



**Downtown Salem Circulation Study**  
Fall 2010 • Portland State University  
Department of Civil and Environmental Engineering

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## Acknowledgements

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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.



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## Executive Summary

The City of Salem is adapting its current transportation infrastructure to enhance active transportation within the City. The City is complying with the goals of Vision 2020 – a comprehensive effort to secure a vibrant future for the downtown core and to create a more sustainable transportation system.

The Portland State University Department of Civil and Environmental and Engineering partnered with The University of Oregon Sustainable Cities Initiative to explore the feasibility of various transportation network alternatives proposed by the City of Salem. The Downtown Salem Circulation Study was conducted by Portland State University civil engineering students in order to evaluate proposed alternatives for bicycle and pedestrian infrastructure improvements. The alternatives came from the Salem Willamette River Crossing Alternate Modes Study, Vision 2020 Bicycle and Pedestrian Working Group, and the Salem Transportation System Plan. These alternatives addressed areas that lack safe and connected travel routes for pedestrians and cyclists along traffic corridors and between neighborhoods.

Ten separate studies were conducted by the civil engineering students. Some project sites were evaluated by more than one group. The groups evaluated existing traffic conditions and developed alternatives that minimized the impact on vehicle and freight traffic, retained existing parking capacity, and supported local businesses.

Although students used computational data to determine the feasibility of each alternative, the main variables affecting recommendations were human factors; safety, scale, environment, aesthetics, cost, and practicality. Some groups suggested that their recommendations were short-term solutions and that major reconstruction of systemic transportation problem areas will need to be considered to fulfill the goal of a sustainable transportation system in Salem.



## Introduction

The City of Salem is developing a sustainable transportation system plan that encourages alternative modes of transportation including bicycle, pedestrian, and public transportation. The Salem River Crossing Bridge Project, The Salem Willamette River Crossing Alternate Modes Study, Vision 2020 Bicycle and Pedestrian Working Group, and the Salem Transportation System Plan were conducted to suggest a number of specific projects as part of a holistic plan to improve Salem's transportation system.

A collaboration between the Sustainable Cities Initiative, the City of Salem, and Portland State University Department of Civil and Environmental Engineering, the Downtown Circulation Study was designed to analyze eight locations of interest in Salem's transportation plans. The study was conducted in the fall of 2010 as the focus of a design course, Urban Transportation Systems, and was led by Dr. Chris Monsere, assistant professor in the Department of Civil and Environmental Engineering at Portland State University. The eight areas of study were assigned to Portland State University civil engineering students for evaluation. Some of the locations were evaluated by more than one student group. Other projects overlapped or were connected parts of an overall area plan.

The main purpose of the Downtown Circulation Study was to develop viable alternatives to enhance circulation of all modes of travel through and within downtown in a manner that encourages bicycle and pedestrian travel, aligning the goals of Vision 2020 while simultaneously minimizing impact on motor vehicle circulation, freight movement, and parking capacity.

The following report is a summary of the Downtown Circulation Study and the recommendations proposed by each of the civil engineering student groups. The projects are organized into four sections, based on the projects' locations.

# Downtown

## Addition of Bike Lanes to High and Church Streets



Figure 1: Church and High Street network under consideration.



Figure 2: Detail view of an intersection modeled in Synchro.

### Introduction

In the United States, transportation planning is undergoing a transition from planning that is car-centric to planning that incorporates and encourages the use of active transportation (bicycle and pedestrian) choices. One way to increase pedestrian and bicycle travel is by adapting existing transportation networks. This project examined the feasibility of adding bike lanes to the High and Church Street couplet, located within the downtown core of Salem.

### Methodology

In order to analyze the potential of adding bike lanes to Church and High streets, baseline conditions for the existing network were established. A comparison was made between the existing network and possible alternatives. In order to accommodate the addition of bicycle lanes, one of the following alterations to the existing roads would need to be made.

- Remove one of the three vehicle lanes
- Reduce lane widths
- Decrease parking availability

The City of Salem is adamant about preserving vehicle parking capacity throughout the downtown core. Local businesses are similarly concerned with maintaining parking capacity for customers. To preserve on-street parking and mandatory vehicle lane width, one vehicle lane would need to be removed to accommodate a bike lane.

Two network systems of Church and High Streets were modeled to determine the impact on motor vehicle traffic. The first system consisted of the existing network, with no bicycle lanes. The second system consisted of the same network with one vehicle lane

removed from both Church and High Street and replaced with an exclusive bicycle lane.

## Results

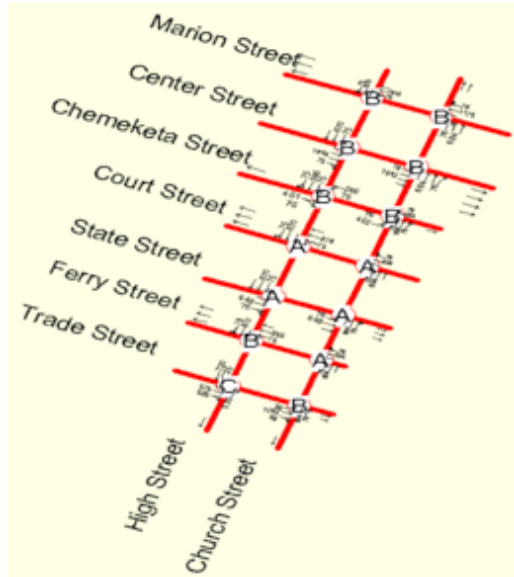


Figure 3: Synchro Level of Service results for System 1 analysis.



Figure 4: Synchro Level of Service results for System 2 analysis.

The adverse effects of lane removal are clear (see Figures 3 and 4); the Level of Service for motor vehicles is reduced at the intersections with Marion, State, and Court Streets with the addition of a bike lane.

The placement of the dedicated bike lane on either side of High and Church Streets may not be a practical solution if the current Levels of Service must be maintained. Also, since High and Church streets are a one-way couplet intersecting with one-way traffic, a dedicated bike lane on one side of the street would limit turning capabilities for cyclists onto every other minor street. For example, if the bike lane was on the right side of the street, a cyclist would have to merge left into motor vehicle traffic or make a series of right turns around the block to make a legal left turn.

### Level of Service

The Highway Capacity Manual and AASHTO Geometric Design of Highways and Streets (“Green Book”) defines the following Levels of Service:

- A = Free flow
- B = Reasonably free flow
- C = Stable flow
- D = Approaching unstable flow
- E = Unstable flow
- F = Forced or breakdown flow



Figure 5: Example of a Sharrow.

## Recommendations

Due to the complications that arise in the execution of turns for bicycles, we do not recommend this network modification. The elimination of 33 percent of lane capacity for the purpose of creating a dedicated bike lane may have costs that outweigh potential benefits.

As a compromise between the conservation of vehicle lanes along Church and High Streets and the desire to promote bicycle use, the City of Salem is advised to adopt the system

used on Commercial Street. Commercial Street currently operates with bicycle-vehicle shared lanes for its leftmost and rightmost lanes, signified by highly visible sharrows.

Incorporating this strategy, the Church and High Street network would operate with similar performance as compared to the existing network. If Salem expanded its current practice of using traffic control devices, it could avoid eliminating vehicle lanes while simultaneously improving cyclist safety throughout the High and Church Street couplet.

## High Street / Church Street Two-Way Conversion

### Introduction

The downtown Salem business district is an important economic, cultural and governing hub for the city and state. It is important that visitors and shoppers have quick, safe, and direct access to businesses and events. The current one-way street couplet on High and Church Streets in the downtown area is sufficient for current traffic volumes, but mobility and accessibility in and around the downtown area may be difficult and confusing for unfamiliar motorists.

The purpose of this project is to convert the one-way couplet of southbound traffic on High Street and northbound traffic on Church Street into two-way operation, north- and southbound on both streets, to improve access to businesses and to spur new development in the area.

### Methodology

The existing typical street cross sections for High Street and Church Street are shown in Figure 6. Currently, the couplet on High Street and Church Street is under capacity. Due to this excess capacity, the design can be guided more by mobility and less by capacity. To maintain and improve business activity and economic conditions, no net loss of parking is allowed.

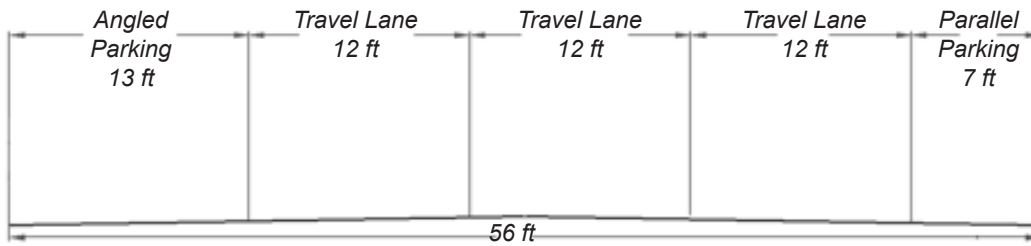


Figure 6: Existing One Way Street Conditions on High and Church Streets.

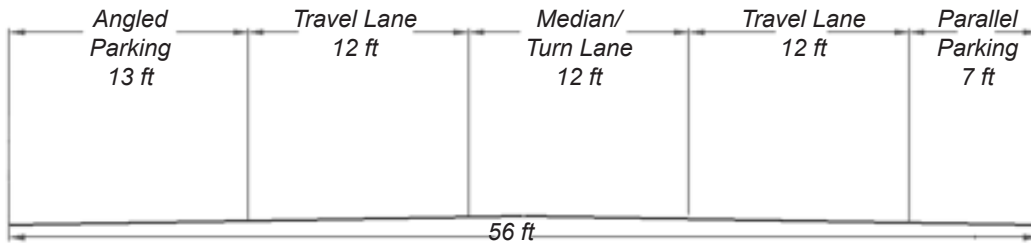


Figure 7: Proposed Two Way Street Conversion.

Although the Salem Transit Center, located between High and Church Streets, is currently condemned and will be relocated in the next 3 to 5 years to another location outside the scope of this project, bus turning movements and scheduling were considered in designing the conversion.

Using transportation modeling software, the existing conditions were used as a base to construct the proposed network model. The method used for the modeling of the proposed network included shifting three lanes into two lanes with a planter median (see Figure 7). In addition to the two-lane median cross section, turning pockets were introduced to eliminate congestion due to turning movements. If an intersection showed signs of major congestion, the turning pocket was extended to accommodate and alleviate this congestion.

## Results

All model performance measures were negatively impacted by this two-way operation proposal (see Figure 8). Both average delay per vehicle and total delay for all vehicles increased. Also, the average stopped delay per vehicle increased nearly 33 percent from the existing conditions. These performance measure degradations can be attributed to the increase of cross traffic

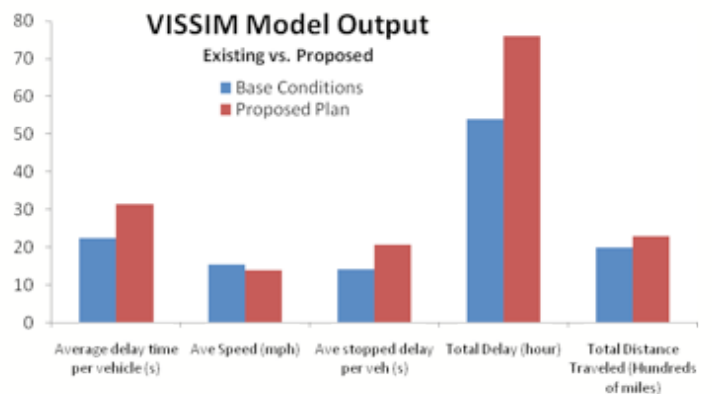


Figure 8: Model Performance Measures – Existing and Proposed.



movements at all intersections. The average speed decreased by 1.3 miles per hour, or about 10%.

## **Recommendations**

Although there was an increase in total distance traveled and other negative impacts for vehicles in this design option, pedestrian and economic benefits may outweigh negative traffic impacts. It is recommended that the City of Salem promote the conversion if funding allows. The downtown area located around the Church and High Street couplet provides access to many commercial businesses. For the purpose of increasing economic activity, this design could increase pedestrian traffic for businesses.

Changing lights, restriping thoroughfares and adding a median to an already functioning system is costly. If the City of Salem plans to increase public transit, bicycle, and pedestrian traffic 25 percent in the downtown area, it must prioritize other modes of transportation and consider them as important as automobile mobility.

## **The Union Street and Commercial Street Crossing**

### **Introduction**

The Union Street Railroad Bridge was recently renovated for bicycles and pedestrians as a means to encourage active transportation. However, inadequate connectivity and difficult crossing conditions complicate pedestrian and bicycle connections at the east end of the bridge. This diminishes the appeal of walking and cycling through the heart of Salem. One of these difficult pedestrian and bicycle crossings is at the intersection of Union and Commercial Streets in downtown Salem.

The purpose of this project is to locate and analyze potential intersection treatments that would improve bicycle and pedestrian safety at Union and Commercial Streets.

### **Methodology**

Using observational data for the intersection of Union and Commercial Streets, potential new traffic control devices and other treatments for pedestrian and bicycle crossings were evaluated.

The pedestrian bridge marks the beginning of Union Street, a two-way road with one lane in each direction. According to the City of Salem Bicycle Plan, Union Street is to become a main corridor for moving pedestrian and bicycle traffic into the downtown commercial core. Traveling east from the bridge, Commercial Street is the second street intersecting with Union Street.

Currently, there are no bicycle facilities or marked crosswalks at Commercial and Union Streets. Commercial Street is a one way southbound road with



Figure 9: Image of Downtown Salem. Source: Google Maps.

four lanes; the two left lanes have faster local traffic while the two right lanes accommodate vehicles travelling at slower speeds. Traffic on Commercial Street has the right-of-way at this intersection, with a two-way stop sign controlling the traffic on Union. The width across Commercial Street is more than 60 feet across, with four traffic lanes and parking on both sides of the street. The two right lanes of Commercial Street turn onto the Marion Street Bridge. Peak hour traffic flows cause the traffic in the two right lanes of Commercial Street to queue up through the Union Street intersection. At the same time, the left lanes of Commercial Street flow freely during peak hour.

The varying traffic speeds in each lane and queuing issues on Commercial Street create problems for pedestrians and bikers when crossing.

Appropriate traffic control devices were considered to improve the safety for pedestrians and bikers crossing a four-lane road with an average daily traffic (ADT) around 12,000-17,000, including;

- Warning signs
- Regular and raised crosswalks
- Traffic signals
- Standard Overhead Flashing Beacon
- High-intensity Activated Cross Walk Beacon
- Rectangular Rapid Flash Beacon

## Results

Beacons alert drivers of crossing pedestrians and cyclists. The most common type is the standard overhead flashing beacon. Unfortunately, their familiarity and ubiquity has conditioned drivers to ignore them.



Figure 10: Difficult crossing across Union Street.



Another beacon type is the High-intensity Activated Cross Walk (HAWK) beacon. It combines flashing red lights with a warning sign and has been proven more successful than standard crosswalks. The HAWK's resemblance to a full traffic signal can lead to confusion among drivers, since there is some ambiguity about how to react to this device when it is not active.

A rectangular rapid flash beacon (RRFB) is a relatively new type of signal approved by the MUTCD in 2008. Like the HAWK, it is demand-actuated. A loop detector can be placed in the bike lane with push button access for pedestrians. When activated, two intensely bright LED lights below a diamond-shaped pedestrian warning sign flash alternately. The RRFB is effective at alerting drivers to yield at crosswalks. Figure 11 shows the results of a study that compared an untreated intersection, the standard beacon, and the RRFB (Shurbutt 2008).

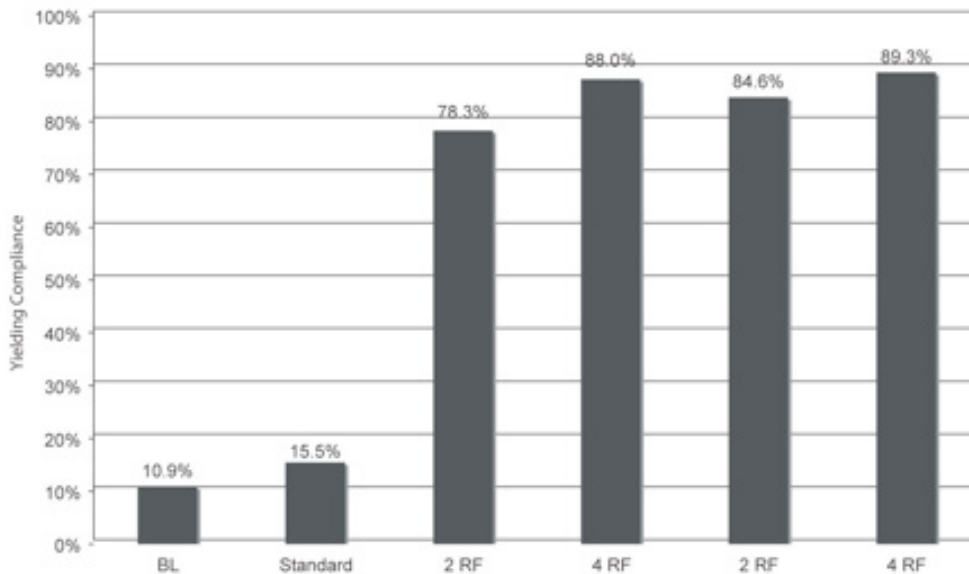
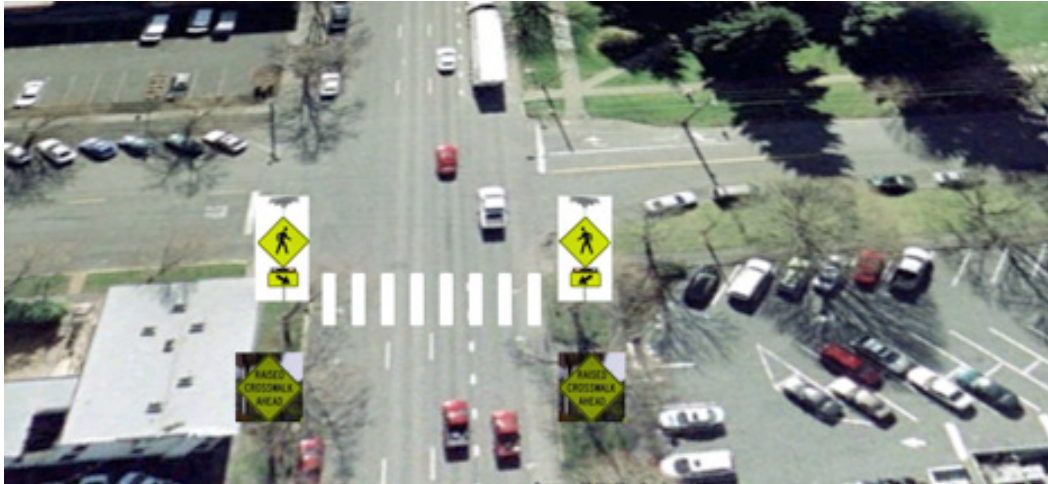


Figure 11: Comparison of vehicle yielding compliance rates at an untreated intersection, a standard beacon, and a variety of rectangular rapid flash beacons (Shurbutt 2008).

## Recommendations

It is recommended that the City of Salem use the RRFB in combination with a crosswalk and signage. This combination is effective and economical. It is also recommended to install a raised crosswalk to decrease traffic speed. If concerns involving the movement of emergency vehicles through the intersection preclude the installation of a raised crosswalk, the city should instead install “international” markings for the crosswalk. The recommended configuration is shown in Figure 12.



*Figure 12: Aerial View, looking south on Commercial Street at Union Street, with Recommended Treatments.*

# Commercial Street SE Bike Lanes

## Solution 1

### Introduction

Commercial Street SE is a three-lane, one-way street that travels south and serves as a main arterial through central Salem. Currently, there are no bike lanes on Commercial Street between Mission and Superior Streets. The existing automobile traffic makes it difficult to allow safe bicycle travel along this corridor. However, adequate bike lanes exist north of Mission Street and south of Superior Street on Commercial Street.

The purpose of this study is to consider bike lanes along Commercial Street SE, while minimizing the loss of on-street parking and the impact on vehicle traffic flow. This project evaluates three different design alternatives that may help to increase safety, accessibility, and bicycle ridership.

### Methodology

The data collection process consisted of on-site observation and measurement, speaking with local residents, accessing available data on traffic characteristics, and reviewing available literature on bicycle facilities. Data relating to vehicle

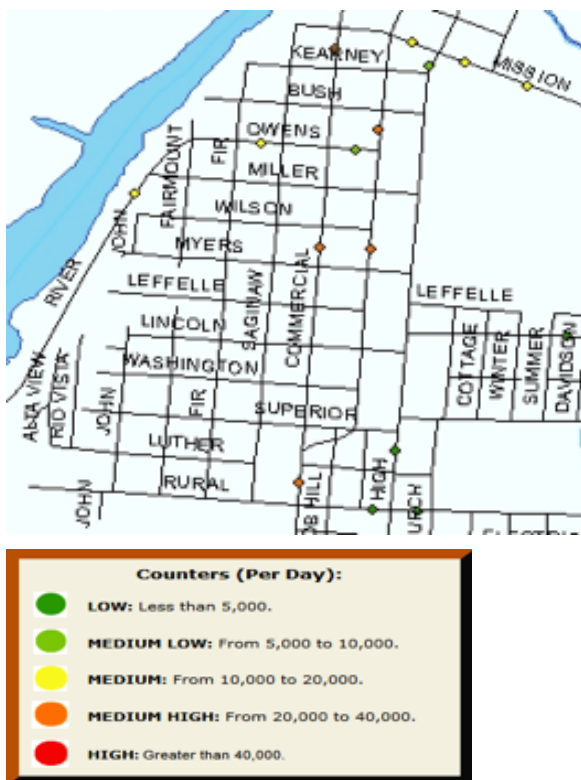


Figure 13: Average Daily Traffic (ADT).



Figure 14: Crash Data.

counts and crashes were obtained from the City of Salem. Geographic information system (GIS) software was also used.

Three designs were considered:

- The status quo option in which the corridor is kept as is.
- Providing a bicycle lane on Commercial Street in the right-of-way.
- Designing a bicycle boulevard that allows bicycle traffic to travel on a low Average Daily Traffic (ADT) roadway that runs parallel to Commercial Street.

## Results

The first alternative considered was the status quo. The current conditions are functional for motor vehicle traffic and there are no direct additional costs. The Commercial Street right-of-way is 42 feet in width (curb to curb). The current speed limit on Commercial Street is 30 mph. Some drivers exceed this limit when traffic is free-flowing. The speed of the vehicles traveling on this corridor is intimidating and potentially hazardous for bicycle riders as well as pedestrians. Although the status quo option is not ideal, it is functional and seems to be accepted by local residents.

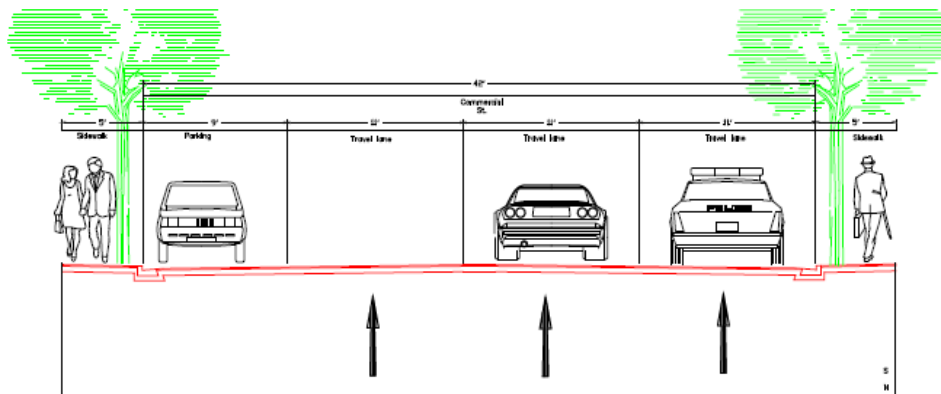


Figure 15: Commercial Street Cross-section from Mission Street to Owens Street, Existing Condition Looking South.

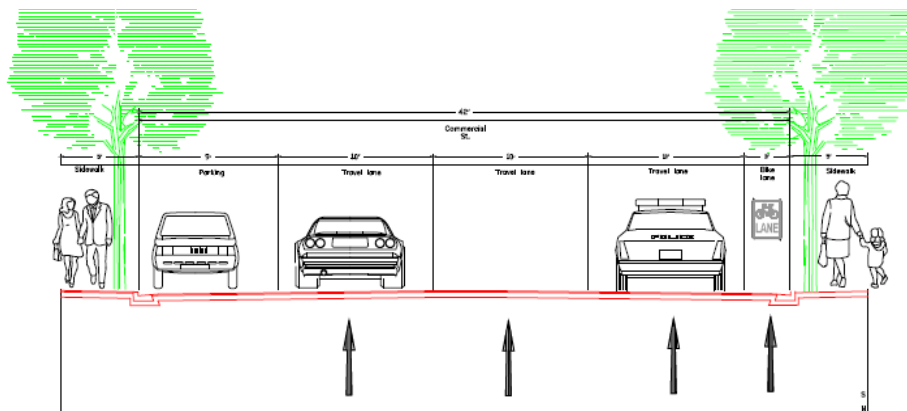


Figure 16: Proposed Cross-section of Commercial Street, Looking South.

The second option considered adding a bike lane to Commercial Street between Mission and Superior Streets. To accomplish this option without eliminating parking, Commercial Street would be widened and parking pockets would be added. Removing a lane or reducing the lanes to 10 feet would also be necessary for adding a bike lane. The bike lane would be 3 feet wide. Figure 16 illustrates a 9-foot parking lane provided on the east side of Commercial Street, three 10-foot travel lanes, and one 3-foot bike lane. At the intersection of Bush and Commercial Streets, Commercial Street is only 40 feet wide; the parking lane would be 7 feet wide along this section.

The speed limit would also need to be reduced to 25 mph, as recommended by the FHWA. Signals along this section of Commercial Street may need to have an extended time allowed for yellow in order to allow bicycles adequate time to clear the intersection.

The third option diverts bicycle traffic from Commercial Street between Mission and Superior Street to a bicycle boulevard. Currently, Saginaw Street has some bicycle signage but is not designated as a bicycle boulevard.



Figure 17: Saginaw Street.



Figures 18 and 19: Bike Dot and Wayfinding Sign Examples.

In order to convert Saginaw Street to a bike boulevard, wayfinding signs and bike dots would be added to Saginaw Street. A bike dot is a roadway marking that indicates the roadway is intended for bicycle use and helps to direct bicyclists who are unfamiliar with the path along the intended course of the bicycle boulevard.

Traffic devices such as stop signs, cross walks, and traffic circles would need to be added to, or modified at, intersections along Saginaw Street.

On Owens Street, a HAWK signal would be provided to allow cyclists to safely cross Owens along Saginaw.



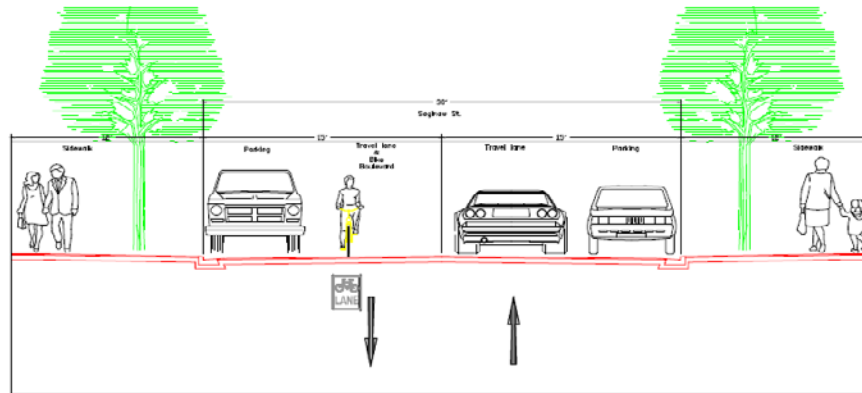


Figure 20: Cross-section of Saginaw Street.

## Recommendation

Of the three options considered, creating a bicycle boulevard on Saginaw Street was found to be the most appropriate solution. Saginaw Street is currently a bike route that would be better utilized if converted to a bicycle boulevard. Because a bicycle boulevard is on the existing roadway network, actual construction is minimal and disruptions to the neighborhood are minimal. Cyclists would reconnect with the designated bike lane on Commercial Street south of Superior Street, where there is enough right-of-way to provide an adequate bike lane.



Figure 21: HAWK Signal as Seen by Motorists.



Figure 22: HAWK Signal and Push Button Signal Activator.

## Solution 2

### Introduction

The goal of this study is to improve bicycle passage along Commercial Street SE, south of downtown Salem. Currently, the bike lane on Commercial Street terminates at Mission Street, forcing cyclists to either merge with traffic or take the bicycle route on Saginaw Street. From observation, the majority of cyclists currently choose to merge with vehicle traffic on Commercial Street. The bike

route on Saginaw is less desirable because there are multiple stop signs and the grade is steeper than the grade on Commercial Street. The posted speed limit on Commercial Street is 30 mph, and the merging of bicycles with vehicular traffic makes this a high-risk area.

## Methodology

Due to the constraints of the right-of-way on Commercial Street between Mission and Owens Streets, the placement of a bike lane would require the removal of street parking on Commercial Street. To assess the impact on local parking in the area, available street parking on Commercial Street was estimated and tabulated.

Reach Of Project	# of Parking Spaces
Mission to Kearney	10
Kearney to Bush	12
Bush to Owens	12
<b>Total</b>	<b>34</b>

Figure 23: Estimated Amount of Parking on SE Commercial Street.



Figure 24: Illustration of the Locations Where Additional Parking may be added.

To mitigate the loss of parking due to the removal of parking on Commercial Street, a preliminary assessment of possible locations for additional street parking was conducted. For each location, the number of parking spots mitigated and the foreseen barriers to adding parking at each location was tabulated. Locations D and E in Figures 24 and 25 are placed in existing driveways to parking lots that have alternate inlet/outlets and therefore would not negatively affect access to the lots.

## Results

One option considered was directing bicycle traffic onto Saginaw Street, which would be converted to a bike boulevard. Underutilization of this bike route by bicycle commuters is expected due to the fact that this route is inconvenient and has steeper grades.

An alternative approach would be to add a bike lane on Commercial Street and angled parking on Kearney and Bush Streets. Installing a bike lane on



<b>Additional Parking Location</b>	<b># of Parking Spots</b>	<b>Potential Barriers/Impact</b>
Location A	1	Fire Code for Adjacent Building
Location B	7	Removes 2 Trees, Right of Way
Location C	3	Right of Way
Location D	1	Driveway
Location E	1	Driveway
<b>Total:</b>	<b>13</b>	

*Figure 25: Number of Parking Spots Available at Proposed Location and Potential Barriers to Utilization.*

Commercial Street would require the addition of parking nearby. Utilizing one-way roads on Kearney and Bush Streets would allow for the efficient implementation of angled parking. Initially, parallel parking was considered, but there was no significant addition to parking using this method.

Another alternative is adding a bike lane on Commercial Street and distributing parking to various locations. Installing a bike lane on Commercial Street would still require removal of on-street parking, but the movement of traffic through this district would remain unaltered. The addition of striping to indicate parking spots along side streets would help to define and regulate on-street parking.

### **Recommendation**

It is recommended that the bike lane on Commercial Street should be extended from Mission Street to Owens Street. Due to a narrow right-of-way, removal of the current parking located along the left side of Commercial Street would be necessary to accommodate a bike lane. To mitigate the impact on local parking demand, additional parking would be added along the adjacent streets, Bush and Kearney, while also marking individual spaces to increase the efficiency of their use.

# Evaluation of Proposed Renovations for the Intersection of Commercial Street and Liberty Road at Vista Avenue



Figure 26: Aerial Photo of Y-Intersection.



Figure 27: Image of model from Synchro.

## Solution 1

### Introduction

Commercial Street SE is a four lane arterial highway running north and south. Liberty Road is a two lane road that splits from Commercial at about 22 degrees. Due to the unique design of the junction, it is hazardous for cyclists to travel south on Commercial Street through the Liberty Road intersection.

The purpose of this study is to find a safe and cost-efficient method for bicyclists to cross the intersection of Commercial Street and Liberty Road without significantly affecting the flow of vehicle traffic.

### Methodology

The data for this traffic analysis problem came from two sources; historical records from the City of Salem and observed traffic flow rates. Once the data collection was completed, an empirical computer model was generated. A model of the area was created using the geometry of the area, the vehicular volumetric data, the signal timing, and an assumed number of pedestrians and bicycles at each intersection.

Four proposals were analyzed for cost-effectiveness, ease of implementation, efficiency, and political viability.

- The Hansen Island approach proposes changes at the Hansen Avenue intersection.
- The Leading Bike Interval proposal adds bike signals to the intersection.
- The Stop Upstream Traffic proposal stops southbound traffic to allow bicyclists a gap to safely cross.

- The Solve Everything proposal recommends reconstruction of the intersection.

## Results

The Hansen Island approach had three alternative options for diverting bicyclists from Liberty Road to Commercial Street. All approaches involve bicyclists traveling across the Hansen Island median. The first solution was creating a bike lane crossing over to the Hansen Island at the Liberty Road and Hansen Avenue intersection. The second solution was installing a HAWK signal at the intersection of Liberty Road and Hansen Avenue. The third option was widening Liberty Road in order to install a crossing island.

For the Leading Bike Interval Approach, a separate bike signal at the corner of Commercial Street and Alice Avenue would be installed. When the bike signal is activated, all vehicle traffic is stopped except northbound Commercial Street. Cyclists would then have an exclusive green light. By providing an opportunity for bike traffic to progress separately from vehicle traffic at the intersection, bicycles would be able to access southbound Commercial Street safely.

The Stop Upstream Traffic approach allows bikes to cross Liberty Road at the Y intersection with the aid of a user activated bike signal. Bicycles traveling southbound onto Commercial Street would have to find a way to cross Liberty Road which, during peak times, is difficult. The bike signal would be placed where Liberty Road splits from Commercial Street.

Another solution would be the Solve Everything approach. This proposal attempts to “Solve Everything” with a major renovation of the Y intersection. Unfortunately, this solution requires the purchase of property, removing access to existing businesses, altering rights-of-way, executing a major construction project that would obstruct traffic for an extended period of time, and high costs.

## Recommendation

After extensive review of the collected data and the results of the modeling, each of the proposals resulted in minimal improvements for bicyclists while making congestion worse for motor vehicles. Instead, a low-cost, short-term solution is recommended. The recommended approach for providing a safe bicycle route on southbound Commercial Street is to make small enhancements and modifications to the existing route. This approach would divert southbound bicycle traffic from Commercial to Liberty at the Y-Intersection. Bicycles would continue on Liberty to the intersection with Vista, where a signal exists to provide a safe means of crossing. Once the bicycle has crossed Liberty, the bike lane would transition to the sidewalk, then reconnect with the existing bike lane on Commercial Street.



Figure 28: Proposed Solution.

In order to implement this plan, there would need to be some changes made to safely accommodate bicycle traffic. A “bike box” would be added for bicycles crossing from the southbound bike lane on Liberty Road to Vista Avenue. The bike box will be a staging area to keep bicycles separate from motor vehicles travelling southbound on Liberty Road. The existing stop bar for northbound traffic on Liberty Road at Vista Avenue would need to be moved south to give drivers a clear view of the bicycle and pedestrian crossing. Warning signs could also be installed. The most costly portion of this proposal is the expansion of the sidewalk on the south side of Vista Avenue to accommodate bicycles and pedestrians. Placing a bike lane on the sidewalk is necessary for the safety of cyclists and to maintain vehicle traffic flow. The existing sidewalk is five feet wide, which would need to be widened to ten feet by moving or eliminating the planted area between the sidewalk and the parking lot. Widening this sidewalk, or providing for safe bicycle travel on this block of Vista Avenue through another means, may require purchasing property from the adjacent landowner.

This proposed solution is the safest route for bicycles, the most economical choice for the city, and has a minimum impact on the existing infrastructure. It is recognized this is a short term solution. The poor level of service for many of these intersections will eventually require city officials to design a comprehensive plan to facilitate better traffic flow, including a more permanent integrated bicycle solution.



## Solution 2

### Introduction

This Report evaluates another set of proposals for the intersection of Commercial Street and Vista Avenue and recommends an appropriate solution.

### Methodology

The primary goal is to maintain or increase the current level of service while increasing safety and ease of travel for bicycles continuing south on Commercial Street. Five potential solutions were evaluated:

- Striping Approach
- Vista Approach
- Bike Box Approach
- Dual Sharrow Approach

The Striping approach includes two proposals to replace a southbound vehicle lane coming into the Alice Avenue / Commercial Street intersection with a bicycle lane.

The Vista Approach redirects bicycle traffic around a section of Commercial Street; bicycles reenter at the intersection of Vista Avenue with Commercial Street. This proposal also includes the retiming of signals at the intersection of Liberty Road and Vista Avenue.



Figure 29: Commercial St SE and Liberty Road.



Figure 30: Striping Proposal 1, Separated Lane.

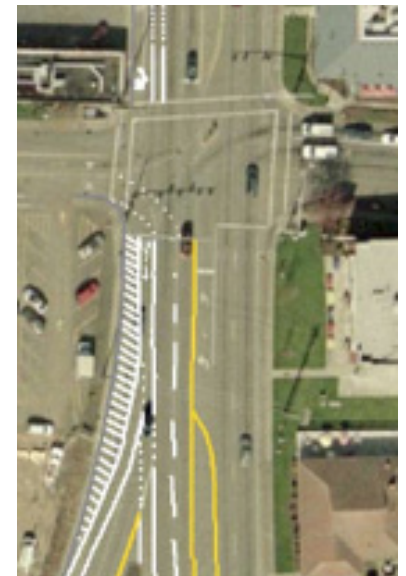


Figure 31: Striping Proposal 2, Reduced Lane.



Figure 32: Vista Approach.



Figure 33: Bike Box Approach.



Figure 34: Dual Sharrow Approach.

The Bike Box Approach installs a bike box on southbound Commercial Street where it intersects Alice Avenue.

The Dual Sharrow Approach places a southbound bike lane between two lanes of traffic on Commercial Street and a right turn lane onto Alice Avenue. Striping is added to the two right lanes of southbound traffic through the intersection and sharrows are added in order to create shared bicycle-auto lanes.

## Results

Preliminary review of the various solutions led to the conclusion that several were not viable. The striping and dual sharrow options would inevitably decrease Commercial Street's flow capacity. The striping approach would cause the removal of a southbound lane on Commercial Street, which is currently already at capacity. The sharrow option would cause increased congestion in the two westernmost lanes of southbound Commercial because cars and cyclists would be using the same lanes. As a result of these findings, these options were immediately discarded as potential options. The remaining options were then analyzed using traffic modeling software.

The three remaining approaches were analyzed: a bike box without a bicycle head start, a bike box with a four-second bicycle head start, and a Vista Avenue re-route approach.

The average delay and speed were calculated from 40 simulation runs on a modeling program. The standard deviation, 95th percentile, and 95th percent upper and lower confidence intervals were calculated.

		Bike Box + 0 sec		Bike Box + 4 sec		Vista Approach	
		Average Delay (Sec)	Average Speed (mph)	Average Delay (Sec)	Average Speed (mph)	Average Delay (Sec)	Average Speed (mph)
<b>Average</b>		98.89	10.12	100.77	10.03	90.3	10.88
<b>Standard Deviation</b>		21.41	1.55	22.84	1.65	23.1	1.85
<b>95<sup>th</sup> Percentile</b>		133.73	12.45	136	12.31	131.79	13.84
<b>95 % Confidence Interval</b>	<b>Low</b>	91.3	9.64	93.45	9.51	82.98	10.29
	<b>High</b>	106.47	10.6	108.08	10.56	97.63	11.47

Figure 35: Results from VISSIM and SYNCHRO Analysis.

The Vista Approach shows the lowest average delay and the highest average speed. The bike box with no head start and the bike box with a 4-second bicycle head start were compared. The delays in the 95th percentile were higher than the Vista Approach.

### Recommendations

Based on the analysis results, we recommend the Bike Box Approach. The Vista Approach did provide a slightly lower traffic delay and may appear to be the best approach based solely upon the data. But the Vista Approach is similar to the current configuration, which is not meeting the City’s needs. If the Vista Approach were implemented, the majority of cyclists would continue to bypass Vista Avenue and merge into vehicle traffic in order to remain on Commercial Street. Also, Vista Avenue does not have a bike lane at this time. Adding a bike lane on Vista Avenue would require the purchase of a right-of-way.

The Bike Box Approach is a safe method for moving bicycle traffic across two lanes of vehicular traffic to continue southbound on Commercial Street. This method works best when the bicycle arrives at the intersection during a red light. To help facilitate this movement, we recommend a light be installed for bicycle traffic only. The light would remain red until a bicyclist came through the bike lane. The bike would trip an induction wire which would send the bicycle light into the traffic queue. Once the vehicle signals were red, the bicycle light would turn green, giving cyclists a head start to safely clear the intersection. Due to the light bicycle traffic (15 per hour), this approach will offer a minimal overall delay.



# West Side Projects

## Bike and Pedestrian Crossing at Wallace Road

### Introduction

The newly renovated Union Street Railroad Bridge carries pedestrian and bike traffic over the Willamette River. On the west side of the river, the Union Street Railroad Bridge becomes the Union Street Bike Path. Wallace Road, or Highway 221, is a four-lane major arterial that moves traffic through a commercial district in West Salem. The Center Street and Marion Street bridges carry Highway 22 over the Willamette River. The Union Street Bike Path ends at Wallace Road in West Salem with no safe, convenient crossing.

Three solutions have been suggested by the Willamette River Alternate Modes Study for continuing the bike path over Wallace Road; an overpass, an underpass, and a combination of the two. The objective of this report is to evaluate the three designs and recommend an appropriate solution.

### Methodology

Three options were outlined in the Salem River Crossing Report for crossing Wallace Road:

- An underground pedestrian tunnel.
- A pedestrian and bicycle overpass.
- Lowering of Wallace Road with a pedestrian overpass.

In addition to the three options, a crosswalk at Bassett Street was also considered.

Data was collected from the City of Salem and Salem River Crossing websites. The City of Salem provided traffic flow counts on Wallace Road. Data from websites and publications were gathered from governmental and traffic agencies such as AASHTO and ODOT. Site visits were conducted by group members to observe and evaluate current conditions. A grading rubric was constructed to help determine the best solution.

### Results

The most appealing aspect of a pedestrian overpass bridge design is the limited traffic interruption. The Oregon based engineering firm OBEC is responsible for several pedestrian bridge projects, including the “Three Bridges” project along the Springwater Corridor in Portland. During construction of one of the three bridges, the McLoughlin pedestrian bridge, traffic was controlled at night over a three-day period with delays of no more than 20 minutes while the deck was put into place.

Using the Americans with Disabilities Act recommended maximum continuous sidewalk grade of 5%, and the AASHTO minimum height requirement of 17 feet, the minimum approach distance on each side of a pedestrian bridge over Wallace Road would need to be 340 feet. Such a long approach is normally a concern; however, the current geometry of the Union Street Bike Path permits such an approach.

Another option considers an underpass to safely cross Wallace Road. An underpass at this location would need to be ADA compliant and follow AASHTO guidelines for design. For a ten-foot tunnel, a 200-foot approach ramp would be needed at each end of the tunnel in addition to the width of Wallace Road. A tunnel of this length and depth would require proper drainage, lighting, security, and ventilation.

A third option is to lower Wallace Road and build a lower pedestrian and bicycle bridge. If Wallace Road was excavated to a level surface from Taggart to Musgrave Streets, the former railroad track grade would be 5 feet higher than Wallace Road. Following AASHTO requirements, it would be possible to have a level, or close to level, bicycle and pedestrian overpass over Wallace Road.

An at-grade crossing at Bassett Street was also considered. Signals for pedestrian and bikes would be added on Wallace Road and Bassett Street, located 200 feet from the Union Street Bike Path. This location provides adequate stopping sight distance for vehicles in each direction on Wallace Road.

To minimize the waiting time for motor vehicles on Wallace Road, a longer



Figure 36: McLoughlin Pedestrian Bridge, Portland.



Figure 37: Aerial View of Project Site.



Figure 38: Example of a Pedestrian Overpass.



Figure 39: Possible at-grade crossing at Bassett Street.

pedestrian timed signal and a shorter bicycle timed signal could be implemented.

The group scored each proposal on a scale of one to three, with one meaning not very effective and three meaning very effective, for eight factors.

Figure 40 shows the “grade” for each proposed solution.

	Reduce Travel Time	Control Movement	Cost to User	Safety	Effectiveness	Ease of Implementation	Sustainability	Building Cost
At Grade	1	3	2	1	1	2	2	1
Overpass	3	3	1	3	3	3	2	3
Underpass	3	3	1	3	3	1	1	3
Combination	3	3	1	3	3	1	2	3

Figure 40: Grading rubric for each proposal.

## Recommendations

According to the grading rubric, the best choice would be an overpass. The advantage of an overpass is that the construction method used is the least disruptive to the flow of traffic on Wallace Road. The disadvantage of the overpass is the additional elevation change that the bicycles and pedestrians must navigate in order to cross over Wallace Road.

The second choice would be an overpass with the excavation of Wallace Road. This solution would be the best long-term choice for encouraging more people to choose active transportation options. A lower overpass would be easy to cross for cyclists and pedestrians of all ages and abilities. The disadvantages of this solution are the complications in excavating Wallace Road. The disruption and diversion of traffic would be complex and costly.



## Wallace Road Multi-use Path

### Introduction

Currently, the Edgewater Path runs along the Willamette River between Highway 22 and Edgewater Street in West Salem. With the possible expansion of Highway 22, this portion of the bike path may be eliminated, creating the need to plan for an alternate route. The problem addressed by this group was the relocation of the bike path west of Wallace Road.

The goal of this project was to create a safe crossing for cyclists and pedestrians without interrupting or impeding the vehicle traffic on Wallace Road, and while maintaining access to businesses on Edgewater Street and in the surrounding area.

### Methodology

Assumptions were made regarding the majority of bike travel in the area. The primary bike route from the east side of the Willamette River to the west side is the Union Street Bike Path. With the possible removal of the Edgewater Path, the simplest solution for rerouting bicycle and pedestrian traffic appeared to be adapting the old railroad bed right-of-way between Wallace Road and Murlark Avenue.

The undeveloped portion of the old railroad bed between Wallace Road and Murlark Avenue is likely to be used in the future for commercial development. A secondary option was to route the bike traffic through local streets, then reconnect with the existing bike lanes on Edgewater Street. Site evaluation determined that routing bike traffic north on Wallace Road, then west on Bassett Street, then south on Murlark Avenue, to continue west on Edgewater Street was a viable solution. This route can be seen in Figure 42.

The determination was made that a route for bicycle and pedestrian traffic would have to be created, independent from vehicle traffic. This would involve the construction of a multi-use bridge spanning Wallace Road.

### Results

In order to facilitate bike and pedestrian movement across Wallace Road, a multi-use bridge was designed. The design incorporates an asymmetrical bridge, with a straight ramped approach from the east and a looped interface to the sidewalk on the west side of Wallace Road. In addition, the sidewalk on the west side of Wallace Road between the proposed bridge and Bassett Street would be widened to 10 feet and striped,



Figure 41: Initial Proposed Route.



Figure 42: Final Proposed Route.

to accommodate bicycle and pedestrian traffic in both directions along this segment.

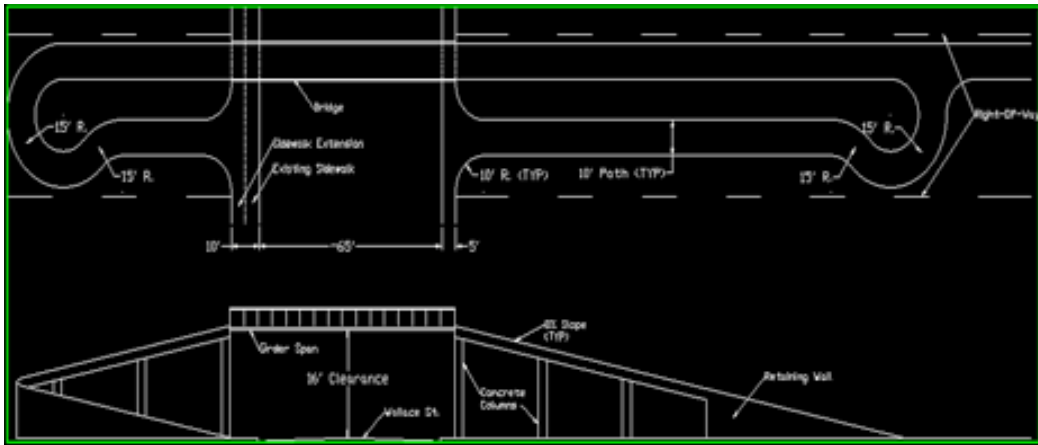


Figure 43: Proposed Multi-use Bridge.

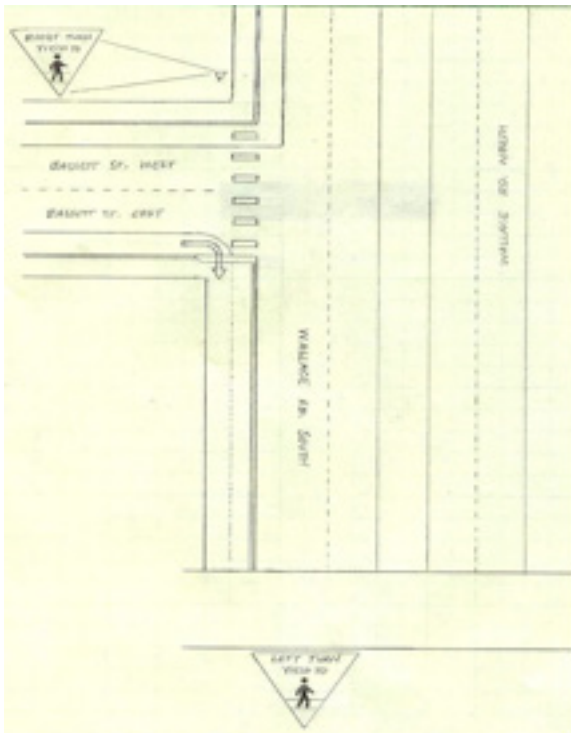


Figure 44: Plan view of bike lane and crosswalk detail for Wallace Road and Bassett Street.

To ensure bicycle and pedestrian safety, the transition from the bridge to Bassett Street would need to be clearly marked. Striping and signage would need to be installed on the sidewalk to guide bike traffic leaving the bridge heading north on Wallace Road and at the transition from the Wallace Road sidewalk to Bassett Street. A crosswalk at Bassett Street would be necessary. Signs to guide bike traffic traveling the opposite direction on Bassett Street onto the Wallace Road sidewalk would be needed.

To further enhance the safety of bikes crossing Bassett Street from the sidewalk, a caution sign would be placed on the sidewalk for bikes and pedestrians, as well as yield signs for vehicles on Wallace Road turning onto Bassett Street from each direction. Signs to indicate to southbound traffic on Wallace Road that bikes are traveling in two directions on their side of the road would also need to be added. Bike lane signs and/or sharrows on both Bassett Street and Murlark Avenue would be needed to guide bikes towards Edgewater Street.

There are some items in the design of the multi-use path that need to be considered. Despite the usage of AASHTO grade specification in the design of the bridge, ultimately the more stringent specifications of the ADA would need to be met. Also, the 16-foot vertical clearance provided between the bridge and Wallace Road does not meet specification for a heavy hauling route, which that section of Wallace Road is designated as. Finally, the specifications for overhead bridges set forth by ODOT were not considered in the design of this project's details that interface with Wallace Road.

### **Recommendation**

The route shown in Figure 42 was determined to be the best solution to connect bicycle traffic between the existing Union Street path and the intersection of Edgewater Street and Rosemont Avenue.

# Edgewater Multi-use Path Realignment

## Introduction

As part of the overall Salem River Crossing Alternative Modes Study, the existing Edgewater bike and pedestrian path may no longer be accessible due

to the proposed expansion of the adjacent Highway 22. An alternate bicycle route from Wallace Road to Rosemont Avenue was considered. This realignment is part of the Salem's long-term transportation goals to enhance accessibility for bike and pedestrian modes of travel. Figure 45 displays the existing Edgewater multi-use path, highlighted in orange.

The purpose of this report is to design a solution for the realignment of the existing Edgewater multi-use path.



Figure 45: Existing Edgewater multi-use path.

## Methodology

The design of the new Edgewater multi-use path realignment was based on a thorough investigation of the site, interviews with various participants, and study of available documents and renderings of the overall proposed project.

Intrusiveness to existing businesses, existing city rights-of-way, neighborhood characteristics, aesthetics, safety, directness of route, traffic flow, design standards, encroachment issues, and private property rights were evaluated.



Figure 46: Proposed Edgewater Bike Path.

It is assumed that the existing Edgewater Path / Wallace Road connection point will be realigned to the north to connect with the existing converted railroad multi-use path. The path cuts through a parcel of land between Bassett



Street and 1st Street along the former railroad tracks and connects with Murlark Avenue to the south.

## Results

The Murlark Avenue and Edgewater Street intersection will be the most critical crossing point for this path realignment project. Therefore, this report recommends that a traffic impact study be conducted to determine whether or not a signalized crosswalk is necessary. Based on the observed traffic flow along this street, this report assumes that a push button signal on both sides of Edgewater Street will be required.

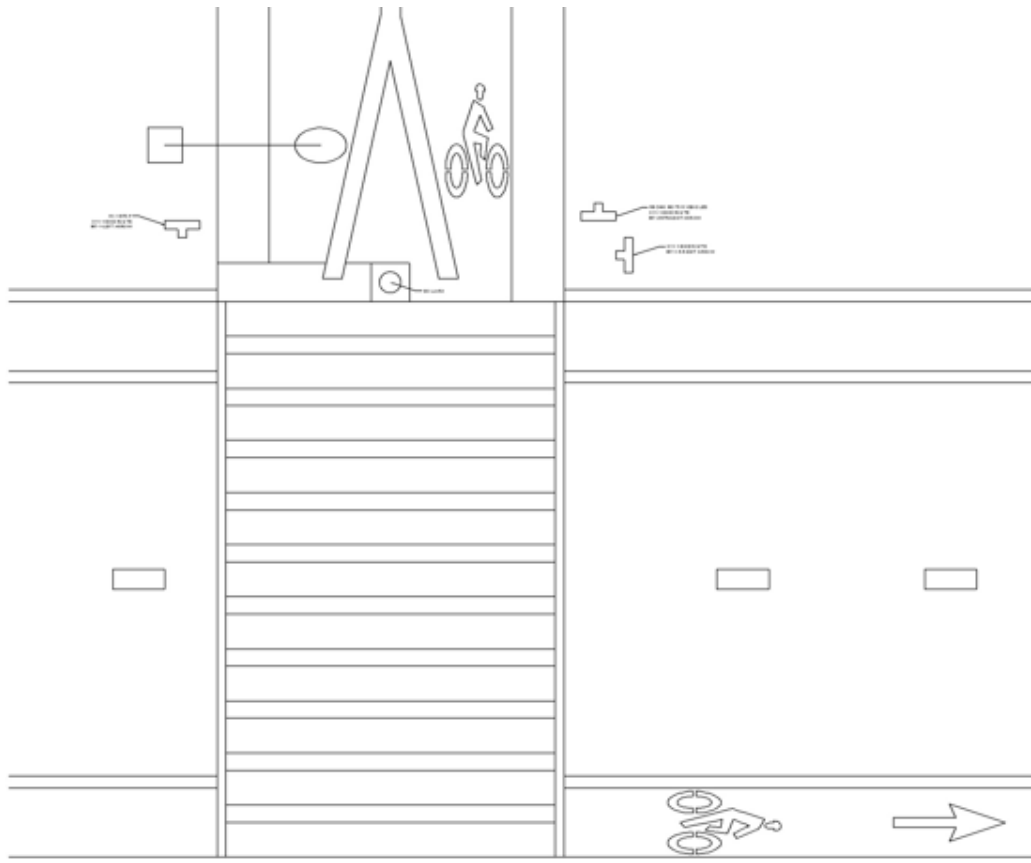


Figure 47: Proposed Bike and Pedestrian Treatment at Murlark Avenue and Edgewater Street.

## Recommendations

This report recommends a new two-way bike path along the east side of Edgewater Street. A continuous gravity barrier would be constructed to separate the proposed multi-use path from vehicular traffic along Edgewater Street. This barrier would break at intersections along Edgewater Street. Cross-sectional dimensions for the gravity barriers are in the range of 2 to 3 feet high along vehicle traffic, and 1 to 1.5 feet high along the bike path, which will provide for a

bench type and/or planter design. Lamps would be installed along the barriers at the midpoint of the high side (see Figure 48).

The new Edgewater multi-use path realignment would begin at the intersection of the proposed bike path along the railroad path south to the connection point at Murlark Avenue. The proposed Edgewater path would replace current on-street parking on the east side of the road; consultation with affected business owners and local residents is recommended.



Figure 48: Cross-sectional view of proposed barrier.

## Conclusion

The main goal of the Downtown Salem Circulation Study was to improve bicycle and pedestrian travel connectivity while minimizing the impact on motor vehicle and freight traffic, existing parking capacity, and local businesses.

A common method used by the students was first looking at the possibility of adding bike lanes on major arterial roads or, as a second choice, creating a bike boulevard or an alternative route. Many groups recommended new treatments such as bike boxes, sharrows, and new signals.

For the groups that studied the downtown area, adding bike lanes to existing downtown streets was not a feasible alternative. It was recommended to improve signal timing and to allow bicycles to share lanes with automobiles. The intersection of Union and Commercial Streets could be improved by using the new Rectangular Rapid Flash Beacon signal and well-marked crosswalks.

Two suggestions were made for improving bike use along Commercial Street south of downtown. One was to modify Saginaw Street to create an effective bicycle boulevard. The other suggestion was to make room for a bike lane on Commercial Street SE by relocating vehicle parking on one side of the street to the cross streets and improving parking capacity by marking parking spots.

The use of bike boxes was recommended on Commercial Street SE at Liberty Road in two different applications. One application was to lead bike traffic to a bike box at Vista Avenue and Liberty Road and a bike path leading to Commercial Street. Another approach was adding a bike box with a designated bike signal at the corner of Commercial Street and Alice Avenue.

In the Edgewater area, it was recommended to construct a multi-use bridge and to purchase the existing railroad property to connect the Union Street Bike Path with Edgewater Street at Murlark Avenue.

To plan for the proposed improvements to Highway 22 and the possible relocation of the Edgewater multi-use path, an innovative two-way bicycle path on Edgewater Street separated by a decorative gravity barrier was proposed.

Many of these recommendations were cost-prohibitive. Some of these recommendations were considered short-term solutions. Students learned that Salem has systemic traffic challenges that require major projects for long-term solutions.

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