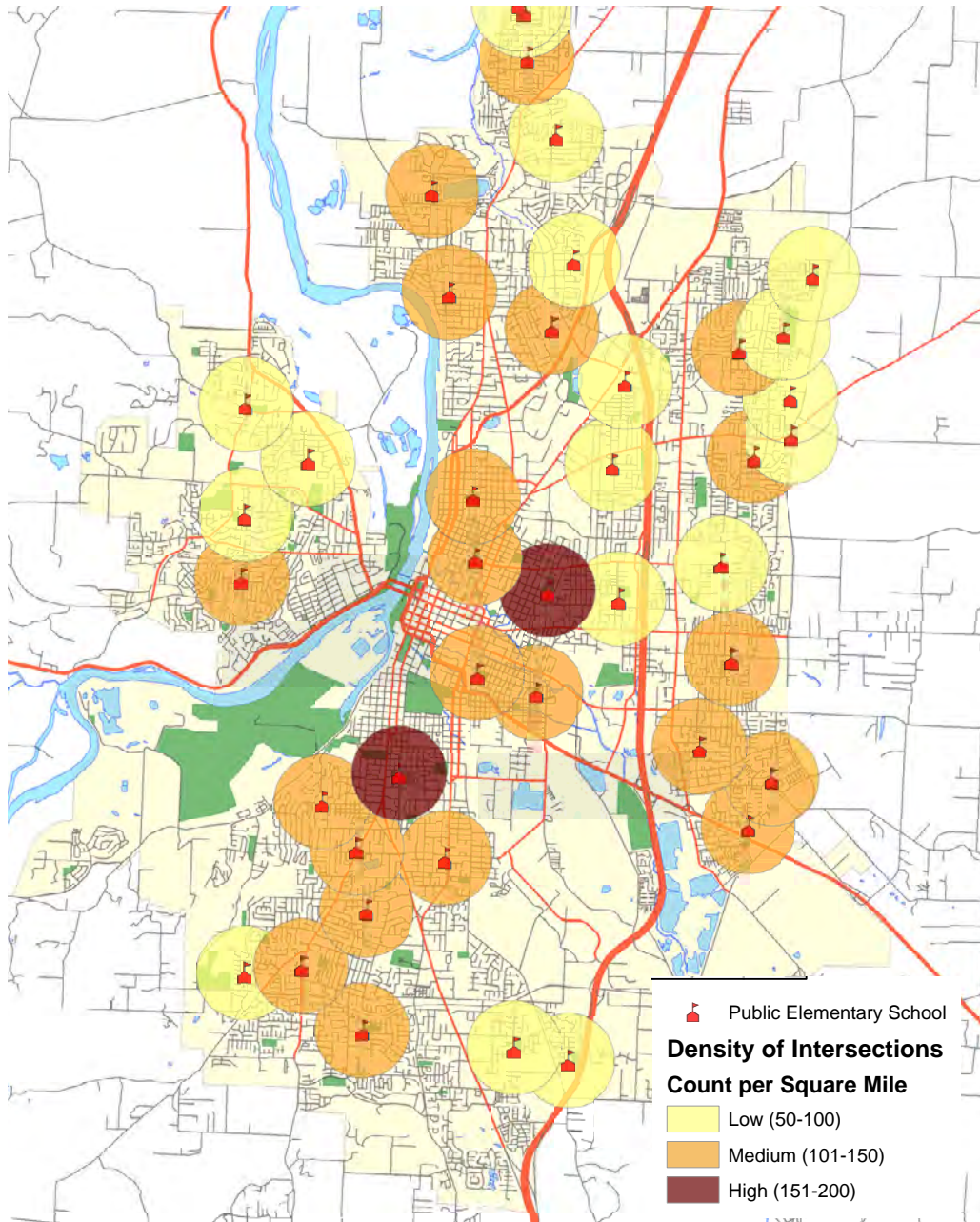


Figure 23: Connectivity Around Salem's Public Elementary Schools. This map shows the density of street intersections around Salem's public elementary schools. This map does not include arterials as options for pedestrian travel.

Findings

There are several schools that fit into the Safe Routes to School model. The challenge for the City of Salem is to determine which schools will have the largest impact on connectivity to parks and green spaces and focus on those schools first. Alternately, if there are barriers to connectivity that can be addressed easily, the city might be able to address those and increase the incentive for residents in those neighborhoods to walk or bike more often.

Recommendations

Focus on Public Elementary Schools

The city could consider using public elementary schools as a focus area due to the large number of elementary schools and their relative spacing throughout the city. By focusing on schools, the city benefits in two ways: first, the target population will be youth, increasing the standards of connectivity and safety to their highest levels; and second, schools often represent neighborhood recreation areas, so increasing connectivity of schools to neighborhoods inherently increases connectivity of parks.

Leverage Safe Routes to School Criteria

The Safe Routes to School program is designed and proven to increase connectivity in neighborhoods surrounding school areas, encouraging families, and particularly youth, to walk or bike to school. This program has positive externalities: as children increase their physical transportation to school, they improve their health and reduce their risk of becoming obese or overweight, conditions affecting 17% of youth in the United States (CDC, 2010).

Planning Based on Intersection Density

The final recommendation is related to future planning of school zones and considerations for the intended park trail plan. This project has highlighted the importance of looking at intersection density as a measure of connectivity throughout the City of Salem. The high number of arterials that run through the city limits pedestrian access to many school and park zones, as children will not feel safe traversing along an arterial road. While street-level data may show a safer option, with increased opportunities for crossing arterials safely and alternate routes that avoid arterials, the routes available for walking or biking may be more readily available.

Pedestrian Connections for Low-Income Populations

Steve Abbott

For the project, the City of Salem emphasized the importance of connecting the community to Salem's downtown parks, but geographic areas or groups of community members to target were not specified. The following study seeks to assure that 'priority populations' are included in considerations of pedestrian routes. For the purposes of this study, priority populations were identified as

low-income residents and residents whose primary means of transportation is something other than an automobile, as outlined by the following section.

Priority Populations

US Census Bureau block groups were used in this study to define “priority populations” as areas where:

1. Annual household income is lower than \$31,000, which is 75% of the average household income of Polk and Marion Counties, and
2. More than 15% of the population commutes to work by modes other than private automobile.

The second variable was included to ensure that pedestrian improvements are prioritized for those who need them most. Figure 24 illustrates that Census block groups with the highest rates of workers who do not drive to work are generally in the same areas as those with median household incomes less than 75% of the average in the surrounding counties.

As an added means of identifying priority populations, low-income housing locations identified by the Salem Housing Authority were added to the study area. Figure 25 displays all populations defined within the project boundaries, as well as the parks and public spaces within downtown Salem.

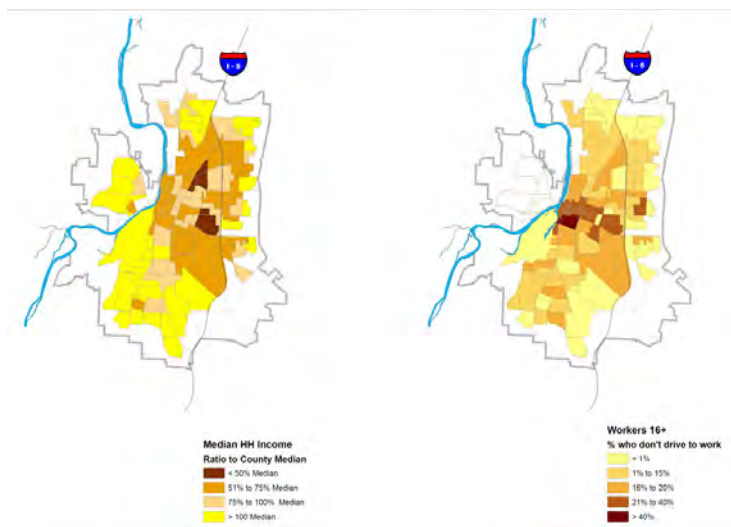


Figure 24-1: Low-Income Priority Populations. Median income lower than \$31,000.

Figure 24-2: Transportation Based Priority Populations. More than 15% of the population commute by modes other than automobile.



Figure 25: Study Area Boundaries. This map shows the geographical boundaries of the study area with priority block groups and low-income housing developments.

Connections to Downtown Attractions

Finding connecting routes between priority populations and downtown Salem requires analyzing the current infrastructure, including the city's designated land uses and proposed urban trails network, and then choosing routes with the greatest amount of comfort and connection to attractions downtown. The following parameters were set to determine route priority:

- Identify a viable pedestrian connection between parks and other public spaces.
- Connect all existing city trails and follow proposed trail routes where sensible.
- Connect popular destinations and districts.
- Connect commercial routes.
- Prioritize transit routes.
- Where all else is equal, prefer sidewalks to other route options.

The proposed pedestrian routes resulting from this process are shown in Figure 26.

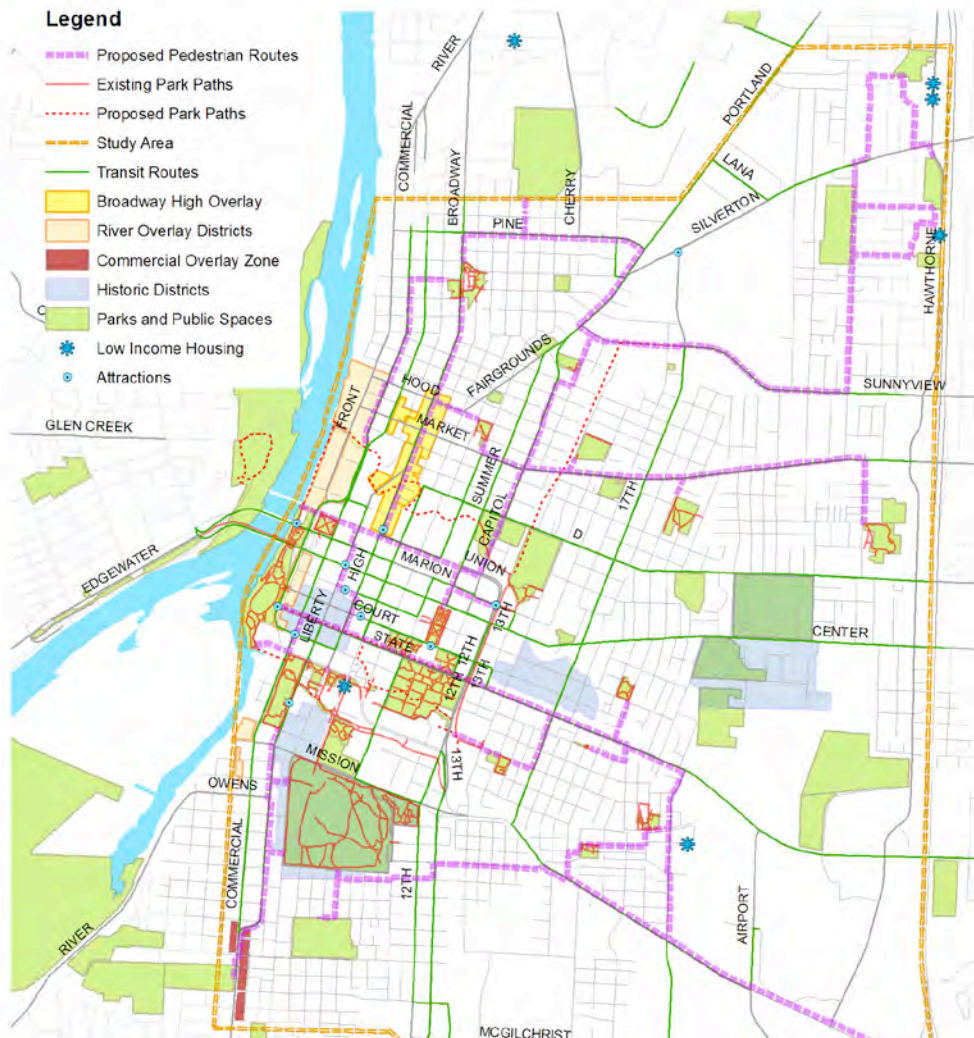


Figure 26: Proposed Pedestrian Routes.

1. Broadway at Highland Park



2. Hines at Mission



3. 25th at State



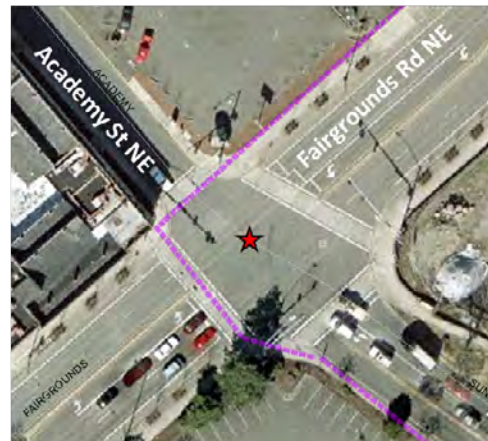
4. Summer at Marion



5. Liberty at Center



6. Academy at Fairgrounds



----- Proposed Pedestrian Routes
 ★ Pedestrian Accident Location

Figure 27: Street Intersections with Histories of Vehicle-Pedestrian Crashes.

Recommendations

Improve Sites with History of Vehicle Crashes Involving Pedestrians

Six intersections along the proposed pedestrian route were identified as locations with a high number of vehicular crashes involving pedestrians (see Figure 27).

The first priority site is located on Broadway Street at Columbia Street, near Highland City Park and Highland Elementary School. Adding a painted pedestrian crosswalk across Broadway Street would protect pedestrians in an area heavily trafficked by automobiles entering and exiting the Columbia Street cul-de-sac.

The second priority location is located at the intersection of Hines Street and Mission Street. Commercial traffic on Hines Street being forced onto Mission Street creates an unsafe environment for pedestrian travel. Once again a controlled pedestrian crossing is recommended and further study is warranted.

The four other sites in Figure 27 have sufficient sidewalks, crosswalks, and crossing signals to provide adequate pedestrian protection, but they should be monitored for potential safety improvements due to high crash rates.

Identify Barriers to Pedestrian Travel

Eliminating barriers along a pedestrian route could potentially “activate” it and make it attractive to pedestrians. Three sites were identified as having significant barriers (see Figure 28) although further study is warranted to locate and prioritize more barriers to pedestrian travel along the proposed routes.

Site A occurs on Mission Street just north of Cascades Gateway Park. The existing footpath will eventually pass under Mission Street and connect to a proposed northbound trail. Mission Street is a significant barrier to pedestrian crossing; an underpass represents an investment that could activate the Cascades Gateway Park path as a useful pedestrian connection for residents south of the park.

At Site B, residents along Hawthorne Avenue are squeezed between Interstate 5 on the east and property line barriers to the west. A break in the fence line could provide shorter and friendlier pedestrian access to parks and retail.

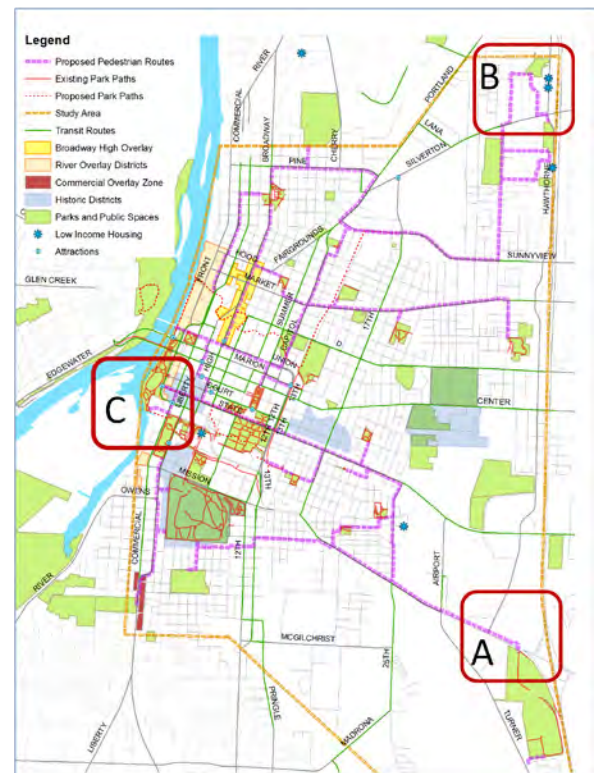


Figure 28: Proposed Pedestrian Routes with Barriers.

At Site C, a proposed footbridge would bring pedestrians from Minto Island to Commercial Street. Careful consideration would need to be given to the Civic Center connection and to the railroad crossing.



Figure 29: Suggestions to Overcome Barriers.

Transit and Bicycle Connections for Low-Income Populations

Alyssa Diamond

The City of Salem is heavily oriented toward automobile transportation. Individuals who do not own a personal vehicle rely on Salem’s public transit service, bicycle and pedestrian network, or both. The following project aims first to connect low-income communities to Salem’s downtown parks via public transit. Second, the project aims to connect those same low-income communities via bicycle transportation because Salem’s public transit service does not currently provide service on weekends.

Salem’s diverse range of parks and open spaces are serviced by the Cherriots bus service and contribute to the way of life that many Salem residents enjoy. The goal of this project was to employ Salem’s bicycle and pedestrian network as a tool for connectivity between lower-income neighborhoods and downtown parks along bus routes, increasing accessibility in a healthy and environmentally friendly manner.

Methodology

First, low-income communities were located using income data from the US Census Bureau. Low-income communities were identified as Census block groups with median household income of less than or equal to \$25,000 per year. Next, bus stops located within those low-income communities were highlighted and corresponding transit routes were chosen based on connection to downtown parks. As a result, five Cherriots transit routes were chosen to connect low-

income communities to downtown parks. Finally, bicycle routes were analyzed as potential substitutes for the same five transit routes, seen below:

1. Chemeketa Community College to Pringle Park
2. Salem-Keizer Transit Center to Riverfront Park
3. Glen Creek Transit Center to Marion Square Park
4. Salem Municipal Airport to Capitol Mall and Willamette University
5. Portland Road and Northgate Avenue to Waldo Park

Findings

There are viable bicycle routes to downtown parks that utilize mostly existing and previously identified bicycle routes and multi-use paths from each of the five bus stops chosen for this study. Only one route, from the Salem-Keizer Transit Center to Riverfront Park, would have more than 10% of its route on proposed paths instead of existing paths.

The #25 bus (West Salem/Downtown) is the only route that serves both the west and east sides of the Willamette River. Several buses connect residents on the outskirts of Salem to the downtown core, but these buses generally run less frequently than the buses that run primarily within the downtown core. These routes tend to be shorter than the routes that serve the downtown area, lending themselves well to bicycle routes. The maps in Figure 30 show the five connecting routes between bus stops in low-income communities and selected parks.

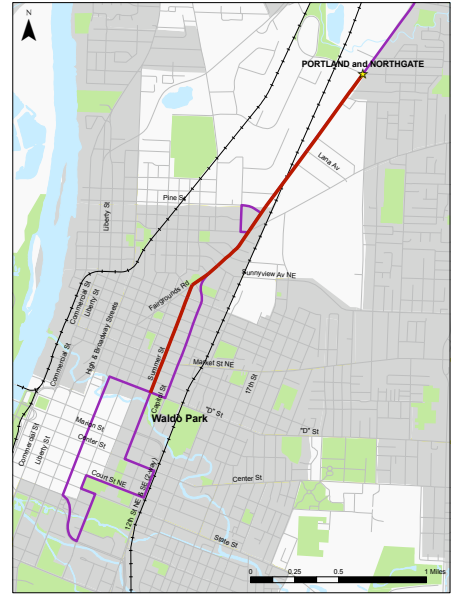
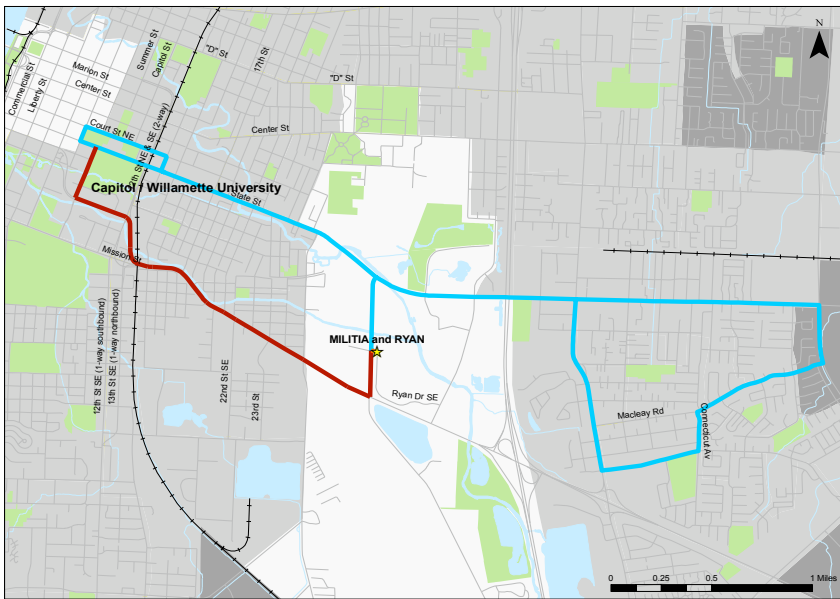
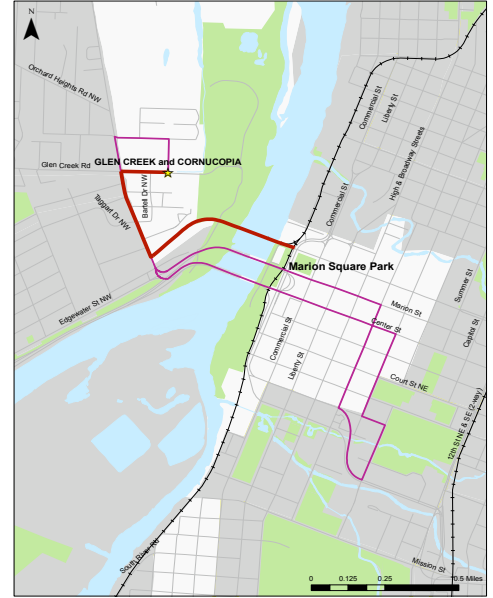
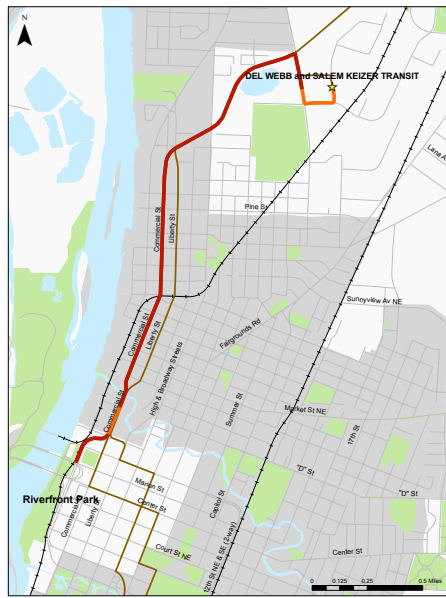
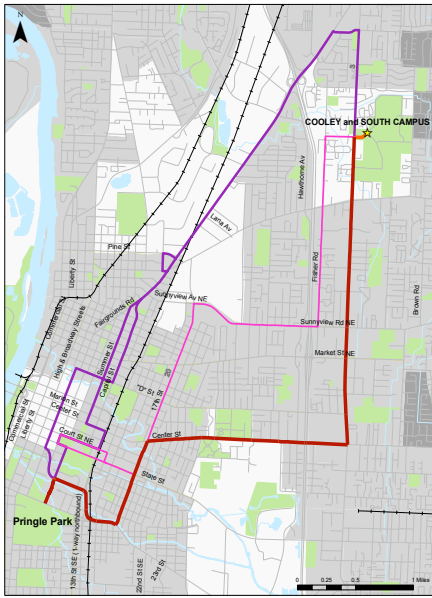


Figure 30 (left to right, top to bottom; dark red lines represent proposed bicycle routes)

Figure 30-1: Chemeketa Community College to Pringle Park.

Figure 30-2: Salem-Keizer Transit Center to Riverfront Park.

Figure 30-3: Glen Creek Transit Center to Marion Square Park.

Figure 30-4: Salem Municipal Airport to Capitol Mall and Willamette University.

Figure 30-5: Portland Road and Northgate Avenue to Waldo Park.

Cherriots Transit Routes	
11, Frequent	12, Standard
13, Standard	14, Frequent
15, Peak	16, Frequent
17, Frequent	18, Peak
19, Frequent	20, Standard
21, Peak	25, Standard

Recommendations

Consider Creating Bicycle Routes along Cherriots Bus Lines

This project shows that the creation of bicycle routes along Cherriots transit routes is a possible solution for residents who do not own a personal vehicle and would like to travel to Salem's downtown parks on the weekends. The assumption follows that the entire bicycle network could be created in the same fashion.

Include Bicycle Maps at Bus Stops

Bus stops and bus shelters create a built-in method for informing bus riders about alternatives to public transit. Riders could be informed of bicycle routes by placing bicycle maps or pamphlets at busy transit stops.

Analyze Route Ridership

Route ridership is a key indicator for further research into creating bicycle routes along current transit routes. Ridership data can be used to determine which routes are most frequented and consequently in need of alternative transportation infrastructure development.

Accessibility and the Americans with Disabilities Act

Daniel Ronan

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) was passed on July 26, 1990. The law was written to strike a balance between reasonable accommodation of citizens' needs and the capacity of private and public entities to respond. Title II of the ADA prohibits state and local governments from discriminating against disabled persons in their programs and activities, and mandates accessibility in all communities for those with disabilities, regardless of the size of a community's population or scope of its budget (MRSC, 2010).

Project Summary

This project attempted to create a Mobile GIS survey tool designed to collect meaningful information about pedestrian accessibility to and from downtown parks and green spaces. The data collected is intended to advance targeted investments for improving pedestrian transportation infrastructure and to further the conversation about accessibility to public spaces.

This study specifically aims to address the "last leg" of the journey to park entrances. This last 50-100 feet may seem irrelevant to typical pedestrian accessibility; however, obstacles such as poor ramp quality or incomplete sidewalk networks can pose serious obstacles for wheelchair access. This study documents intersection conditions specific to street corners and street crossings that abut six parks located in Salem's downtown core area.

What is Mobile GIS?

ArcPad Mobile GIS technology enables spatial data, such as layer files and shapefiles, to be manipulated or enhanced by entering new information. Existing data is changed through a customizable survey interface (see Figure 31) that uses quantitative as well as qualitative questions to assist in real time, in-the-field data collection.

The numerical value associated with each answer is added to columns in an “attribute table” associated with existing spatial data or created for new data collection. These values in the attribute tables are subsequently symbolized in ArcMap. For more information creating ArcPad surveys and transferring data between ArcPad, Personal Digital Assistants (PDAs), and ArcMap refer to Appendix 1.

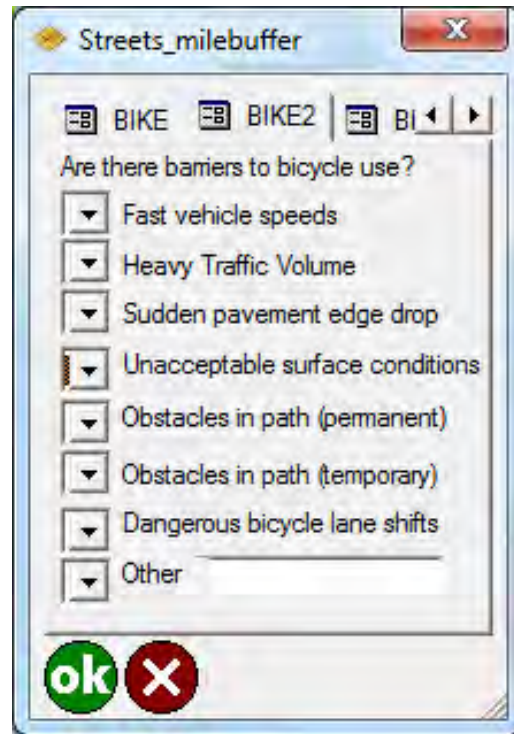


Figure 31: Mobile GIS Survey Interface.

Survey Questions

The overall goal with these survey questions is to answer the question, “Does the given area encourage or discourage walking to the nearby park?” Variable questions were formulated from that overarching question that might be useful to engineers, transportation planners, or pedestrian advisory committees.

The following table includes selected questions pertaining to intersection street corners with their relative variables and responses:

Question	Possible Responses
Is there a ramp available?	Yes, No
What is the condition of the ramp?	Good, Fair, Poor
Is the street corner an access point to a park or green space?	Yes, No
Is there a push button available?	Yes, No
What is the condition of the ramp landing?	Good, Fair, Poor

The following table includes selected questions pertaining to intersection crossings with their relative variables and responses:

Question	Possible Responses
Is a crossing available?	Yes, No
What is the condition of the marked crosswalk?	Good, Fair, Poor
Are there additional crosswalks nearby?	Yes, No
Is a visual crossing device available?	Yes, No
Is an audible crossing device available?	Yes, No

Research Area

The six groupings of parks and green spaces in this experiment include Grant Park and Grant School; Old Governor’s Grounds and Mill Creek; The Oregon State Capitol Mall, Wilson Park, and Capitol Park; Bush’s Pasture Park and Deepwood Estate; Mill Race Creek and Pringle Creek; and Riverfront Park and Marion Square Park (see Figure 32).

Salem Parks Accessibility

Park Intersections Studied

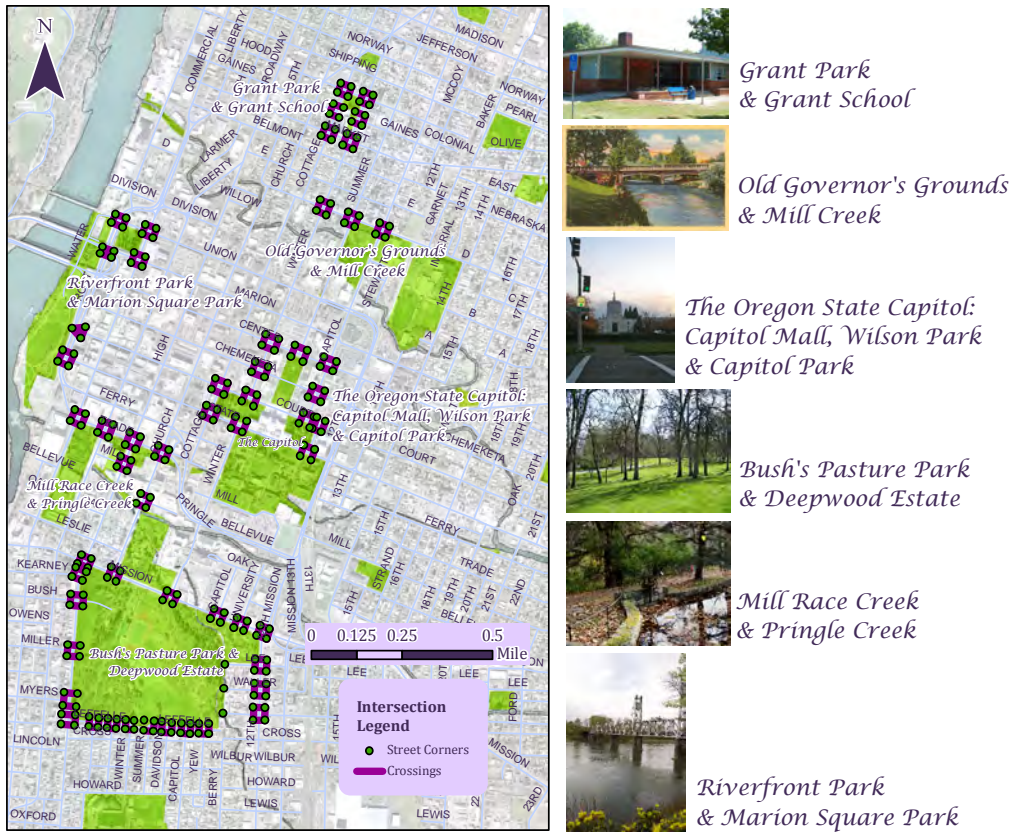


Figure 32: Parks Chosen for Intersection Study.

Findings

Data shows that downtown Salem parks are generally accessible to pedestrians, however accessibility could be improved in many instances. Street corners are not standardized and vary in quality. Summaries of ‘walkability’ trends for each grouping of parks are included below.

Grant Park and Grant School

All intersections around this site have ramps and ramp landings that are in moderately good condition. Marked crosswalks are rare, with only one marked crossing per intersection on average. Streets have lower traffic speeds and traffic calming measures such as traffic circles and bulb-out curbs that support pedestrian accessibility.

Old Governor’s Grounds and Mill Creek

The intersections at D Street and Capitol Street, and D Street and Summer Street, are model intersections for pedestrian accessibility, including audible visual crossing devices and marked crosswalks. Ramps at the intersection of D Street and Winter Street are in fair condition. The intersection is without marked crossings, discouraging pedestrian access.

Oregon State Capitol: Capitol Mall, Wilson Park, and Capitol Park

The quality of marked crossings around the State Capitol were noted as fair and poor, and sometimes non-existent. The absence of crossings near the Capitol building and lack of audible and visual crossing devices was particularly notable.

Bush’s Pasture Park and Deepwood Estate

Pedestrian facilities on Leffelle Street SE are conspicuously absent. A lack of marked crossings across Mission Street SE, a major arterial street, also denotes low pedestrian accessibility.

Mill Race Creek and Pringle Creek

These green spaces share boundaries with two creeks that traverse the downtown streetscape. Ramp conditions within these corridors are favorable to the pedestrian experience, but a few intersections, such as the Church Street SE and Bellevue Street SE intersection, do not provide adequate accessibility due to a lack of marked crosswalks and absence of audible and visual crossing devices.

Riverfront Park and Marion Square Park

Two highways, Front Street NE and Commercial Street NE, running adjacent to the parks, limit accessibility to these parks. Marked crossing availability is common but not present at all intersections. High vehicle traffic and speeds hamper the pedestrian experience, and poor ramp quality contributes to lower pedestrian accessibility, particularly for Marion Square Park.

Recommendations

Apply consistent baseline accessibility standards and guiding policies

The data indicates that various policies have shaped accessibility standards over time. Some intersections include marked crosswalks in all directions, while others do not. By applying policies and standards toward the goal of a robust and continuous pedestrian system, more individuals would be inclined to choose walking as their preferred mode of travel.

Encourage walking equally among other transportation modes

After accessibility standards and guiding policies have been established, we recommend considering policy adjustments for current funding mechanisms. It is important that current traffic laws be enforced to create an environment that encourages walking as a cost-effective, healthy alternative to other travel modes.

Community Engagement in Planning

Bicycle-Pedestrian Mobility

Trafton Bean and Emma Silverman

Public Opinion and Mobile GIS

The topic of bicycle and pedestrian mobility is often addressed under the context of barriers that city staff members need to fix. Planners try to target problems and fix them in ways that please the public. The task of pleasing the general public is difficult in itself, and issues of population growth and urban sprawl have made the democratic process of gathering public opinion increasingly difficult.

Mobile GIS technology presents an opportunity to engage and integrate a wide variety of public opinion into planning projects. It allows participants to travel through the city answering questions to assess bicycle and pedestrian infrastructure. Planners can then use the information to formulate a transportation network based on these surveys that theoretically represent a collective public voice.

This Mobile GIS experiment employs the use of a digitized survey that asks questions pertaining to land use, roadway infrastructure, bicycle infrastructure, and pedestrian infrastructure of specific street segments (see Figure 33). The answers to these questions are integrated into a formula that produces a comprehensive “Mobility Rating” score for each street segment. Studies using Mobile GIS as a planning tool have been referred to as a “Complete Streets Assessment.”

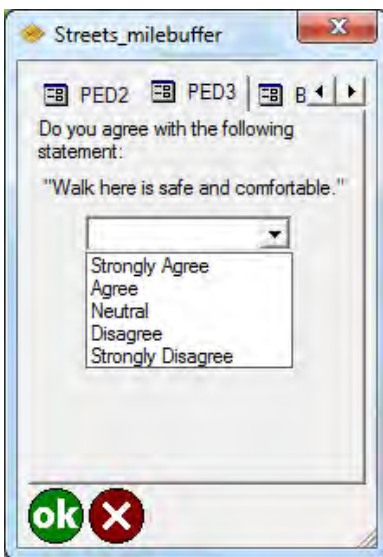


Figure 33: Mobile GIS Interface.

Survey Questions

The survey is designed to address bicycle and pedestrian mobility with three types of questions. Questions 1 through 7 are objective questions asking for concrete, quantitative information about each specific road segment and the surrounding area. Questions 9 through 11 are subjective questions asking for the opinion of the person or persons completing the survey. Asking about perceived level of comfort and safety from a pedestrian or cyclist’s point of view helps planners consider the intangible or unquantifiable factors that make a street more or less attractive for travel. Questions 12 through 14 ask about transportation barriers. These questions are useful by themselves as they help planners target problematic street segments that can be fixed in the short term. The answers to these questions are visually displayed as pie charts in the “Results” portion of this section.

Figure 34 displays all questions and possible answers included in the survey.

Objective Questions	1. <i>What is the street type?</i>	Objective Questions (cont.)	6. <i>Are there sidewalks?</i>	Transportation Barriers	12. <i>Does anything diminish this route for pedestrian use? (choose all that apply)</i>
	<ul style="list-style-type: none"> <input type="radio"/> Major Arterial <input type="radio"/> Minor Arterial <input type="radio"/> Local Street 		<ul style="list-style-type: none"> <input type="radio"/> None <input type="radio"/> One Side <input type="radio"/> Both Sides 		<ul style="list-style-type: none"> <input type="radio"/> Sidewalks not continuous <input type="radio"/> Lack of wheel chair ramps <input type="radio"/> Surface conditions unacceptable <input type="radio"/> Obstacles in path (permanent) <input type="radio"/> Obstacles in path (temporary) <input type="radio"/> Problematic high volume driveways
	2. <i>How many automobile lanes?</i>		7. <i>Is there a cul-de-sac?</i>		13. <i>Are there any barriers to bicycle use? (choose all that apply)</i>
	<ul style="list-style-type: none"> <input type="radio"/> 1 Lane <input type="radio"/> 2 Lanes <input type="radio"/> 3 Lanes <input type="radio"/> 4 Lanes <input type="radio"/> 5 Lanes 		<ul style="list-style-type: none"> <input type="radio"/> Yes <input type="radio"/> No 		<ul style="list-style-type: none"> <input type="radio"/> High automobile speeds <input type="radio"/> Heavy traffic volume <input type="radio"/> Sudden pavement edge drop <input type="radio"/> Surface conditions unacceptable <input type="radio"/> Obstacles in path (permanent) <input type="radio"/> Obstacles in path (temporary) <input type="radio"/> Dangerous bicycle lane shifts <input type="radio"/> Other...
	3. <i>Is there a median dividing traffic?</i>		8. <i>Is there a buffer space between pedestrians and auto traffic?</i>		14. <i>Any other problems or points of interest? (choose all that apply)</i>
<ul style="list-style-type: none"> <input type="radio"/> Yes <input type="radio"/> No 	<ul style="list-style-type: none"> <input type="radio"/> No <input type="radio"/> Paved Area (other than sidewalk) <input type="radio"/> Parked Cars <input type="radio"/> Bike Lane <input type="radio"/> Planting Strip 	<ul style="list-style-type: none"> <input type="radio"/> Raised sidewalks <input type="radio"/> Car parked on sidewalk <input type="radio"/> Vegetation in travel way <input type="radio"/> Post blocking travel way <input type="radio"/> Numerous driveway entrances <input type="radio"/> No sidewalk <input type="radio"/> Other 1... <input type="radio"/> Other 2... 			
4. <i>What is the posted speed limit?</i>	9. <i>“Walking here is safe and comfortable.”</i>	Subjective Questions	10. <i>Where is the most likely place to ride a bicycle?</i>		
<ul style="list-style-type: none"> <input type="radio"/> 45 MPH <input type="radio"/> 40 MPH <input type="radio"/> 35 MPH <input type="radio"/> 30 MPH <input type="radio"/> 25 MPH <input type="radio"/> 15 MPH <input type="radio"/> 10 MPH 	<ul style="list-style-type: none"> <input type="radio"/> Strongly Disagree <input type="radio"/> Disagree <input type="radio"/> Neutral <input type="radio"/> Agree <input type="radio"/> Strongly Agree 		<ul style="list-style-type: none"> <input type="radio"/> Shared automobile traffic lane <input type="radio"/> Paved Shoulder (not marked) <input type="radio"/> Adjacent path <input type="radio"/> Marked on-street bike lane 		
5. <i>Describe the land use.</i>	11. <i>“A casual cyclist would feel comfortable riding on this street.”</i>				
<ul style="list-style-type: none"> <input type="radio"/> Industrial <input type="radio"/> Strip Mall <input type="radio"/> “Main Street” Commercial <input type="radio"/> Medium Density Residential <input type="radio"/> Low Density Residential <input type="radio"/> Park or Open Space 	<ul style="list-style-type: none"> <input type="radio"/> Strongly disagree <input type="radio"/> Disagree <input type="radio"/> Neutral <input type="radio"/> Agree <input type="radio"/> Strongly Agree 				

Figure 34: Survey Questions.

Results

Mobility Rating

Project members conducted an experiment with the Mobile GIS rating tool on city streets surrounding Willamette University. The answers to each question were combined to create a composite “Mobility Rating” for each individual street segment surveyed (refer to Appendix 3 for metadata and the complete “Mobility Rating Scorecard”). The results are displayed in a color-coded map of the study showing the range of “Mobility Ratings” that were produced from the survey questions (see Figure 35).

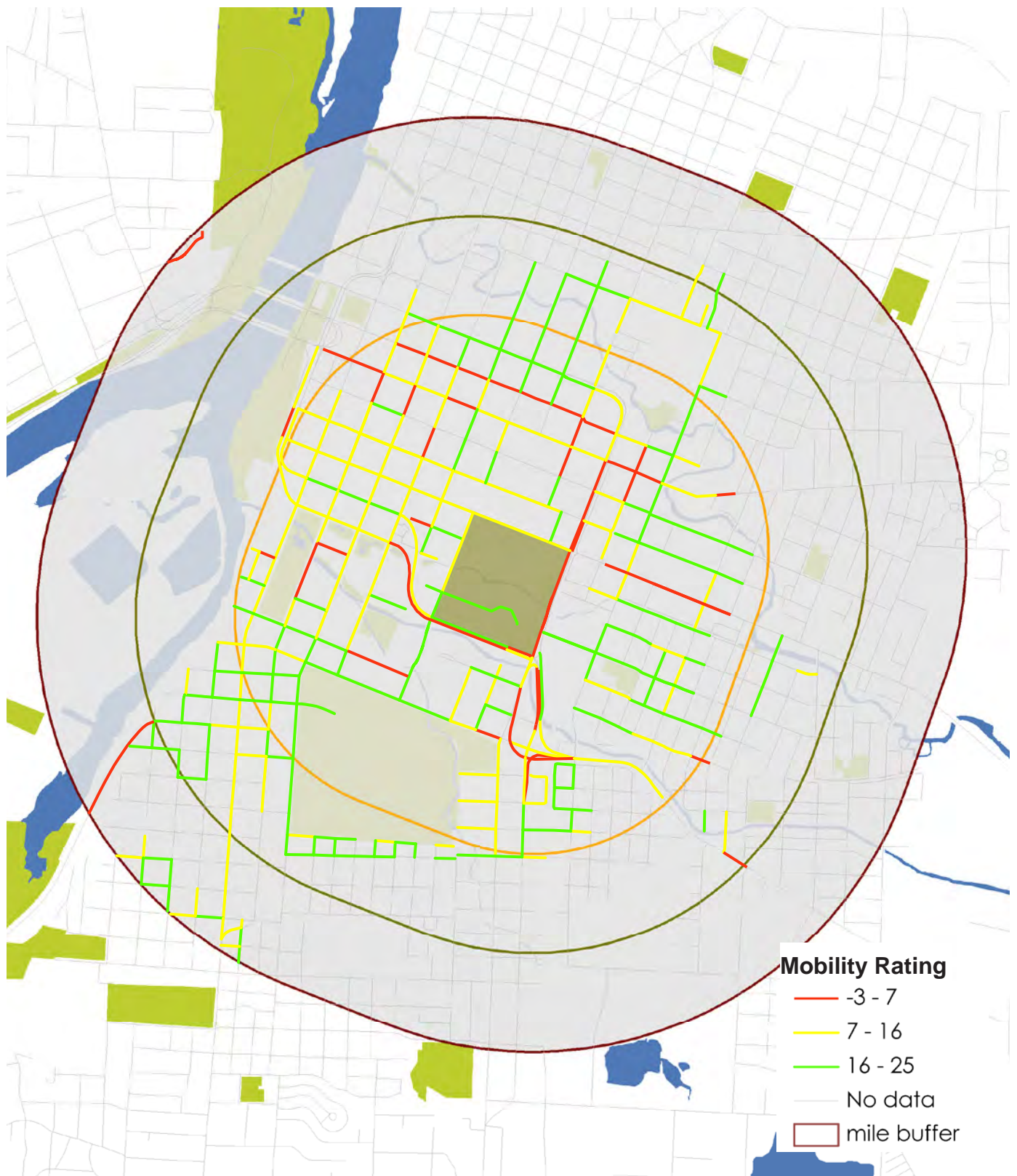


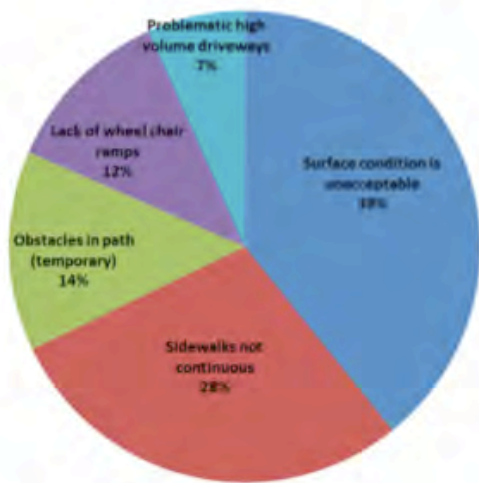
Figure 35: Mobility Rating Map. The three ratings for these streets were calculated from the survey answers for each street segment, green streets were seen as having the greatest pedestrian and bicycle mobility, yellow streets had slightly lower mobility, and red streets had the lowest mobility.

Planners can use this map to visualize corridors with greater bicycle and pedestrian connectivity. These corridors can then be further improved and promoted as active transportation routes. Conversely, this map can be used to target streets or areas that limit the utility and connectivity of active transportation corridors.

Transportation Barriers

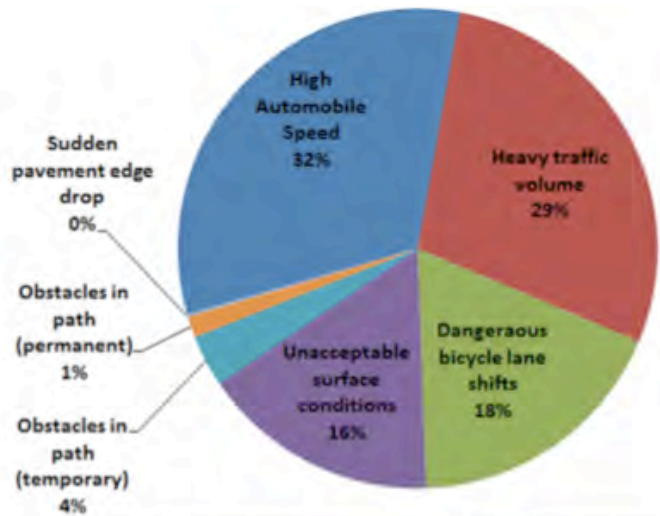
The mobility survey is also designed to target barriers to bicycle and pedestrian mobility. In the study area around Willamette University, common barriers include dangerous automobile speeds (noted as a problem on 56% of all streets), high traffic volumes (49%), dangerous lane shifts for bicycles (31%), and unacceptable surface conditions (25%) (see Figure 36).

Barriers to Pedestrian Travel



Barrier Type	% Total	Observations
Surface condition is unacceptable	25%	100
Sidewalks not continuous	18%	73
Obstacles in path (temporary)	9%	35
Lack of wheel chair ramps	7%	30
Problematic high volume driveways	4%	17
Obstacles in path (permanent)	2%	7

Barriers to Bicycle Travel



Barrier Type	% Total	Observations
High Speeds	56%	223
Heavy traffic volume	49%	197
Dangerous bicycle lane shifts	31%	125
Unacceptable surface conditions	28%	111
Obstacles in path (temporary)	6%	24
Obstacles in path (permanent)	2%	10
Sudden pavement edge drop	0%	1

Figure 36: Bicycle and Pedestrian Transportation Barriers.

Planners can also use the data to single out specific barriers. For example, Figure 37 shows which streets were noted as having “Unacceptable Surface Conditions” for bicycle and pedestrian travel. This information will allow planners to prioritize which roads may need to be repaved.

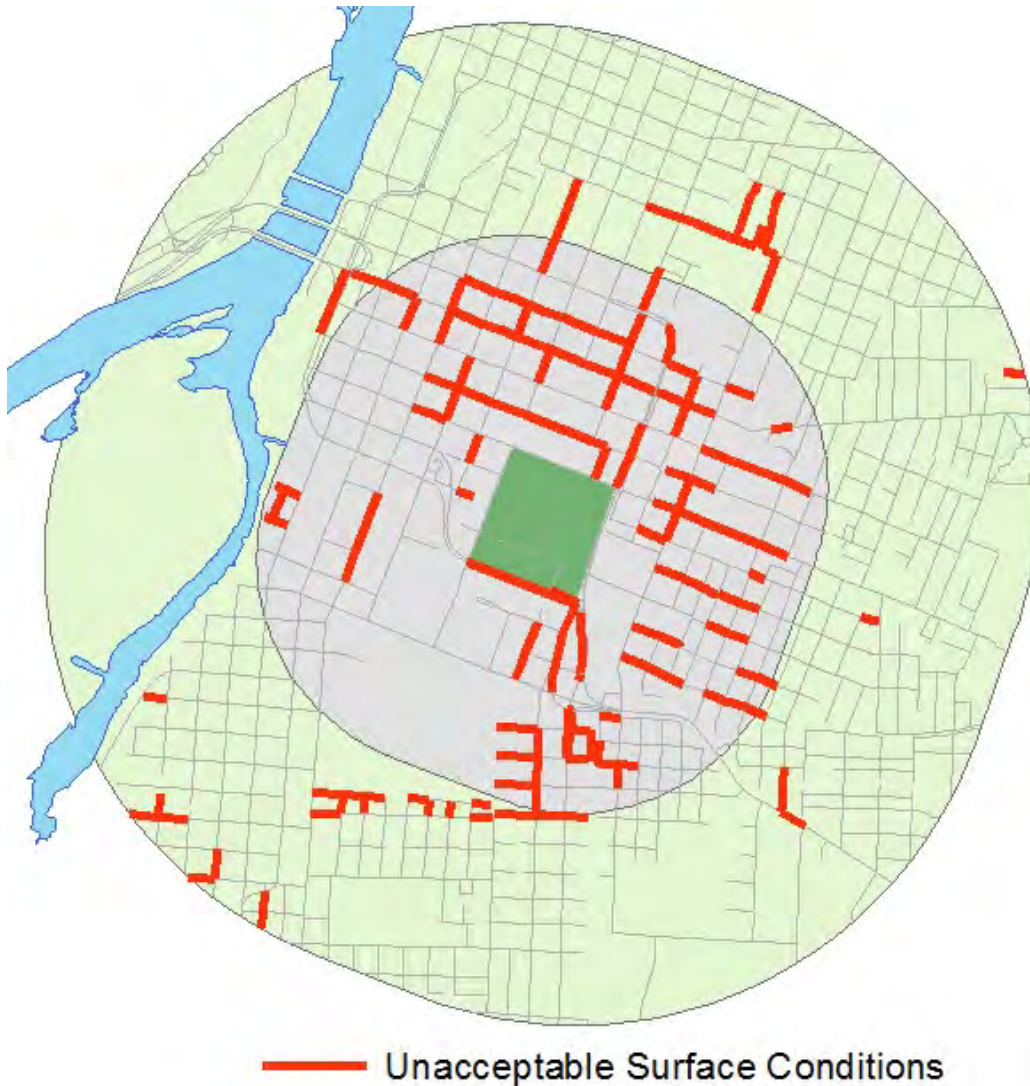


Figure 37: Streets with Unacceptable Surface Conditions.

Recommendations

Conduct Background Research on Study Area

Project members consulted “Complete Streets Assessment” tools and questionnaires to create the Mobile GIS survey. The survey generated proper results, but it could have been made more effective by customizing questions to the specific infrastructure and community needs of Salem.

For example, project members noticed that bicyclists often preferred riding on sidewalks when no bicycle lane was present, which was a potential answer to the question, “Where is the most likely place to ride a bicycle?” The question, “Is there a buffer space between pedestrians and auto traffic?” had several

possible answers including “Bicycle Lane,” “Parked Cars,” and “Planting Strip,” however only one answer was allowed. Most streets had multiple buffer spaces. More accurate data could have been obtained by allowing multiple answers to this question.

Solicit Help from a Wide Variety of Volunteers

The two-person project team needed approximately eight hours to assess 9.2 linear miles of streets around Willamette University. More volunteers could reduce the amount of time and could increase the boundaries of a selected study area. Soliciting the aid of a wide variety of volunteers could also create a more complete picture of public opinion.

Mobile GIS assessments are useful not only for providing accurate and custom data, but also for their ability to engage a wide variety of citizens and integrate their opinions into planning projects. If used properly, Mobile GIS is a powerful civic engagement tool. Integrating this tool into Bicycle and Pedestrian Advisory Committee meetings or focus groups could allow participants to voice their opinions on matters they feel a personal investment in, or it could allow otherwise uninvolved citizens to learn more about their own city.

Consider Separate Surveys for Bicycle and Pedestrian Travel

This report details a “Complete Streets Assessment,” which combines the safety and comfort of all methods of active transportation. Future projects may require more focused and detailed information about either bicycle or pedestrian travel.

For example, if planners are searching for a road to convert into a “bicycle boulevard,” they would have less need for pedestrian mobility data. Instead they would want to ask more detailed questions about bicycle infrastructure, such as “Are there bicycle lanes on this street?” or “Are there stop signs that disrupt the flow of bicycle traffic?” Similarly, if planners want to find the most suitable street to convert into an pedestrian boulevard or outdoor mall, they could tailor their questions towards pedestrian mobility.

Consider Street Intersection Assessment Survey

This report focuses only on street segments, but assessing intersections and crossings is equally important in the streets connectivity discussion. Given more time, the project team would have liked to include questions about street intersections in the survey and integrated them into the “Mobility Rating.”

Conclusion

The Sustainable Cities Initiative is an interdisciplinary effort to promote education, service, public outreach, and research on the development of sustainable cities. The University of Oregon has the distinct purpose of serving as a machine for generating innovative ideas and recommending strategies to put these ideas into action. Listed below is a summary of the recommendations generated from this course as well as references to the sections of this report containing more detailed recommendations.

Utilize New Tools for Transportation Planning

The initial concern that project members felt the need to address was the lack of adequate data within the city's existing GIS layers to accurately analyze bicycle and pedestrian transportation. Several GIS-based tools were created to fill this void in transportation planning, including network analysis tools, mobile GIS tools, and several methods for targeting barriers to bicycle and pedestrian connectivity. For more detailed recommendations, refer to the following sections of this report: Downtown Pedestrian Network Web Application, Downtown Pedestrian Network GIS Data and Equations, Downtown Bicycle Network, Downtown Bicycle Network GIS Data and Equations, Bicycle-Pedestrian Mobility, and Accessibility and the Americans with Disabilities Act.

Implement Bicycle and Pedestrian Oriented Policies

The City of Salem has already begun integrating bicycle and pedestrian transportation into city policies with the Transportation System Plan (TSP) and Vision 2020. Project members suggested that one next step could be development of accessibility standards for street intersections, crosswalks, and park entrances. Ensuring that these accessibility standards are included in the Comprehensive Parks and Recreation Master Plan (CPRMP) will provide a top-down approach to creating more accessible connections to Salem's parks and green spaces. For more detailed recommendations, refer to the following sections of this report: Accessibility and the Americans with Disabilities Act and Downtown Pedestrian Corridors.

Emphasize Bicycle and Pedestrian Corridors

Current transportation conditions reflect an automobile-oriented planning focus throughout the City of Salem. Several minor adjustments could be made to create corridors that would allow for safe and efficient pedestrian and bicycle transportation amidst automobile traffic. Improvements include added signage for pedestrian trails and retrofitting streets to accommodate bicycles. This process of retrofitting current infrastructure would most plausibly be implemented in multiple phases. For more detailed recommendations, refer to the following sections of this report: Downtown Pedestrian Corridors and Bicycle

Boulevard Network.

Transit Improvements

Public transit is also a key factor in creating a livable community, as it increases mobility and decreases the number of personal vehicles on the road. Several recommendations were proposed to improve transit connectivity to parks and to enhance the public transit system to improve bicycle infrastructure. Recommendations include reinstating Cherriots service on the weekends, adding bicycle maps at bus stops, and creating bicycle routes along Cherriots bus routes. For more detailed recommendations, refer to the following sections of this report: Public Transit Connections to Downtown Parks and Transit and Bicycle Connections for Low-Income Populations.

Engage the Community

The City of Salem's lively and active community is a distinct asset that could be further activated toward improving the city. Project members have offered tools for community engagement in planning and recommended developing network tools specifically for community member use. For more detailed recommendations, refer to the following sections of this report: Bicycle-Pedestrian Mobility, Downtown Pedestrian Network Web Application, and Downtown Bicycle Network.

Funding and Economic Development

The most critical issue in putting these recommendations into action is finding appropriate project funding and economic support. Several projects identified potential funding mechanisms that could make bicycle and pedestrian connectivity aspirations economically feasible, including proposals for Safe Routes to School funding, the Salem Marathon, bicycle tourism, and targeting low-income populations. For more detailed recommendations, refer to the following sections of this report: Safe Routes to School Funding, Salem Marathon, Bicycle Tour of Salem, Pedestrian Connections for Low-Income Housing, and Transit and Bicycle Connections for Low-Income Populations.

Appendices

Appendix 1 – Mobile GIS User Guide

Survey Creation using ArcPad Studio 7.1 and ArcPad 8.0

The survey interface is developed in ArcPad Studio 7.1, a computer software program that enables a user to tailor a Mobile GIS survey tool to the context of a given experiment. Questions can take the form of “yes/no,” “multiple choice,” “check box,” and “fill in the blank.” The first three question formats are assigned particular answers and numerical values. The questions are uploaded onto a personal digital assistant (PDA) device for in-the-field data collection.

Survey questions ask about spatial data that are loaded onto ArcPad 8.0. To test the survey, the survey developer can load the survey window, record test answers, and close the window. The developer can verify the tool’s functionality by opening the survey window a second time. This test period allows the developer an additional opportunity to modify the survey before using it in the field.

Data Collections using Personal Digital Assistant (PDA)

The survey tool is uploaded onto a PDA equipped with ArcPad 8.0. ArcPad is loaded with the data layers that will be modified by the survey. The user can collect, modify, and erase any spatial data on the PDA and then download the newly modified data or data layers to a computer after completing the project.

Data Analysis using ArcMap

The final step is uploading the data from the ArcPad survey into ArcMap for analysis. The data is transferred into the data chart of a shapefile on ArcMap, where it can be analyzed within ArcMap and visually manipulated to reveal trends, patterns, and realities. This visualization may be achieved using colors, gradients, shapes, and other standard GIS mapping techniques.

Appendix 2 - Pedestrian Network Web Application JavaScript

The Downtown Salem Walking Network web application was made using the ArcGIS JavaScript API. It utilizes a route-creation function and a service area creation function based on which button the user clicks; sample maps on the ESRI web site inspired much of the functionality.

All of the network functions of the web application are stored in the networkFunctions.js file. The web page is linked to this file in order to perform the networking functions. This file was the most important code to implement when creating the web application.

```
//Routing
function enableQuickRoute(){
  if (serviceArea != null){
    dojo.disconnect(serviceArea);
  }
  // Enables addStop onClick event for Routing
  route = dojo.connect(map, "onClick", addStop);
  route;
  routeTask = new esri.tasks.RouteTask("http://geogtest.uoregon.edu/ArcGIS/rest/services/Temp/SalemBase/NAserver/Route");
  routeParams = new esri.tasks.RouteParameters();
  routeParams.stops = new esri.tasks.FeatureSet();

  dojo.connect(routeTask, "onSolveComplete", showRoute);
  dojo.connect(routeTask, "onError", errorHandler);

  stopSymbol = new esri.symbol.SimpleMarkerSymbol().setStyle(esri.symbol.SimpleMarkerSymbol.STYLE_CROSS).setSize(15);
  stopSymbol.outline.setWidth(4);
  routeSymbol = new esri.symbol.SimpleLineSymbol().setColor(new dojo.Color([0, 0, 255, 0.5])).setWidth(5);
}

function enableSafeRoute(){
  if (serviceArea != null){
    dojo.disconnect(serviceArea);
  }
  // Enables addStop onClick event for Routing
  route = dojo.connect(map, "onClick", addStop);
  route;
  routeTask = new esri.tasks.RouteTask("http://geogtest.uoregon.edu/ArcGIS/rest/services/Temp/SalemBase/NAserver/Route");
  routeParams = new esri.tasks.RouteParameters();
  routeParams.stops = new esri.tasks.FeatureSet();

  dojo.connect(routeTask, "onSolveComplete", showRoute);
  dojo.connect(routeTask, "onError", errorHandler);

  stopSymbol = new esri.symbol.SimpleMarkerSymbol().setStyle(esri.symbol.SimpleMarkerSymbol.STYLE_CROSS).setSize(15);
  stopSymbol.outline.setWidth(4);
  routeSymbol = new esri.symbol.SimpleLineSymbol().setColor(new dojo.Color([0, 0, 255, 0.5])).setWidth(5);
}

//Adds a graphic when the user clicks the map. If 2 or more points exist, route is solved.

function addStop(evt) {
  var stop = map.graphics.add(new esri.Graphic(evt.mapPoint, stopSymbol));
  routeParams.stops.features.push(stop);

  if (routeParams.stops.features.length >= 2) {
    routeTask.solve(routeParams);
    lastStop = routeParams.stops.features.splice(0, 1)[0];
  }
}

//Adds the solved route to the map as a graphic
```

```

function showRoute(solveResult) {
    map.graphics.add(solveResult.routeResults[0].route.setSymbol(routeSymbol));
    infoTemplate = new esri.InfoTemplate("Attributes", "${Total_Minutes}");
    solveResult.routeResults[0].route.setInfoTemplate(infoTemplate);
    dojo.byId("info").innerHTML = "Total time: " + solveResult.routeResults[0].route.getContent() + " minutes";
}

//Displays any error returned by the Route Task
function errorHandler(err) {
    alert("An error occured\n" + err.message + "\n" + err.details.join("\n"));

    routeParams.stops.features.splice(0, 0, lastStop);
    map.graphics.remove(routeParams.stops.features.splice(1, 1)[0]);
}

//*****Service Area*****
function enableServiceArea() {
    if (route != null){
        dojo.disconnect(route);
    }
    serviceArea = dojo.connect(map, "onClick", mapClickHandler);
    serviceArea;

    params = new esri.tasks.ServiceAreaParameters();
    params.defaultBreaks= [2,4,6];
    params.outSpatialReference = map.spatialReference;
    params.returnFacilities = false;
    params.trimOuterPolygon = true;
    serviceAreaTask = new esri.tasks.ServiceAreaTask("http://geogtest.uoregon.edu/ArcGIS/rest/services/Temp/SalemBase/NAServer/");
}

function mapClickHandler(evt){
//define the symbology used to display the results and input point
var pointSymbol = new esri.symbol.SimpleMarkerSymbol(esri.symbol.SimpleMarkerSymbol.STYLE_CIRCLE, 12,
    new esri.symbol.SimpleLineSymbol(esri.symbol.SimpleLineSymbol.STYLE_SOLID,
    new dojo.Color([88,116,152]), 0.001),
    new dojo.Color([110,59,255,1]));
var inPoint = new esri.geometry.Point(evt.mapPoint.x,evt.mapPoint.y,map.spatialReference);
var location = new esri.Graphic(inPoint,pointSymbol);

map.graphics.add(location);
var features = [];
features.push(location);
var facilities = new esri.tasks.FeatureSet();
facilities.features = features;
params.facilities = facilities;
}

//solve
serviceAreaTask.solve(params,function(serviceAreaSolveResult) {

    var result = serviceAreaSolveResult;

    var polygonSymbol = new esri.symbol.SimpleFillSymbol(esri.symbol.SimpleFillSymbol.STYLE_SOLID, new esri.symbol.SimpleLineSymbol(
        new dojo.Color([232,104,80]), 0.001),new dojo.Color([170,102,205,0.25]));

    dojo.forEach(serviceAreaSolveResult.serviceAreaPolygons,function(polygon) {

        var polygonGraphic = new esri.Graphic(polygon,polygonSymbol);

        map.graphics.add(polygonGraphic);

    });

},function(err){

    console.log(err.message);

});
}

```

The web application incorporates the jQuery JavaScript library for aesthetic purposes. This library allows for greater customization of the user interface and smooth animations. Our use of it is limited, but it serves to make the application a bit more appealing than the generic ArcGIS map interface.

The GIS data for the web application is hosted by the University of Oregon InfoGraphics Lab using ArcGIS Server. Depending on the behavior of the user, the application will send and receive data from the server to return a different zoom level of the map, calculate and display routes and service areas, and return statistics.

Appendix 3 – GIS Metadata for Selected Reports

Downtown Pedestrian Network

Eric Stipe and Tanner Semerad

The following chart contains the new pedestrian route information used to create the network data, which is located in the geodatabase “tsemerad_estipe_salem.gdb.” The fields below are the newly created fields. There are two identical feature classes in the provided database, which are titled “WalksLine11_21_1_1” and “WalksLine11_26.”

Geodatabase – tsemerad_estipe_salem.gdb		
Factor	Field Name	Description
Type of pedestrian route	Walk_Type	1 - Primary Path 2 – Alternate Path 3 – Crossing 4 – Painted Crossing 5 – Stop Crossing 6 – Driveway 7 – Alley 8 – Parking Lot 9 – Narrow/Unsafe Street 10 – Dangerous Crossing
Estimated Transit Time	Time Time_Minutes	Divided “Distance” field over rate of 4MPH walk speed to calculate time in minutes
Adjusted Transit Time	time_adjusted	Time_Minutes multiplied by Walk_Type time multiplier. Used to simulate accurate walking time.
Estimated Route Accessibility	SafetyValue_1	Value used to multiply by “Length_Feet” field to calculate adjusted length
Adjusted Route Accessibility	SafetyValueNormalized	Length_Feet multiplied by SafetyValue_1 accessibility multiplier. Used to create route based on accessible paths.

The new paths in the geodatabase are accompanied by several files used to create the basemap and final map products.

Title	File Name	Description
Pedestrian Route Layer File	WalksLineSymbol.lyr	Includes symbolization used for the digitization of the walks
Pedestrian Network Map	Tsemerad_estipe_SalemBasemap.mxd	ArcGIS MXD that can be used to work in with the provided geodatabase

Downtown Pedestrian Corridors

Ben Reder

Title	File Name	Description
Parks and Green Spaces	B Reder parks.shp	Parks and green spaces utilized in research
Pedestrian Corridors	B Reder trails.shp	Manipulated street centerline file to include park trails and other pedestrian walkways

Downtown Bicycle Network

Michael Duncan, Kory Northrop, and Ted Sweeney

Title	File Name	Description
New Downtown Bicycle Network	Bike_Infrastructure_Citywide.shp	The new original bike network data set
Salem Streets	Ctrline_UGB.shp	Salem street centerline file clipped to the Salem-Keizer UGB, used to populate data fields in the new bike network layer during digitization process.
Existing Bike Routes	Existing_bikeroute.shp	Salem's bike network shape file with only existing bike routes included (proposed routes and infrastructure were removed)

Geodatabase – tsemerad_estipe_salem.gdb		
Factor	Field Name	Description
Type of pedestrian route	Walk_Type	1 - Primary Path 2 – Alternate Path 3 – Crossing 4 – Painted Crossing 5 – Stop Crossing 6 – Driveway 7 – Alley 8 – Parking Lot 9 – Narrow/Unsafe Street 10 – Dangerous Crossing
Estimated Transit Time	Time_Minutes	Divided “Distance” field over rate of 4MPH walk speed to calculate time in minutes
Adjusted Transit Time	time_adjusted	Time_Minutes multiplied by Walk_Type time multiplier. Used to simulate accurate walking time.
Estimated Route Accessibility	SafetyValue_1	Value used to multiply by “Length_Feet” field to calculate adjusted length
Adjusted Route Accessibility	SafetyValueNormalized	Length_Feet multiplied by SafetyValue_1 accessibility multiplier. Used to create route based on accessible paths.

Public Transit Connectivity

Nick Garcia

Title	File Name	Description
Comprehensive Green Spaces Layer	Salem_green_spaces_all_NG_2.shp	Updated, comprehensive green spaces layer created for research.
Green Space Accessibility	GreenSpaces_wIndices.xls	This spreadsheet contains the transit accessibility calculations for each park. The first tab Greenspace_Data_Static is the one the should be used for joining. See below for important fields within spreadsheet.

GreenSpace_wlndices.xls spreadsheet		
Field	Description	Values
ST_ADDR	Streets taken from Salem centerline data.	e.g. "CENTER ST NE"
RD_CLASS	Street classification taken from Salem centerline data used to determine speed limits if not in ODOT data	e.g. "1300" or "1510"
SPEED	Speed limit of the street that bike infrastructure is on.	e.g. "25" or "40"
LANES	Number of car lanes on the street. However, for "Intersection" segments, this field corresponds to the number of lanes crossed. Additionally, intersections crossing two-way residential streets that do not have a painted centerline were classified as having only "1" lane to cross due to them being less challenging to bicyclists than other two-lane intersections	"1", "2", "3", etc.
TYPE	The type of bike infrastructure that exists on the street segment.	"Multi-Use Path", "None", "Shoulder", "Sharrow"
TYPE_VAL	Corresponds to value of each bike infrastructure type in Fear Factor calculations. (See Figure 38 in Appendix 4)	"Bike Lane", "Sharrow", "Shoulder", "Intersection", "None"
Oneway	Denotes directionality of the bike segment (i.e. one-way or two-way)	"FT", "TF"
Parking	Is there car parking on the street that the bike infrastructure exists on?	"Yes", "No"
Length	Length of the bicycle infrastructure segment (feet)	e.g. "705.3145"

Bicycle-Pedestrian Mobility

Trafton Bean and Emma Silverman

Title	File Name	Description
Bad Surface Street	BadSurfaceStreets.shp	Streets marked as having “Poor Surface Conditions” for bicycles and pedestrians on Mobile GIS survey.
Surveyed Streets	Streets_ TraftonEmmaMergeGood. shp	Fields from all streets surveyed with Mobile GIS tool. Used to calculate composite “Mobility Score.”
Partial Surveyed Streets (1 of 2)	Streets_Emma.shp	One-half of streets surveyed with Mobile GIS tool. Joined after survey in ArcMap to calculate composite “Mobility Score” in “Streets_ TraftonEmmaMergeGood. shp.”
Partial Surveyed Streets (2 of 2)	Streets_Trafton.shp	One-half of streets surveyed with Mobile GIS tool. Joined after survey in ArcMap to calculate composite “Mobility Score” in “Streets_ TraftonEmmaMergeGood. shp
Willamette University Buffer	WillametteU_MileBuffer. shp	Surrounding area within 1 mile of Willamette University campus
Streets within Willamette Buffer	Streets_MileBuffer.shp	Salem Streets within 1 mile of Willamette University
Willamette University Campus Boundaries	WillametteU_ CampusBOundaries3.shp	Updated campus boundaries layer around Willamette University

The chart below notes the questions and possible responses in the Mobile GIS survey, as well as the metadata and values associated with each answer. The final “Mobility Rating” was calculated by adding corresponding values of each response together.

<i>Survey Question</i>	<i>Survey Response</i>	<i>Data Value</i>	<i>GIS Data Field</i>	<i>Field Properties</i>
Street Type	Major Arterial	1	ST_TYPE	Short Integer
	Minor Arterial	2		Precision 10, Scale 0
	Local Street	3		
Are there any auto lanes?	5 Lanes	1	AUTO_LANE	Short Integer
	4 Lanes	2		Precision 10, Scale 0
	3 Lanes	3		
	2 Lanes	4		
	1 Lane	5		
Is there a median?	No	0	MEDIAN	Short Integer
	Yes	-1		Precision 10, Scale 0
What is the posted speed limit?	45 MPH	-4	SPEED_LMT	Short Integer
	40 MPH	-3		Precision 10, Scale 0
	35 MPH	-2		
	30 MPH	-1		
	25 MPH	0		
	20 MPH	1		
	15 MPH	2		
Describe the land use:	Industrial	-2	LAND_USE	Short Integer
	Strip Mall	-1		Precision 10, Scale 0
	"Main Street" Commercial	0		
	Medium Density Housing	1		
	Low Density Residential	2		
	Parks or Open Space	3		
Are there sidewalks?	None	0	SIDEWALK	Short Integer
	One Side	1		Precision 10, Scale 0
	Both Sides	2		
Is there a cul-de-sac?	Yes	-1	CUL_DE_SAC	Short Integer
	No	0		Precision 10, Scale 0
Is there a buffer space between pedestrians and traffic?	No	-1	BUFF_DSC	Short Integer
	Parked Cars	1		Precision 10, Scale 0
	Paved Area	0		
	Bike Lane	2		
	Planting Strip	3		
"Walking here is safe and comfortable."	Strongly Disagree	1	WALK_SAFE	Short Integer
	Disagree	2		Precision 10, Scale 0
	Neutral	3		
	Agree	4		
	Strongly Agree	5		
Most likely place to ride a bike:	Shared automobile travel lane	0	BIKE_RIDE	Short Integer
	Paved Shoulder (not marked)	-1		Precision 10, Scale 0
	Adjacent Path	1		
	Marked on-street bike lane	2		

"A casual cyclist would feel comfortable riding on this street."	Strongly Disagree	1	<i>BIKE_SAFE</i>	Short Integer
	Disagree	2		Precision 10, Scale 0
	Neutral	3		
	Agree	4		
	Strongly Disagree	5		
Does anything diminish this route for pedestrian use?	Sidewalks not continuous	-1	<i>OB_SDWALK</i>	Short Integer
	Lack of wheel chair ramps	-1	<i>OB_RAMPS</i>	Precision 10, Scale 0
	Surface condition is unaccepta	-1	<i>OB_SRFCE</i>	
	Obstacles in path (permanent)	-1	<i>OB_OBST</i>	
	Obstacles in path (temporary)	-1	<i>OB_TEMP</i>	
	Problematic high volume drive	-1	<i>OB_DRVWY</i>	
Are there barriers to bicycle use?	High Speeds	-1	<i>PROB_SPEED</i>	Short Integer
	Heavy traffic volume	-1	<i>PROB_TRAFF</i>	Precision 10, Scale 0
	Sudden pavement edge drop	-1	<i>PROB_DROP</i>	
	Unacceptable surface condition	-1	<i>PROB_SURFA</i>	
	Obstacles in path (temporary)	-1	<i>PROB_TEMP</i>	
	Obstacles in path (permanent)	-1	<i>PROB_PERM</i>	
	Dangeraous bicycle lane shifts	-1	<i>PROB_SHIFT</i>	
	Other problem	-1	<i>PROB_OTHER</i>	
General problem or point of interest:	Raised sidewalk	-1	<i>POI_SDWK</i>	Short Integer
	Car parked on sidewalk	-1	<i>POI_CAR</i>	Precision 10, Scale 0
	Vegetation in travel way	-1	<i>POI_VEG</i>	
	Post blocking travel way	-1	<i>POI_POST</i>	
	Numerous driveway entrances	-1	<i>POI_ENT</i>	
	No sidewalk	-1	<i>POI_NSW</i>	
	Other 1...	-1	<i>POI_OTH1</i>	
	Other 2...	-1	<i>POI_OTH2</i>	

Salem Marathon

Kevin Belanger

Title	File Name	Description
Marathon Course Route	Marathon_course.shp	Proposed course for Salem Marathon
Aid Stations	Aid_Stations.shp	Proposed locations for 12 aid stations along course route.
Mile Marker	Mile_markers.shp	Location of each one-mile interval marker along course.
Aid Station Barriers	Barriers.shp	Analysis of landscape noting barriers – sharp turns, bicycle/pedestrian conflict, intersections, driveways, and railroads – to placing an aid station in a particular location along course route.

Appendix 4: New Bicycle Network GIS Data and Equations

Michael Duncan, Kory Northrop, and Ted Sweeney

Similar to the analysis of pedestrian connectivity, project members also recognized the need for a new digital bicycle network that shows Salem's street network in terms of bicycle travel as opposed to automobile travel. The process included digitizing bicycle routes from an aerial photograph and categorizing each route segment based on safety and connectivity to create this new network, which were labeled as "Fear Factor" rating.

GIS Data and Digitization Method

Line segments were digitized in ArcGIS 9.3 using aerial photos of Salem from 2008. New segments were delineated any time one of the following conditions occurred: an intersection was reached, the number of car lanes increased or decreased, the speed limit of the street changed, bicycle infrastructure appeared or disappeared, a street became a new road after a turn, or the bicyclist would be forced to "take" a vehicle lane to either move through the space or prepare for a left turn.

Line segments were drawn on the parts of streets where bicycles would logically and legally travel. On streets with no bike lane or shoulder, the bike routes were drawn in the direction of travel on the far margins of each side of the street. Where bike lanes or shoulders were present, line segments were drawn in the direction of legal travel. Drawing in the direction of travel meant that each segment began where a bicycle would legally start on the section if travelling through and ended at a point farther along that imaginary bicycle's path. This directionality was inputted in a field called, "Oneway," using the values: "FT", "TF", and <Null>. The value "FT" (from-to) signifies a one-way segment that was digitized in the direction of travel. "TF" (to-from) signifies a one-way segment that was digitized in the opposite direction of travel; there are only a few segments with a "TF" value because they were created early on before we knew how to effectively and easily model directionality. Multi-use path segments were drawn in the middle of paths and were given a <Null> value in the Oneway field, signifying that they are multi-directional.

Attributes were recorded based on information from city shapefiles using Spatial Adjustment functions and through manual entry. Two city shapefiles were set up for Attribute Transfer Mapping during the digitization process. "Speed Zone," which contains speed limits for some streets based on ODOT zone orders, was mapped to the "SPEED" field in the Bike_Infrastructure_Citywide shapefile. Speed limits of nearby streets were referenced to determine speed limits of street segments not contained in the "Speed Zone" file. While this is the best data available, it is inadequate; actual speed limits for every street in Salem would improve the reliability of future analyses. Salem's "ctrline" data was mapped to the "ST_ADDR" field. Using the aerial photo as a reference, the following fields were populated with an objective determination of existing

conditions; “LANES” were counted, “TYPE” was filled in for the sort of infrastructure present, “Parking” signified the presence of on-street parking, and “LANEXING” was populated with the number of times a cyclist would have to move one lane to the left in the span of the segment. For “Intersection” segments, “LANES” signifies the number of lanes of the perpendicular street.

Fear Factor Formulas

“FearFactor” was based on a formula describing the interactions between the various recorded attributes. The field “TYPE_VAL” was created to assign numerical values to the observed infrastructure types (see Figure 38).

$$FF = ((SPEED-25) * 4) + (LANES * 30) + (LANEXING * 60) - TYPE_VAL$$

The formula was altered for intersections and segments without any bicycle infrastructure so that TYPE_VAL was multiplied by the number of lanes on the street:

$$FF = ((SPEED-25) * 4) + (LANES * 30) + (LANEXING * 60) - (TYPE_VAL * LANES)$$

This formula was arrived at through trial and error, and is completely adjustable. The multiplication factors used here can be changed to reflect results of community surveys on how important these factors are to the bicycling experience in Salem or new academic research into the subject.

A network data set was created in ArcCatalog using the newly created “Bike_Infrastructure_Citywide” shapefile. Junctions were allowed at “any vertex”, not just endpoints. Two cost evaluators were created: one based on segment length (in feet) and one based on FearFactor. The “Oneway” field was set up as a restrictor so that segments could be traversed only in the appropriate direction.

ArcGIS 9.3 has a built-in recognition of directionality that understands the values “FT”, “TF”, and <Null> when used in conjunction with the new field named “Oneway”, which simplified our efforts to model directionality. After the network was built in ArcCatalog, it could be queried and analyzed using the Network Analyst tools in ArcMap. Our analyses utilized the Route functionality of Network Analyst. Because our network contained two cost evaluators (length and FearFactor), we were able to calculate two different routes between any origin and destination point. Additionally, the total fear and total length of each route was captured by using the “Accumulation” functionality of Network Analyst.

Table 2: TYPE_VAL Values for Infrastructure Types

Bike Lane	50
Sharrow	20
Shoulder	0
Intersection	-10
None	-20
Off-Street Bike Facility	*

** All Off-Street Bike Facilities received an FF value of “0” and thus no TYPE_VAL was assigned*

Figure 38. TYPE_VAL Values for Infrastructure Types. These values were used in the Fear Factor calculations.

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