City of Lake Forest Park
COUNCIL COMMITTEE OF THE WHOLE REGULAR MEETING
MONDAY, April 25, 2022
6:00 p.m.
AGENDA
Meeting to be Held Virtually
See page 2 for information about how to participate virtually
The Council Chambers are not yet open to the public

6:00 p.m. **Call to Order**

1. Review of Council Policies and Procedures on New Policy Introduction
2. Introduction and Discussion of Speed Limits and Traffic Calming

Citizen Comments *(Each speaker has three minutes to comment)*
Click on the following link for information about how to provide oral Citizen Comments:
https://www.cityoflfp.com/615/Virtual-Meetings-during-COVID-19
Because the City has implemented oral comments, written comments are no longer read under Citizen Comments.

ITEM 2 ATTACHMENTS

7:30 p.m. **Adjourn**

Future Schedule

Thursday, April 28, 2022 City Council Regular Business Meeting 7 pm *virtual meeting*
Saturday, May 7, 2022 City Council Special Meeting for Council Retreat 9:00 a.m. to 1:30 p.m. *virtual meeting*
Thursday, May 12, 2022 City Council Work Session Meeting 6 pm *virtual meeting*
Thursday May 12, 2022 City Council Regular Meeting 7 pm *virtual meeting*
Thursday, May 19, 2022 City Council Budget and Finance Committee 6 pm *virtual meeting*
Monday, May 23, 2022 City Council Committee of the Whole Meeting 6 pm *virtual meeting*
Thursday, May 26, 2022 City Council Regular Business Meeting 7 pm *virtual meeting*
Monday, May 30, 2022 City offices closed for Memorial Day

Instructions for participating in this meeting virtually are on the next page.

Instructions for participating in this meeting virtually:

When: **Apr 25, 2022 06:00 PM** Pacific Time (US and Canada)
Topic: **Committee of the Whole Meeting**, 4/25 at 6:00 p.m.

Please click the link below to join the webinar:
https://us06web.zoom.us/j/83043684004

Or One tap mobile :
US: +12532158782,,83043684004# or +16699006833,,83043684004#
Or Telephone:
Dial(for higher quality, dial a number based on your current location):
US: +1 253 215 8782 or +1 669 900 6833 or +1 346 248 7799 or +1 408 638 0968 or +1 646 876 9923 or +1 301 715 8592 or +1 312 626 6799
Webinar ID: 830 4368 4004
International numbers available: https://us06web.zoom.us/u/k8t3WV2En

FEHR PEERS

Safe Streets

Recommendations for Improving Safety and Connections to Transit and Amenities

July 2017

Prepared for the City of Lake Forest Park

CITY OF LAKE FOREST PARK
INCORPORATED 1961

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Table of Contents

EXECUTIVE SUMMARY

Project Overview

The City of Lake Forest Park is committed to making its streets safer for all users and improving connections to key amenities, such as parks, schools, trails, and retail. To achieve this objective, City Council authorized an effort called "Safe Streets," which City staff initiated in the fall of 2016. The Safe Streets project addresses locations experiencing conflicts between pedestrians, cyclists, and motorists, and it improves connections to transit and amenities. There is a concurrent project happening, called "Safe Highways," which is looking at the two state highways (SR 522 and SR 104) and how to make them safer, more accommodating to transit, and more walkable and bikeable. The Safe Streets project is separate and is looking at all the other local streets in Lake Forest Park.

This document serves as the culmination of the Safe Streets effort and identifies specific projects ranked according to priority for an enhanced Capital Improvements Program (CIP). These projects will be a community investment in the City's sidewalks, streets, and infrastructure to help ensure that Lake Forest Park remains an attractive and safe place to live.

Recommendations

This report provides a vision for transforming Lake Forest Park's streets into what the community desires. Through this process, the following projects were identified as candidates for future funding to improve the safety of Lake Forest Park Streets for all users. Note that projects are divided into two priority tiers:

TIER 1 (HIGHEST PRIORITY)

1. Brookside Elementary Safe Routes to School
2. Permanent Speed Warning Signs
3. Lake Forest Park Elementary Safe Routes to School
4. Briarcrest Safe Routes to School
5. NE 178th Street Sidewalk

TIER 2 (LOWER PRIORITY)

6. 37th Avenue NE Traffic Calming
7. Perkins Way Pedestrian/Bike Infrastructure
8. North Area Pedestrian and Bike Connections
9. 55th Avenue NE Sidewalk
10. NE 187th Street, NE 184th Street, and 47th Avenue NE Sidewalk

To arrive at this list of ten projects, the consultant team evaluated project ideas that stemmed from the public outreach process, including the 21 project ideas developed by the consultant team and new ideas generated during the outreach process. This evaluation was conducted on the basis of feasibility; cost; professional judgement; and effectiveness at improving the pedestrian environment, bicycle environment, and access to transit and amenities, among others. Ultimately, the ten projects above ranked the highest in this evaluation process.

FUNDING AND IMPLEMENTATION

Lake Forest Park will need to consider how to fund the recommended projects identified in this report. While the City is familiar with several well-known funding sources, the final section of this report identifies additional sources available to cities for transportation purposes.

INTRODUCTION

The City of Lake Forest Park is leading an effort called "Safe Streets" to make its streets safer for all users and to improve connections to transit and amenities like the Burke-Gilman Trail, Interurban Trail, parks, schools, and retail. These destinations should be safe and accessible for moms with strollers, cyclists, elderly, people with disabilities, students walking to school, and all other types of users. Through this process, we hoped to accomplish four goals:

- Address key conflicts between pedestrians, cyclists, and motorists.
- Develop an enhanced Capital Improvement Program (CIP) that includes specific projects ranked according to priority.
- Conduct a robust public engagement process to ensure the community has ownership in the solutions identified.
- Increase safe connections to transit and amenities.

There is a concurrent project happening, called "Safe Highways," which is looking at the two state highways (SR 522 and SR 104) and how to make them safer, more accommodating to transit, and more walkable and bikeable. The Safe Streets project is separate and is looking at all the other local streets in Lake Forest Park. The Safe Streets project, authorized by City Council, was initiated by City staff in the fall of 2016 and is being led by a project team of City and consultant staff. The project builds on past City planning efforts including the Strategic Plan, Comprehensive Plan, and Legacy 100-Year Vision.

PROCESS

The project team conducted a series of stakeholder interviews in January and February 2017 to learn about challenges and opportunities regarding safety and access on Lake Forest Park streets. Interviewees included City Councilmembers, the Mayor, Police Department staff, Public Works staff, and three school principals. The stakeholder interviews helped inform the public engagement efforts and initial project ideas. A summary of the stakeholder interviews is available in **Appendix A**. Concurrently, the project team reviewed existing plans, policies, and research studies to provide context for the public outreach process and this report. The planning context memo that stemmed from this analysis is available in **Appendix B**.

This led to a public outreach process in February and March 2017 to identify community priorities. Community members had the opportunity to share their ideas at an open house, at a meeting with Block Watch leaders, through an online comment form on the project website, and by contacting Neil Jensen, City Engineer. Through this process, participants provided information on the types and locations of transportation safety issues that currently exist and helped identify high priority transportation improvement projects.

Public Engagement Activities

OPEN HOUSE

The City held an open house on March 21, 2017 to hear community members' ideas for how to make its streets safer and improve connections. In order to encourage broad attendance and participation, the City spread the word about the open house in a number of ways, which included:

- Sharing event information on the project and City websites, the City's newsletter, Facebook, Twitter, the City's web newsflash, Next Door, and the Shoreline Area News;
- Contacting Brookside, Lake Forest Park, and Briarcrest Elementary Schools and asking them to share event information with student families and staff;
- Contacting over 15 community organizations and asking them to share event information with their members;

Approximately 70 people participated in the lively open house. The event began with people informally viewing posters and sharing initial thoughts on projects needed to improve street safety. City and consultant staff then gave a presentation on the project and 21 draft transportation improvement projects that could be used for capital project planning. Following the presentation, participants worked in small groups to prioritize their top five projects, coming to consensus on the best way for the City to use limited resources. Groups placed dots on table maps, using a green dot for their top priority project and red dots for their remaining top four priorities. At the end of the exercise, each small group reported out to the larger group, and the facilitator created a composite map capturing the results.

The composite map revealed projects that the majority of open house participants considered high priority (i.e. projects that received a green or red dot), as well as new projects for the City to consider. The results of the mapping exercise from the open house are provided in **Appendix C**.



Open house participants were enthusiastic about the possibility of addressing some of their street safety issues. As one woman expressed at the end of the event, the method of shared identification of priority projects was extremely effective and successfully highlighted where the city should target its resources.

BLOCK WATCH MEETING

The project team met with Block Watch "Captains" on March 27, 2017 following the open house. **Approximately 20 community members** participated. After a brief presentation by the project team, the Block Watch Captains participated in the same mapping exercise from the open house. The results of the mapping exercise were similar to those from the open house, though a few new project ideas were proposed. The results of the mapping exercise from the Block Watch meeting are combined with the results from the open house in **Appendix C**.

ONLINE COMMENT FORM

An online comment form was available on the project website from February 13 through April 1, 2017 for community members to provide feedback on the Safe Streets project. The comment form posed the following questions:

- What are some of the challenges with Lake Forest Park's streets today? Are there specific locations that feel unsafe?
- What specific locations/safety improvement projects should the City prioritize?

Over 100 submittals were received. Input received through the comment form is captured in the public comment summary in **Appendix C**.

EMAILS

A handful of emails were submitted directly to the Lake Forest Park City Engineer. This input was also captured in the public comment summary in **Appendix C**.

WHAT WE HEARD

Several themes emerged from all the public outreach conducted as part of this process. First, Lake Forest Park community members provided numerous examples of locations where speeding, cut-through traffic, and/or insufficient pedestrian/bicycle amenities are creating conflicts between street users. Traffic calming, sidewalks, crosswalks, bike lanes, and trails were all proposed treatments.

Second, safe walking routes are a clear priority for many people in the community. Residents want either sidewalks or pedestrian paths with an extruded curb along streets that kids frequently use to get to school. Providing pedestrian infrastructure in many of these locations would have multiple co-benefits, such as providing better access to transit and parks.

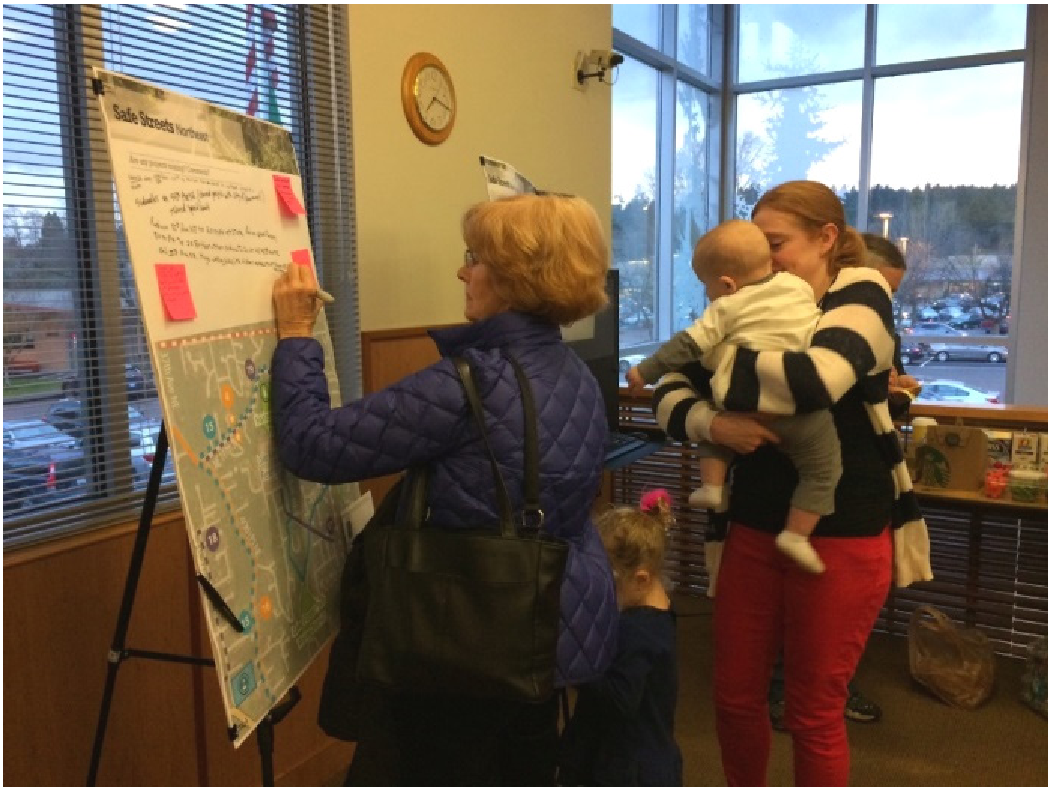
Another top priority for the community is providing better pedestrian and cyclist access to popular amenities like the Town Center, Burke-Gilman trail, Interurban trail, public transit stops, parks, and more. As one interviewee put it, Lake Forest Park's streets should be "the string connecting the pearls." Lake Forest Park's winding streets and hilly topography make this difficult, but it is critical to have designated routes connecting destinations with adequate lighting, pedestrian amenities (such as sidewalks or trails), and carefully considered crosswalks.

When developing potential solutions, it will be essential to consider accessibility for all – cyclists, kids going to school, individuals with disabilities, etc. It is hard for people in wheelchairs and parents pushing strollers to navigate many Lake Forest Park streets.

Many residents expressed an interest in implementing traffic calming projects in targeted locations. Some of the ideas mentioned include: reducing speed limits (citywide or in strategic locations); adding chicanes, speed bumps, stop signs, or traffic circles; and blocking off certain streets to through traffic. Other residents expressed an interest in citywide policies, such as reducing speed limits on residential streets and educational campaigns similar to those implemented in Seattle to reduce speeding – "20 is plenty."

Lastly, some community members expressed the importance of prioritizing eco-friendly projects. Lake Forest Park has numerous creeks, and future projects should respect the creeks and minimize runoff.

A full summary of public comments and project ideas heard through the open house, Block Watch meeting, stakeholder interviews, and online public comments are available in **Appendix C**.



RECOMMENDATIONS

This report provides a vision for transforming Lake Forest Park's streets into what the community desires. This section describes key public realm investments that were identified by the community as priorities for increasing safety and connections to key amenities in the City, which are broken into two priority tiers:

TIER 1 (HIGHEST PRIORITY)

1. Brookside Elementary Safe Routes to School
2. Permanent Speed Warning Signs
3. Lake Forest Park Elementary Safe Routes to School
4. Briarcrest Safe Routes to School
5. NE 178th Street Sidewalk

TIER 2 (LOWER PRIORITY)

6. 37th Avenue NE Traffic Calming
7. Perkins Way Pedestrian/Bike Infrastructure
8. North Area Pedestrian and Bike Connections
9. 55th Avenue NE Sidewalk
10. NE 187th Street, NE 184th Street, and 47th Avenue NE Sidewalk

To arrive at this list of ten projects, the consultant team evaluated project ideas that stemmed from the public outreach process, including the 21 project ideas developed by the consultant team and new ideas generated during the outreach process. This evaluation was conducted on the basis of feasibility; cost; professional judgement; and effectiveness at improving the pedestrian environment, bicycle environment, and access to transit and amenities, among others. Ultimately, ten projects ranked the highest in this evaluation process.[1] These projects are shown in **Figure 1**.

The consultant team carefully considered how these projects would help achieve the critical goal of increasing safe connections to transit and amenities, such as parks, schools, trails, and retail. Lake Forest Park residents and employees visit these destinations on a daily basis, and it is critical that they can access them safely via all modes. These projects are designed to be the **strings connecting the City's pearls**. The top ten projects help fill gaps in pedestrian and cyclist networks that connect to key destinations, address many safety concerns raised in the public outreach process, and help improve connectivity Citywide.

The public expressed a desire for improvements at the intersection of NE 178th Street, NE 180th Street, and Brookside Boulevard NE. However, given recent City investments to improve pedestrian safety in this location, this intersection is not included in the top priority list. The City may choose to reassess this intersection at a later date.

For all of the projects referenced in this document, additional consideration will be needed with regards to proper illumination and stormwater infrastructure. Many participants commented on how the City's dark streets can be a safety concern, particularly in the winter. Moreover, the City's topography and number of creeks and streams necessitate careful planning of infrastructure to ensure that transportation and stormwater facilities complement one another.

[1] Additional engineering study is needed prior to design and construction of the projects recommended in this study.

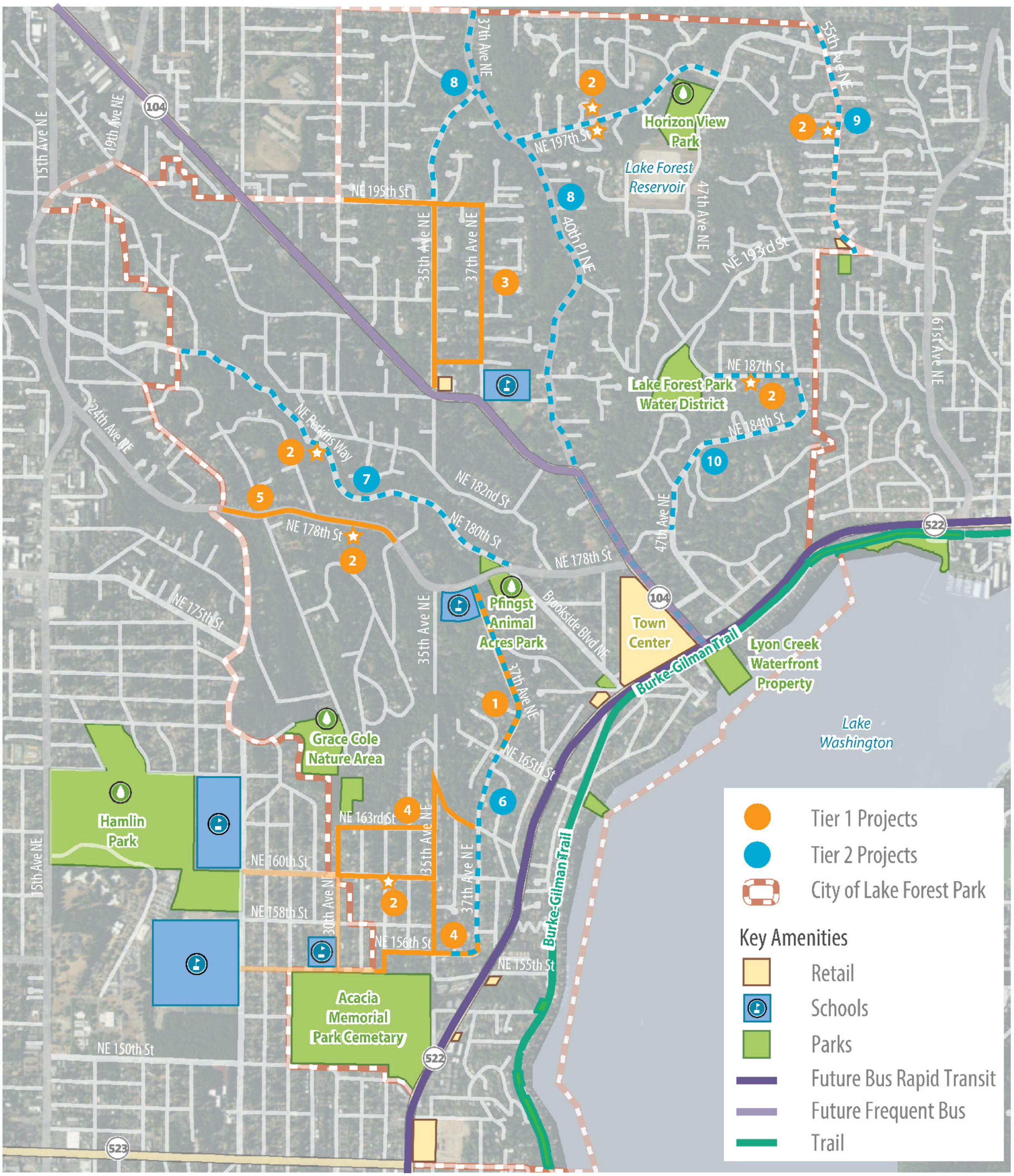
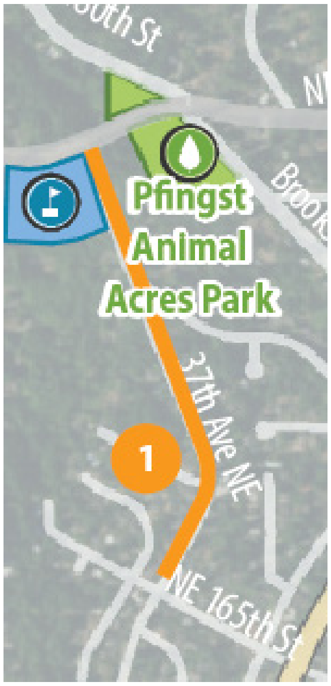


Figure 1: Tier 1 and 2 Project Recommendations

Project 1: Brookside Elementary Safe Routes to School

PROJECT DESCRIPTION



Through the open house, Block Watch meeting, stakeholder interviews, and online public comments, we heard numerous concerns about the safety of children walking to Brookside Elementary School along 37th Avenue NE since there is no sidewalk (except for a short segment directly across the street from the school) or pedestrian path with extruded curb, as demonstrated in **Figure 2**. There have also been several "near-misses" between pedestrians and motor vehicles. Topography is a contributing factor, as cars tend to gain momentum down 37th Avenue NE towards the school. Therefore, this project adds a sidewalk on 37th Avenue NE from just south of NE 178th Street, where the existing sidewalk ends, to NE 165th Street. Given this project's proximity to Brookside Elementary, it would be preferable to include a landscaped buffer to provide additional pedestrian safety, as shown in **Figure 4**. The preferred minimum sidewalk width recommended for safe routes to school is five to six feet.[2] This project was identified as a top priority during the Open House and Block Watch Meeting dot exercises.

PROJECT BENEFITS

- Creates a safe, dedicated space for pedestrians of all ages to walk.
- Increases pedestrian connections to Brookside Elementary, Pfingst Animal Acres Park, and the Burke-Gilman Trail.
- Increases pedestrian sense of safety, which will make residents more comfortable walking in Lake Forest Park.
- Given this project's proximity to Brookside Elementary, there is the potential to tap into Washington State Safe Routes to School funding.
- Since NE 165th Street has sidewalks, this project provides a safe connection to transit on SR 522.

Figure 2: Existing Conditions on 37th Avenue NE

Figure 3: Existing Conditions on 37th Avenue NE

[2] SRTS guide. "Sidewalks." http://guide.saferoutesinfo.org/engineering/sidewalks.cfm

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- Brookside Elementary School regarding safety considerations and drop off/pick up.
- Public Works Department regarding surface water infrastructure.
- Sound Transit regarding safe connections to transit.

POTENTIAL CHALLENGES TO IMPLEMENTATION

- Potential impacts to adjacent residents during construction.
- Width and grade issues in the 17400 block of 37th Avenue NE.
- Compatibility with surface water infrastructure since Hillside Creek crosses 37th Avenue NE.

Figure 4: Sidewalk with landscaping buffer. Source: threepullpa.com

Project 2: Permanent Speed Warning Signs

PROJECT DESCRIPTION

Speeding and increasing amounts of cut-through traffic through Lake Forest Park's streets are key concerns. In a stakeholder interview, the Police Department indicated that installing permanent speed warning signs in targeted locations to replace existing mobile warning signs would provide a good "bang for the City's buck," as each sign is only roughly $12,000-$14,000. Therefore, this project adds permanent speed warning signs in seven locations that experience frequent speeding:

- 55th Avenue NE
- NE 160th Street
- NE 178th Street
- NE 187th Street
- NE 197th Street (east bound)
- NE 197th Street (west bound)
- NE Perkins Way

Figure 5: Speed Warning Sign. Source: OkSolar.com

PROJECT BENEFITS

- Reduces motor vehicle speeds on residential streets.
- Permanent speed warning signs are a relatively low cost option for traffic calming.
- A study conducted in Bellevue, Washington found that various types of radar speed signs installed in 31 locations resulted in statistically significant speed reductions in the 85th percentile generally ranging from approximately 2-6 mph, with a few exceptions.[3] Numerous other studies have shown their effectiveness in speed reduction, but results vary somewhat by specific circumstances.

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- City of Shoreline regarding NE 178th Street speed limit.
- Police Department regarding location siting.

POTENTIAL CHALLENGES TO IMPLEMENTATION

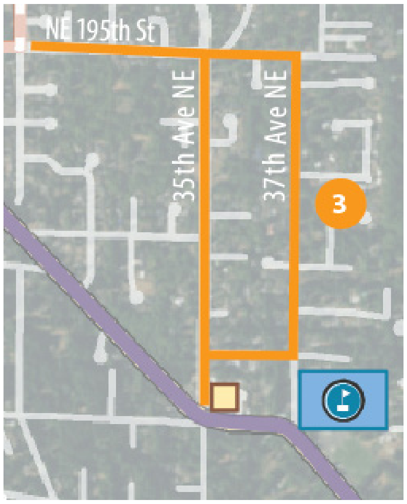
- Additional traffic calming measures may be required to reduce speeds to desired levels.

[3] City of Bellevue Transportation Department. "Stationary Radar Sign Program: 2009 Report." http://www.ci.bellevue.wa.us/pdf/Transportation/radar_sign_report_2009.pdf

Figure 6: (from top to bottom) Existing Conditions on NE 160th Street, NE 178th Street, and NE Perkins Way

Project 3: Lake Forest Park Elementary Safe Routes to School

PROJECT DESCRIPTION



Lake Forest Park Elementary School students have the option to participate in "Walking Wednesdays," where parent volunteers walk students through the neighborhood to school. Sidewalks or pedestrian paths (as shown in **Figure 11**) are missing for most of the route, so kids must walk in the street. Further, 37th Avenue NE gets very congested during drop-off/pick-up times, which results in illegal and unsafe driving behavior in close proximity to students. (See **Figure 9**.) This project requires collaboration with the City of Shoreline, who would be responsible for completing sidewalks that link Shoreline residences to this project, as Shoreline students also attend Lake Forest Park Elementary. This project adds the following pedestrian amenities to increase safety:

- A sidewalk on 35th Avenue NE from NE 195th Street to Ballinger Way NE (SR 104).
- Bike lanes or "sharrows" (see **Figure 31**) on 35th Avenue NE from NE 195th Street to SR 104, in conjunction with Project 8.
- A sidewalk or pedestrian path on NE 195th Street from the City border to 37th Avenue NE.
- A sidewalk or pedestrian path on 37th Avenue NE from NE 195th Street to NE 187th Street.

PROJECT BENEFITS

- Creates a safe, dedicated space for pedestrians of all ages to walk.
- Increases pedestrian and cyclist connections to Lake Forest Park Elementary and transit service (existing and future) on SR 104.
- Increases pedestrian sense of safety, which will make residents more comfortable walking in Lake Forest Park.
- Given this project's proximity to Lake Forest Park Elementary, there is the potential to tap into Washington State Safe Routes to School funding.

Figure 7: Existing Conditions on Walking Wednesday route

Figure 8: Existing Conditions at bus stop on 35th Avenue NE

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- City of Shoreline regarding continuation of sidewalks/pedestrian paths into Shoreline.
- King County Metro regarding safe connections to transit.
- Public Works Department regarding surface water infrastructure.
- WSDOT and the Lake Forest Park Safe Highways project team regarding how the new infrastructure connects to SR 104.

POTENTIAL CHALLENGES TO IMPLEMENTATION

- Determining if a sidewalk or pedestrian path is most appropriate on NE 195th Street and 37th Avenue NE.
- Potential impacts to adjacent residents during construction.
- Project may require right-of-way acquisition and/or negotiation with adjacent property owners.
- Culverts L 110, L 115, and L 155 intersect these streets.
- Requires collaboration with the City of Shoreline to create complete, safe routes.

Figure 9: Existing Conditions on 37th Avenue NE near Lake Forest Park Elementary (this segment includes a pedestrian path)

Figure 10: Sidewalk with landscaping buffer. Source: threepullpa.com

Figure 11: Pedestrian path with an extruded curb. Source: concretecrafters.com

Project 4: Briarcrest Safe Routes to School

PROJECT DESCRIPTION

Briarcrest Elementary School students also participate in "Walking Wednesdays," yet most of the route lacks sidewalks or pedestrian paths. This project provides the following improvements to create safer routes to school for Briarcrest Elementary, Kellogg Middle School, and Shorecrest High School. While these schools are located in Shoreline, Lake Forest Park kids attend these schools. This project requires collaboration with the City of Shoreline, who would be responsible for completing sidewalks that link the Lake Forest Park project to the school property. The City may want to also consider lowering the speed limit on NE 160th Street and potentially other streets.

- A sidewalk in the following locations:
  - 35th Avenue NE from NE 162nd Street to NE 160th Street
  - NE 162nd Street from 35th Avenue NE to 37th Avenue NE
  - NE 156th Street/37th Avenue NE from 35th Avenue NE to NE 157th Street
- A painted pedestrian walking area in the following locations:
  - NE 160th Street. (This could ultimately be upgraded to a pedestrian path or sidewalk as a Phase 2 improvement since it is an important connector street for three schools.)
  - NE 163rd Street ("Walking Wednesday" route)
  - 30th Avenue NE ("Walking Wednesday" route)
  - NE 155th Street and NE 156th Street to 35th Avenue NE ("Walking Wednesday" route)
  - 35th Avenue NE from NE 160th Street to NE 156th Street
- Traffic calming measures, such as chicanes, speed humps, or traffic circles, in these locations:
  - NE 160th Street; 35th Avenue NE; NE 162nd Street

Figure 12: Existing Conditions on NE 160th Street

Figure 13: Existing Conditions on Walking Wednesday route

PROJECT BENEFITS

- Creates a safe, dedicated space for pedestrians of all ages to walk.
- Reduces motor vehicle speeds on residential streets.
- Increases pedestrian connections to three schools.
- Increases pedestrian sense of safety, making residents more comfortable walking in the City.
- Given this project's proximity to three schools, there is the potential to tap into Washington State Safe Routes to School funding.

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- Briarcrest, Kellogg, and Shorecrest schools regarding safety considerations and drop off/pick up.
- City of Shoreline regarding continuation of sidewalks/pedestrian paths into Shoreline.
- Sound Transit regarding safe connections to transit.

POTENTIAL CHALLENGES TO IMPLEMENTATION

- Potential impacts to adjacent residents during construction.
- Requires collaboration with the City of Shoreline to create complete, safe routes.
- This project may require right-of-way acquisition and/or negotiation with adjacent property owners.

Figure 14: Example of a chicane. Source: Richard Drdul

Figure 15: Example of a traffic circle. Source: Re:Streets

Figure 16: Sidewalk with landscaping buffer. Source: threepullpa.com

Figure 17: Pedestrian path with an extruded curb. Source: concretecrafters.com

Project 5: NE 178th Street Sidewalk

PROJECT DESCRIPTION

NE 178th Street is one of the biggest hotspots for motor vehicular speeding in Lake Forest Park due to significant grade change and the speed limit changing from 30 miles per hour on the Shoreline side of 178th to 25 miles per hour on the Lake Forest Park side. However, the sidewalk does not extend west past 33rd Avenue NE to the city boundary. It is viewed as one of the key street "spines" through town and will likely continue to see increasing traffic as the region grows. Therefore, this project adds a sidewalk or pedestrian path on NE 178th Street from 33rd Avenue NE to the city border.

PROJECT BENEFITS

- Creates a safe, dedicated space for pedestrians of all ages to walk.
- Increases pedestrian connections to Brookside Elementary and Pfingst Animal Acres Park.
- Increases pedestrian sense of safety, which will make residents more comfortable walking in Lake Forest Park.
- A sidewalk would help calm traffic to some degree by providing more visual interest in the peripheral vision of drivers.

Figure 18: Existing Conditions on NE 178th Street

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- City of Shoreline regarding NE 178th Street speed limit and potential for continuation of pedestrian infrastructure.

POTENTIAL CHALLENGES TO IMPLEMENTATION

- Determining if a sidewalk or pedestrian path is most appropriate.
- Potential impacts to adjacent residents during construction.
- This project may require right-of-way acquisition and/or negotiation with adjacent property owners.

Figure 19: Sidewalk with landscaping buffer. Source: threepullpa.com

Figure 20: Pedestrian path with an extruded curb. Source: concretecrafters.com

Project 6: 37th Avenue NE Traffic Calming

PROJECT DESCRIPTION

Project 6 is an extension of Project 1. As mentioned in the Project 1 description, several community members are concerned about speeding on 37th Avenue NE. A variety of different residents use this segment, such as kids walking to Brookside Elementary, kids walking to Briarcrest Elementary on Walking Wednesdays, cyclists accessing the Burke-Gilman and Interurban Trails (as this is part of the southern connector route), and pedestrians travelling to the transit stop. It is also a common cut-through route for motor vehicles avoiding SR 522, as this is the only north-south alternative to SR 522 within city limits. Another concern is that there is only space for one lane of through traffic when cars are parked on both sides of the street, as shown in Figure 22. While on-street parking helps slow cars down, it creates conflicts and potentially dangerous situations. To address the community's concerns, this project incorporates traffic calming measures on 37th Avenue NE between NE 178th Street and NE 156th Street, as well around the corner onto NE 156th Street. At this stage, specific treatments have not been selected, but they could include traffic circles, chicanes, a raised intersection at NE 165th Street, speed humps, or other proven traffic calming measures after further engineering evaluation. This project could also remove parking on one side of the street to help minimize conflicts and provide space for traffic calming improvements.

PROJECT BENEFITS

- Improves comfort and safety for walking and cycling.
- Reduces motor vehicle speeds on residential streets.
- Builds safer trail connections.
- A raised intersection or potentially a traffic circle would improve pedestrian and cyclist safety at the intersection of 37th Avenue NE and NE 165th Street, a key intersection.

Figure 21: Existing Conditions on 37th Avenue NE

Figure 22: Existing Conditions on 37th Avenue NE during morning and evening commutes

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- Brookside Elementary School regarding safety considerations and drop off/pick up.
- Sound Transit regarding safe connections to transit.

POTENTIAL CHALLENGES TO IMPLEMENTATION

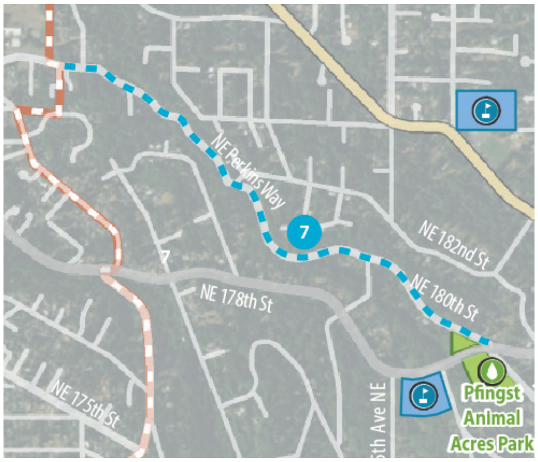
- Determining which treatments are most appropriate.
- Potential impacts to adjacent residents during construction.
- This project may require right-of-way acquisition and/or negotiation with adjacent property owners.

Figure 23: Example of a chicane. Source: Richard Drdul

Figure 24: Example of a traffic circle. Source: Re:Streets

Project 7: Perkins Way Pedestrian/Bike Infrastructure

PROJECT DESCRIPTION



Many cyclists use NE Perkins Way since it is part of the northern connector route between the Burke-Gilman and Interurban Trails. However, the street does not have a shoulder despite its many blind curves and hidden drives. Cars (and cyclists) speed due to the topography, which creates conflicts and dangerous situations. To improve access and safety for pedestrians and bicyclists on NE Perkins Way, this project widens the street to provide a shared use path for walking and cycling. Specifically, the shared use path would provide a climbing lane for cyclists traveling westbound and designated space for pedestrians walking in both directions. Sharrows would be added in the street for cyclists riding downhill. Generally, it makes most sense for the facility to be on the north side of the street so the bike lane buffers pedestrians from traffic, though special consideration would be needed in locations that have retaining walls. Wayfinding signage would also be added for cyclists.

PROJECT BENEFITS

- Shared use paths are a great way to encourage more walking and cycling.
- Increases pedestrian/bicycle access from residential neighborhoods to the Burke-Gilman Trail, Interurban Trail, Pfingst Animal Acres Park, Brookside Elementary, and other destinations.
- Increases comfort and safety along the corridor. Shared use paths tend to attract bicyclists with a wide range of skill levels, including novice riders and young children, as the buffer increases actual and perceived safety.

Figure 25: Existing Conditions on Perkins Way NE

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- City of Shoreline regarding connections to the Interurban Trail and other Shoreline pedestrian and bike infrastructure.
- Natural resource agencies regarding stream protection.
- Cyclist communities, such as Cascade Bicycle Club, Native Planet Cycling, and Cyclists of Greater Seattle, regarding project design.

POTENTIAL CHALLENGES TO IMPLEMENTATION

- This project will likely require right-of-way acquisition and/or negotiation with adjacent property owners.
- Potential impacts to adjacent residents during construction.
- Cost of construction given very challenging site conditions.
- Stream protection will be challenging.

Figure 26: Shared use path pavement markings. Source: sellwoodbridge.org

Figure 27: Shared use path example. Source: aviewfromthecyclepath.com

Project 8: North Area Pedestrian and Bike Connections

PROJECT DESCRIPTION

40th Place NE is a key street spine, and many use it to access Mountlake Terrace. However, it lacks sidewalks in most places, motor vehicles frequently speed, and conflicts between street users are commonplace. NE 197th Street also frequently sees speeding and lacks safe facilities for walking and cycling, despite its proximity to Horizon View Park and the reservoir. Therefore, to improve access and safety of cyclists and pedestrians on 40th Place NE and NE 197th Street, this project:

- Adds a sidewalk or pedestrian path on 35th Avenue NE, 37th Avenue NE, 40th Place NE where there is currently a gap in pedestrian facilities (between NE 185th Street and NE 197th Street), and on NE 197th Street.
- Adds bike lanes or "sharrows" (see **Figure 31**) to 35th Avenue NE, 37th Avenue NE, 40th Place NE, and NE 197th Street.

PROJECT BENEFITS

- Creates safe and welcoming facilities for walking and cycling that help complete the street network.
- Corridor enhancements will encourage active transportation and recreation.
- Increases pedestrian/bicycle access from residential neighborhoods to the Lake Forest Park Town Center, Burke-Gilman Trail, Horizon View Park, Lake Forest Reservoir, Mountlake Terrace, and other destinations.
- Provides a direct connection to the sidewalk and bike lane network on Cedar Way in Mountlake Terrace.
- Creates two new north-south spines in Lake Forest Park, in conjunction with Project 3.
- Provides a safe connection to Lake Forest Park Elementary's Walking Wednesday route, as described in Project 3.
- There is potential to extend the sidewalk and bike lane network on SR 104 to SR 522 through the Safe Highways initiative.

Figure 28: Existing Conditions on 40th Place NE

Figure 29: Existing Conditions on NE 197th Street

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- King County Metro regarding safe connections to transit.
- Sound Transit regarding safe connections to transit.
- City of Mountlake Terrace regarding connections to their pedestrian and bike infrastructure.
- Cyclist communities, such as Cascade Bicycle Club, Native Planet Cycling, and Cyclists of Greater Seattle, regarding project design.
- Public Works Department regarding surface water infrastructure.
- WSDOT and the Lake Forest Park Safe Highways project team regarding pedestrian and bike infrastructure improvements on SR 104.

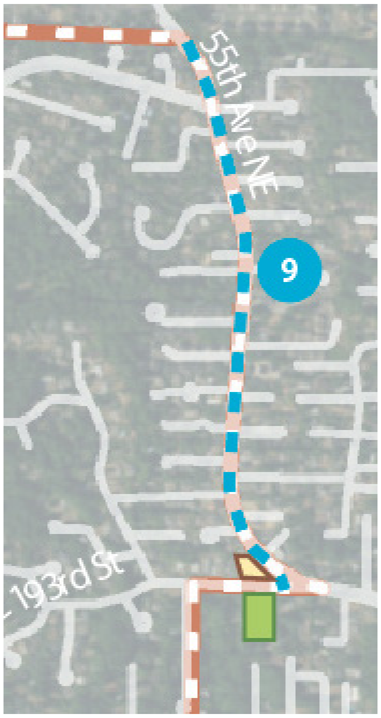
POTENTIAL CHALLENGES TO IMPLEMENTATION

- Determining which bike treatments are most appropriate and feasible.
- Potential impacts to adjacent residents during construction.
- This project may require right-of-way acquisition and/or negotiation with adjacent property owners.
- Culverts L 160, L 170, L 180, L 190, L 220, L 230, L 240, L 250, and L 255 intersect these streets.

Figure 30: Example of a bike lane.
Source: velotraffic.com

Figure 31: Example of sharrows.
Source: cossdotblog.wpengine.netdna-cdn.com

Project 9: 55th Avenue NE Sidewalk



PROJECT DESCRIPTION

Several community members expressed concern about the lack of sidewalks on 55th Avenue NE. Students walk along this corridor to access school bus stops, yet the shoulders are small, there are ditches on one or both sides of the road in several locations, there are narrow driveways that require backing out into the travel lane, and motor vehicles speed. This project adds a sidewalk or pedestrian path on 55th Avenue NE.

PROJECT BENEFITS

- Creates a safe, dedicated space for pedestrians of all ages to walk.
- Increases pedestrian connections to Linwood Park, Children's School and Montessori, Coffee Sensations, and Seven S Market near Linwood Park.
- Increases pedestrian sense of safety, which will make residents more comfortable walking in Lake Forest Park.
- A sidewalk would help calm traffic to some degree by providing more visual interest in the peripheral vision of drivers.

Figure 32: Existing Conditions on 55th Avenue NE

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- Cities of Kenmore and Brier regarding continuation of sidewalks/pedestrian paths across city limits as well as surface water infrastructure.
- Public Works Department regarding surface water infrastructure.

POTENTIAL CHALLENGES TO IMPLEMENTATION

- Determining if a sidewalk or pedestrian path is most appropriate.
- Potential impacts to adjacent residents during construction.
- This project may require right-of-way acquisition and/or negotiation with adjacent property owners.
- Compatibility with surface water system.

Figure 33: Sidewalk with landscaping buffer. Source: threepullpa.com

Figure 34: Pedestrian path with an extruded curb. Source: concretecrafters.com

Project 10: 187th Street, 184th Street, and 47th Avenue Sidewalk

PROJECT DESCRIPTION

The Police Department and several community members discussed challenges for pedestrians walking on NE 187th Street and NE 184th Street. Students walk along this corridor to access school bus stops, yet the shoulders are small in several locations, sometimes with a ditch on one or both sides of the street, there are blind curves, and grade change is an issue. It is also a common cut-through route for motor vehicles. This project adds a sidewalk or pedestrian path on NE 187th Street, NE 184th Street, and a short segment of 47th Avenue NE between NE 184th Street and NE 178th Street. There is an existing pedestrian path on NE 178th Street connecting to SR 104.

PROJECT BENEFITS

- Improves comfort and safety for all street users.
- Creates a safe, dedicated space for pedestrians of all ages to walk.
- Increases pedestrian connections to the Town Center, transit, and two school bus stops.
- Increases pedestrian sense of safety, which will make residents more comfortable walking in Lake Forest Park.
- Since NE 178th Street has a pedestrian path, this project provides a new safe connection to transit on SR 104.

Figure 35: Existing Conditions on NE 184th Street

Figure 36: Existing Conditions on NE 187th Street

POTENTIAL PROJECT PARTNERS AND COORDINATION NEEDS

- Shoreline School District regarding connection to school bus stops.
- King County Metro regarding safe connections to transit.

POTENTIAL CHALLENGES TO IMPLEMENTATION

- Determining if a sidewalk or pedestrian path is most appropriate.
- Potential impacts to adjacent residents during construction.
- This project may require right-of-way acquisition and/or negotiation with adjacent property owners.

Figure 37: Sidewalk with landscaping buffer. Source: threepullpa.com

Figure 38: Pedestrian path with an extruded curb. Source: concretecrafters.com

FUNDING SOURCES

Lake Forest Park will need to consider how to fund the recommended projects identified in this report. While the City is familiar with several well-known funding sources, the following table identifies additional sources available to cities for transportation purposes. The table shows authorized sources and how they were being used to fund transportation in King County as of 2013. The table does not include repealed or discontinued funding sources.

Funding Source	Description and Restrictions	King County Example(s)
Transportation/Capital Specific Funds	**These are funds that are specially earmarked for transportation projects. Because transportation projects are so capital-intensive, we have lumped these funds in with transportation-specific funds.**	
Motor Vehicle Excise Tax (MVET) *RCWs 81.100 and 81.104*	Up to a 0.8% MVET tax can be imposed for funding high capacity transportation services locally.	The City of Seattle has instituted a local-option Motor Vehicle Excise Tax (MVET)
Commercial Parking Tax *RCW 82.80.030*	A city has jurisdiction to enact a tax on commercial parking (either the business, based on gross proceeds or number of stalls, or directly on the customer, as in an admissions tax) within their jurisdiction. No specific rate is set, although specific parameters for rate setting are provided. Tax-exempt carpools, vehicles with handicapped decals, and government vehicles are exempt from the tax. The funds collected through this tax can be used for general transportation purposes, including construction and operation of roadways, public transportation, high capacity transportation, transportation planning and design, and/or other transportation-related activities. *This tax is subject to planning provisions and an exclusive councilmanic referendum procedure.*	The following King County cities levy commercial parking tax: ▪ Bainbridge Island ▪ Bremerton ▪ Burien ▪ Des Moines ▪ Monroe ▪ Mukilteo ▪ SeaTac ▪ Seattle ▪ Tukwila
Local Improvement District (LID) Formation *RCW 35.43 to 35.56*	Allows cities to carry out public improvements, including transportation improvements through mechanisms that assess those costs to benefitted property owners.	▪ SeaTac

Funding Source	Description and Restrictions	King County Example(s)
GMA Impact Fees *RCW 82.02.050(2), 82.02.060, and 82.02.070*	Local governments can adopt a schedule of impact fees for each type of development activity. Impact fees can support transportation needs from development. *GMA Authorized impact fees may only be levied to finance specific public improvements addressed by a capital facilities plan.* Many of the projects identified in this study could be eligible for impact fees. Many communities are increasingly funding multimodal projects, like sidewalks and bike facilities, as these projects provide increased transportation capacity for moving additional person trips related to new development.	The following cities in King County levy a Transportation Impact Fee: ▪ Auburn ▪ Bellevue ▪ Bothell ▪ Burien ▪ Covington ▪ Des Moines ▪ Duvall ▪ Federal Way ▪ Issaquah ▪ Kenmore ▪ Kent ▪ Kirkland ▪ Maple Valley ▪ Newcastle ▪ North Bend ▪ Redmond ▪ Renton ▪ Sammamish ▪ SeaTac ▪ Seattle (SEPA-based) ▪ Woodinville
Levied by Transportation Benefit Districts (TBDs) *RCW 36.73*	TBDs are independent taxing districts that can impose an array of fees or taxes to fund transportation improvements. TBDs can be established in jurisdictions ranging from a city to multi-county area. TBDs are intended to finance the construction of, and operate, improvements to roadways, high capacity transportation systems, public transit systems, and other transportation management programs.	▪ Burien No. 1 ▪ Des Moines ▪ Lake Forest Park ▪ Seattle ▪ Shoreline
Sales and Use Tax *RCW 82.14.0455*	Cities can authorize local TBDs that provide up to a 0.2% local sales and use tax with voter approval. This tax may not be in effect longer than 10 years unless reauthorized by voters.	North Bend has instituted a $0.002 sales tax on its TBD.

Funding Source	Description and Restrictions	King County Example(s)
Motor Vehicle Excise Tax (MVET) *RCWs 81.100 and 81.104*	TBDs can levy up to a $100 fee for each new vehicle weighing less than 6,000 pounds registered in its jurisdiction. $20 of this fee can be leveraged without a public vote.	Several TBDs leverage a MVET Fee, these include: ▪ $10: Burien No. 1 ▪ $20: Des Moines, Edmonds, Lake Forest Park, Olympia, Prosser, Seattle, Shoreline, and Snoqualmie
Real Estate Excise Tax (REET) 1 *RCW 82.46.010*	All cities and counties may levy a quarter percent real estate tax on all sales of real estate. Cities and counties with a population of 5,000 or more that are planning under GMA must spend the first quarter percent of their real estate excise tax receipts solely on capital projects that are listed in the capital facilities plan element of their comprehensive plan.	All cities in King County levy a REET 1 tax.
Real Estate Excise Tax (REET) 2 *RCW 82.46.035*	Cities and counties planning under the Growth Management Act have the authority to levy a second quarter percent tax (REET 2). Revenues from this tax must be used for financing capital projects specified in a capital facilities plan element of a comprehensive plan. Acquisition of land for parks is not a permitted use of REET 2 receipts.	All cities in King County except Skykomish levy a REET 2 tax.

What We Heard

Stakeholder Interview Summary

February 2016

In January and February 2017, a series of stakeholder interviews were conducted as part of the consultant team's initial efforts to learn about challenges and opportunities regarding safety and access on Lake Forest Park streets. These interviews are helping inform the public outreach event on March 21. This document summarizes key ideas raised by multiple interviewees.

Vehicle Conflicts with Pedestrians and Cyclists

All the interviewees gave examples of locations where speeding, cut-through traffic, and/or insufficient pedestrian/bicycle amenities are creating conflicts between street users. Interviewees also noted roadway impediments such as overgrown vegetation and garbage bins, which affect pedestrian/cyclist safety and level of comfort. **NE 178th Street** was discussed by multiple interviewees. The sidewalk does not extend west past 33rd Avenue NE to the city boundary, and speeding is a major issue given grade change and speed limit change from 30 miles per hour on the Shoreline side of 178th to 25 miles per hour on the Lake Forest Park side. It is viewed as one of the key street "spines" through town, and it will likely see more traffic as the region grows.

There were also numerous concerns raised regarding **NE Perkins Way**. Many cyclists use Perkins Way since it is a connection to the Interurban Trail, yet the street does not have a shoulder despite its many blind curves and hidden drives. Cars (and cyclists) speed due to the topography, which creates conflicts and dangerous situations.

40th Place NE was mentioned by a few interviewees due to its lack of sidewalks, vehicular speeding, and conflicts between users. It is a key street spine, and many use it to access Mountlake Terrace. Further, we heard that cars frequently run the stop signs at the intersection of 35th Avenue NE and NE 202nd Street. **NE 197th Street** sees a lot of speeding and lacks safe facilities for walking and cycling, despite its proximity to Horizon View Park and the reservoir. There are also conflicts between street users along **NE 184th Street** and **47th Avenue NE**, as there are no crosswalks or sidewalks despite grade issues and the presence of a school bus stop. Several interviewees noted that speeding is an issue on **55th Avenue NE**, though conflicts with pedestrians and cyclists are generally seen as less of an issue in this location.

Safe Routes to School

Numerous interviewees feel Safe Routes to School are a top priority. Lake Forest Park Elementary and Briarcrest Elementary[1] both have **Walking Wednesdays**, where parent volunteers walk students through the neighborhood to school. Sidewalks are missing for most of these routes, including on NE 195th Street, 35th Avenue NE, 37th Avenue NE, 40th Place NE, NE 155th, 156th, and 163rd Streets, and 30th Avenue NE. Crosswalks would also be helpful at crucial intersections.

Numerous students walk on **37th Avenue NE** to get to Brookside Elementary, but there are no sidewalks (except for a short segment directly across the street from the school). There have been a few "near misses" between cars and pedestrians, and the street gets very congested during drop-off/pick-up

[1] Briarcrest is technically in Shoreline, but it has students who live in Lake Forest Park and is therefore important to consider.

times. Speeding has also been an issue, particularly between NE 156th and 169th Streets, and vehicles roll through stop signs at 165th and 162nd Streets, but there are fewer conflicts with pedestrians in this section because there are sidewalks. There are also concerns on 37th Avenue NE north of SR 104 near Lake Forest Park Elementary. The street gets very congested during drop-off/pick-up times, which results in illegal and unsafe driving behavior in close proximity to students and student crossing guards.

There were also concerns about **NE 160th Street**. While the Police Department does not view speeding as a chronic issue on this street, vehicle speeds are a key concern for many community members, especially after a pedestrian was killed on 160th between 34th and 35th Avenues in 2016. We heard requests for sidewalks, better lighting, traffic calming measures, and a reduced speed limit on 160th.

Accessing the Burke-Gilman Trail, Transit, and Other Amenities

Another top priority for interviewees is providing better pedestrian and cyclist access to popular amenities like the shopping center, Burke-Gilman trail, public transit stops, parks, and more. As one interviewee put it, Lake Forest Park's streets should be "the string connecting the pearls." Lake Forest Park's winding streets and hilly topography make this difficult, but it is critical to have designated routes connecting destinations with adequate lighting, pedestrian amenities (such as sidewalks or trails), and carefully considered crosswalks. Lake Forest Park has many cul-de-sacs and dead end streets, such as 35th Avenue NE, which may provide opportunities for pedestrian and cyclist trail connections paired with quiet residential streets.

When developing potential solutions, it will be essential to consider accessibility for all – cyclists, kids going to school, individuals with disabilities, etc. It is hard for people in wheelchairs and parents pushing strollers to navigate Lake Forest Park streets, and even if there are sidewalks, many are narrow and hard to maneuver. This should be addressed.

Balancing Different Visions for Lake Forest Park

Interviewees pointed out that residents have conflicting visions for Lake Forest Park. Some residents were drawn to Lake Forest Park because of the quiet, residential character of its streets. They do not necessarily want sidewalks and streetlights. Other residents want a safe place to walk their dog, ride a bike, or push a stroller, and are comfortable with some change in character if it accomplishes these goals. It will be important to find common ground among these different, equally valid visions.

Traffic Calming

Most interviewees expressed an interest in implementing traffic calming projects in targeted locations. Some of the ideas mentioned include: reducing speed limits (citywide or in strategic locations), converting two-way streets to one-way streets, chicanes, speed bumps, and blocking off certain streets to through traffic. Further discussion is needed to determine which traffic calming measures are appropriate for specific locations, but traffic calming measures in a general sense were supported.

Respecting the Environment

A few interviewees mentioned the importance of prioritizing eco-friendly projects. Lake Forest Park has numerous creeks, and future projects should respect the creeks and minimize runoff.

MEMORANDUM

Date:	March 1, 2017
To:	Neil Jensen, City of Lake Forest Park
From:	Sarah Saviskas and Kendra Breiland, Fehr & Peers
Subject:	**Safe Streets: Existing Conditions, Opportunities, and Challenges**

The Comprehensive Plan identifies the following vision for Lake Forest Park: "*Our neighborhoods are safe and connected to each other and to community gathering places by well-designed paths, sidewalks, and bike lanes."* In order to realize this vision, it is important to understand challenges with Lake Forest Park's streets today and opportunities for improving safety and access. Several prior efforts have explored these issues, so Fehr & Peers reviewed existing plans, policies, and research studies to provide context for the Safe Streets public outreach event on March 21, 2017 and final report. The main sources of our research included:

- 2035 Comprehensive Plan (2015)
- Legacy 100-Year Vision Report (2008)
- Metro Connects - King County Metro Long Range Plan (2016)
- Police Department Survey Results (2016)
- Sound Transit 3 (ST3) Project List (2016)
- Strategic Plan (2016)
- Comprehensive Plan Telephone Survey Results (2014)

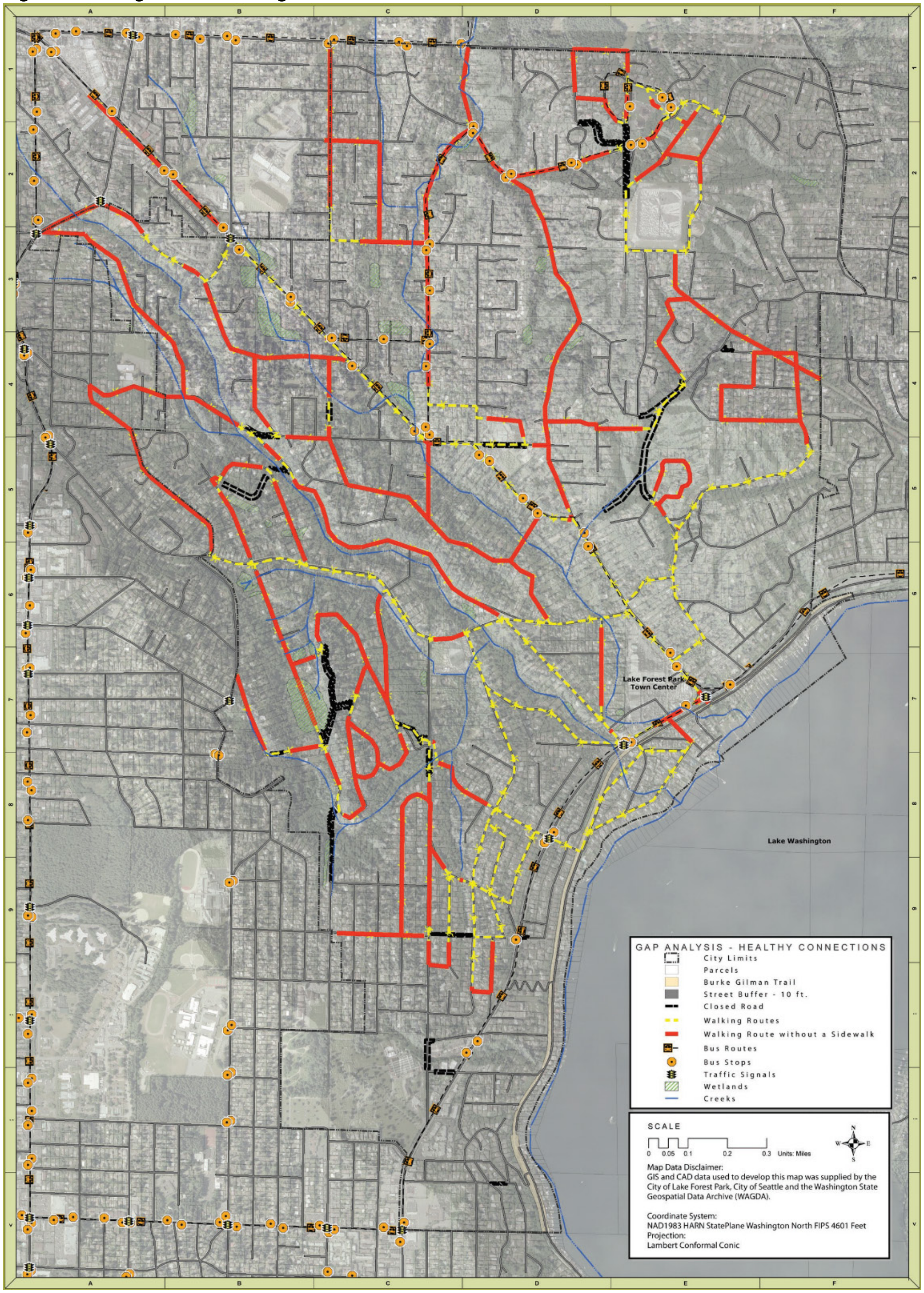
Fehr & Peers also conducted 8 interviews with key stakeholders in early 2017, which informed this memorandum. The following sections describe public realm and transportation conditions in Lake Forest Park, organized by pedestrian, bicycle, auto, and transit transportation modes. A figure at the end of this document summarizes high-level findings from this outreach.

Pedestrian Environment

There are designated walking routes throughout Lake Forest Park, but many routes do not have a completed sidewalk on one or both sides of the street. Pedestrian facilities range from sidewalks with curb ramps to paved roadway shoulders with extruded curbs to dirt paths along roadway shoulders. The 2008 *Legacy 100-year Vision Report* inventoried all walking routes, which is shown in **Figure 1**. All routes without a sidewalk are in red, and all routes with sidewalks on one or both sides of the road are dashed yellow. This map is outdated, but it begins to paint the picture of Lake Forest Park's pedestrian environment. Gaps in the pedestrian network provide a starting point for discussion about which projects should be prioritized.

The Comprehensive Plan Telephone Survey revealed that residents rated "sidewalks, crosswalks, and pedestrian walkways" as the most important transportation improvement to fund over the next 10 years, with 79 percent of residents rating these facilities as very or somewhat important. In response to an open ended question about services that should be increased or added, a desire for increasing the number of sidewalks and bike lanes was among the most common responses.

Figure 1. Designated Walking Routes



Source: City of Lake Forest Park Legacy 100-Year Vision, 2008.

Interviewees pointed out that residents have conflicting visions for Lake Forest Park's pedestrian environment. Some residents were drawn to Lake Forest Park because of the quiet, residential character of its streets. They do not necessarily want sidewalks and streetlights. Other residents want a safe place to walk their dog, ride a bike, or push a stroller, and are comfortable with some change in character if it accomplishes these goals. For example, many Lake Forest Park streets are not well lit, which many residents view as an asset. However, in certain locations, such as intersections and along pedestrian routes, lighting is a potential safety issue. It will be important to find common ground among these different, equally valid visions.

Safe Routes to School are a priority for many Lake Forest Park residents, yet most of the streets serving Lake Forest Park Elementary, Brookside Elementary, and Briarcrest Elementary lack sidewalks or shoulders with extruded curbs. Speeding has also been reported as an issue on many of these same streets. Another top priority is providing better pedestrian access to popular amenities like the shopping center, Burke-Gilman trail, public transit stops, parks, and more. Lake Forest Park's winding streets and hilly topography make this difficult, but it is critical to have designated routes connecting destinations with adequate lighting, pedestrian amenities (such as sidewalks or trails), and carefully considered crosswalks. Lake Forest Park has many cul-de-sacs and dead end streets, such as 35th Avenue NE, which may provide opportunities for pedestrian and cyclist trail connections paired with quiet residential streets.

When developing potential solutions, it will also be essential to consider accessibility for all, including cyclists, kids going to school, and individuals with disabilities. It is hard for people in wheelchairs and parents pushing strollers to navigate Lake Forest Park streets, and even if there are sidewalks, many are narrow and hard to maneuver. This should be addressed.



Bicycle Environment

The Burke-Gilman Trail and Interurban Trail are two key amenities that Lake Forest Park cyclists access. As noted in the *Comprehensive Plan*, the Burke-Gilman Trail is a well-traveled, separated bicycle and pedestrian facility that runs parallel to the Lake Washington shoreline in Lake Forest Park. The trail connects Seattle with North Shore and Eastside communities (including Lake Forest Park, Kenmore, and Bothell). The North Interurban Trail is a north-south bicycle route that starts in Downtown Seattle, passes through Shoreline, and continues to Everett. From Lake Forest Park, cyclists often access the North Interurban Trail via NE 180th Street/NE Perkins Way as well as NE 155th and 156th Streets to the south.

Several bicycle routes have been identified to help connect cyclists to these trails and other key amenities from Lake Forest Park's residential streets. **Figure 2** shows the designated bicycle routes within the City in green. However, there are no painted bicycle lanes, and cyclists must share the road with automobiles. (Note: Phase 2 of the NE 178th Street Improvement Project is adding a bicycle lane on NE 178th Street from Brookside Boulevard to 33rd Avenue NE.) Further, the bicycle routes also lack wayfinding signage.

The Comprehensive Plan Telephone Survey revealed that 60 percent of residents rated "bike lanes and bike paths" as very important or somewhat important to fund over the next 10 years. Additionally, the Comprehensive Plan has an explicit goal to "improve signage and safe walkways, including pedestrian sidewalks, to Lake Forest Park trails such as the Burke-Gilman and between the Burke-Gilman and Interurban Trail."

It is particularly challenging for cyclists (and pedestrians) to cross Bothell Way NE to access the Burke-Gilman Trail, so this is a crucial area for improvement. Also, NE Perkins Way is frequently used by cyclists because it is the north connection street to the Interurban Trail. However, it does not have a shoulder despite its many blind curves and hidden drives. Cars (and cyclists) often speed due to the topography, creating a potentially dangerous condition.

Figure 2. Designated Bicycle Routes.

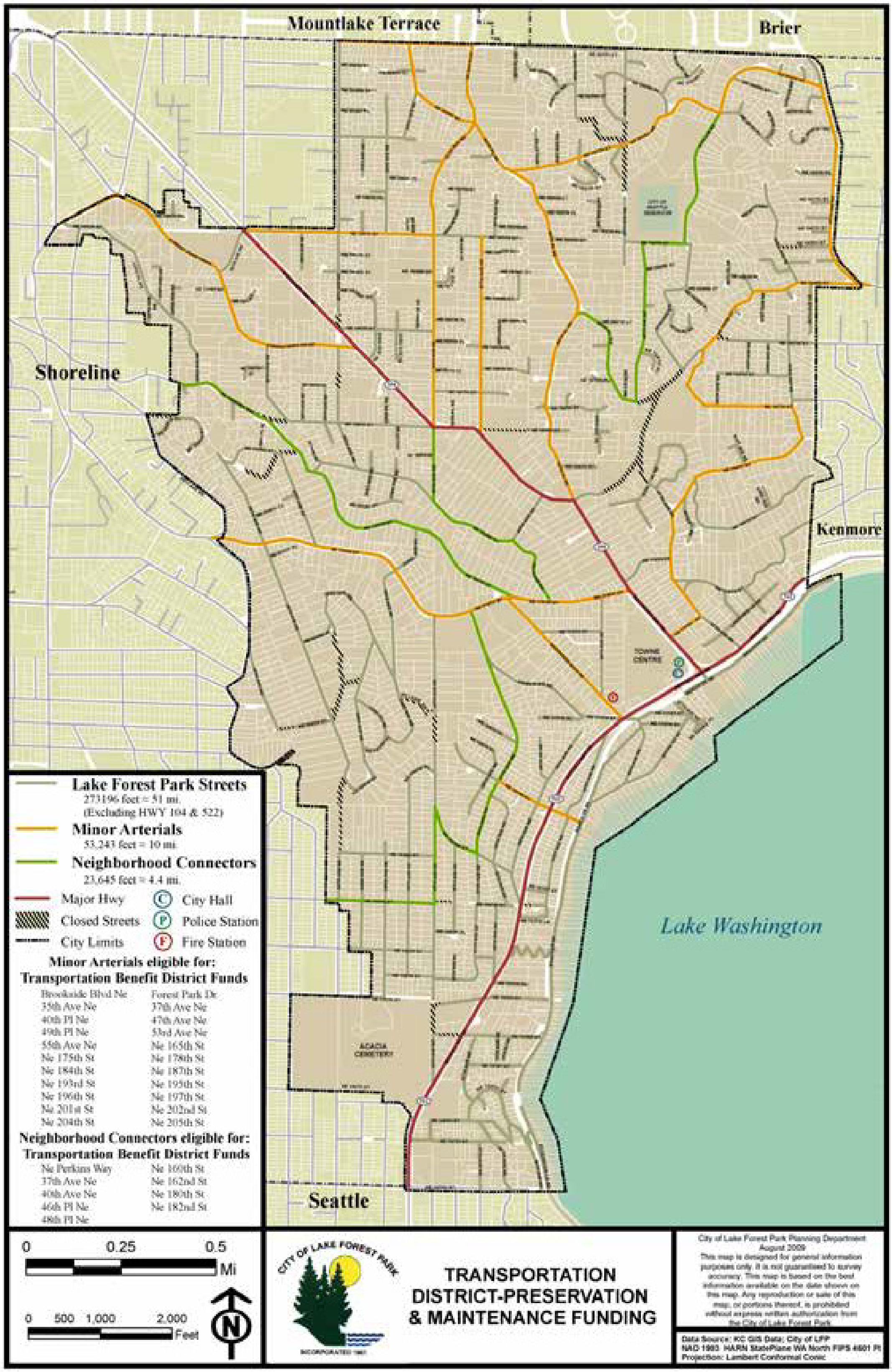
Auto

As the Puget Sound region continues to grow, traffic passing through Lake Forest Park will increase. Therefore, speeding, cut through traffic, and traffic enforcement are primary concerns for Lake Forest Park citizens, mainly on the arterial roads and neighborhood connector streets. See **Figure 3** for an overview of Lake Forest Park's street classifications.

Speeding is currently a key issue on NE 178th Street, Perkins Way NE, NE 197th Street, 40th Place NE, 55th Avenue NE, and the southern portion of 37th Avenue NE. While the Police Department does not view speeding as a chronic issue on NE 160th Street, vehicle speeds are a key concern for many community members, especially after a pedestrian was killed on 160th between 34th and 35th Avenues in 2016. One challenge is that the Police Department is understaffed. Their traffic enforcement officer serves as a general patrol officer, which takes away from the time he can devote to his traffic enforcement duties.

Most interviewees expressed an interest in implementing traffic calming projects in targeted locations. Some of the ideas mentioned include: reducing speed limits (citywide or in strategic locations), converting two-way streets to one-way streets, chicanes, speed bumps, and blocking off certain streets to through traffic. Further discussion is needed to determine which traffic calming measures are appropriate for specific locations.

Figure 3. Roadway Functional Classification System



Transit

As noted in the *Comprehensive Plan*, public transit service in Lake Forest Park is operated by King County Metro and Sound Transit. Transit service operates on Bothell Way, Ballinger Way, and 35th Avenue NE/NE 197th Street north of Ballinger Way. There is generally frequent transit service north-south from Lake Forest Park to large employment and shopping centers such as Downtown Seattle, University of Washington, and Northgate. On Bothell Way, there is a continuous Business Access Transit (BAT) lane in the southbound direction, but there is a gap in the northbound BAT lane from just north of NE 145th Street to 41st Avenue NE. Transit service also operates along SR 104, 35th Avenue NE, NE 190th Street, and NE 197th Street through the city, though service is more limited. **Figure 4** shows public transit currently serving Lake Forest Park**,** and **Table 1** shows the transit service area and service hours.

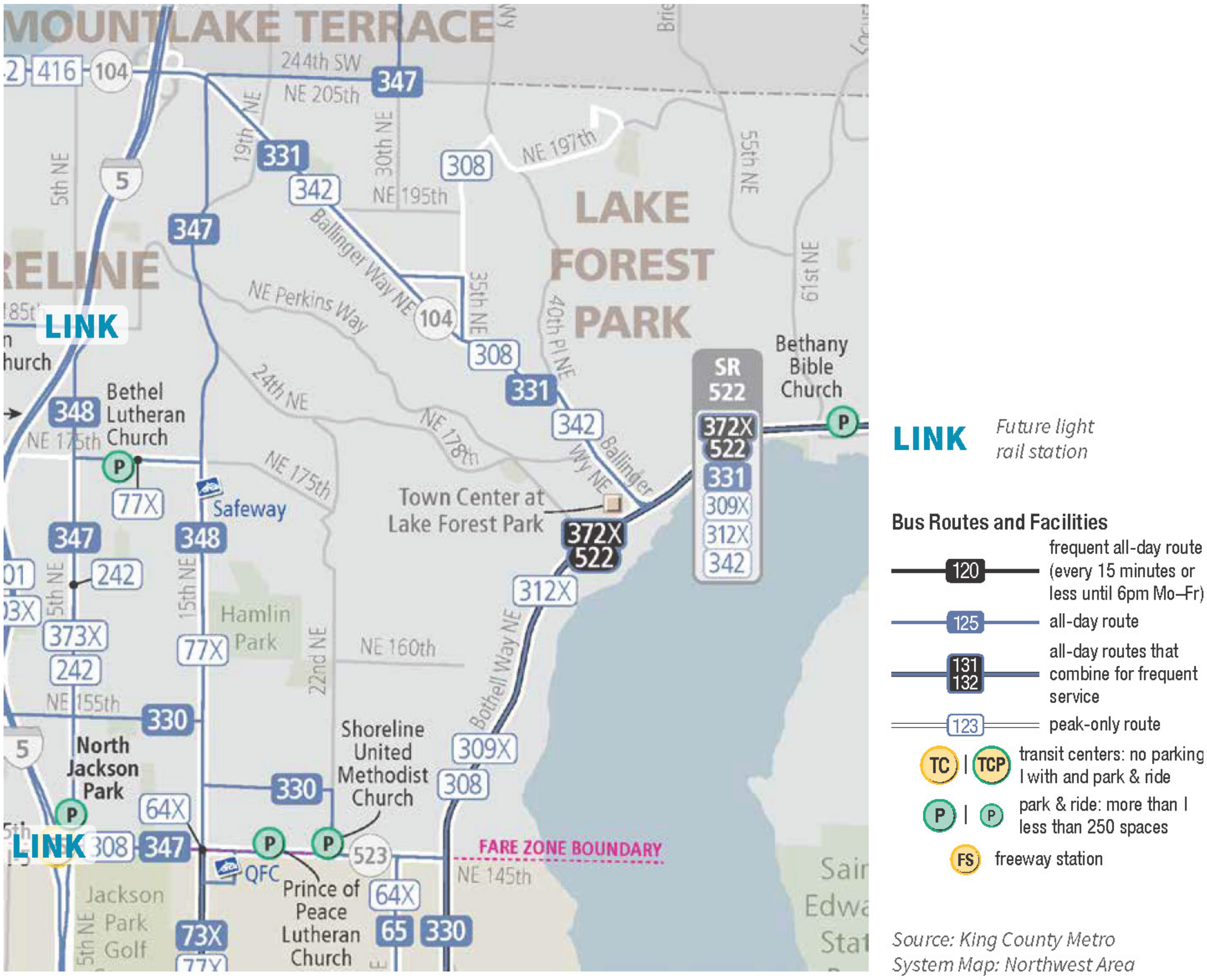
The *Comprehensive Plan* points out that transit demand is high in Lake Forest Park. Many residents commute via bus to employment centers in Seattle and the Eastside, and peak hour buses operate at capacity. Community members have called for expanded transit service and Park & Ride facilities to serve future high capacity transit along SR 522. The Comprehensive Plan Telephone Survey revealed that 73 percent of residents think that increased access to public transportation is very important or somewhat important. Residents in South Lake Forest Park were more likely to feel that increased access to public transportation is “very” important than those in North Lake Forest Park (55 percent compared to 28 percent). Lake Forest Park residents want to see direct, safe bicycle/pedestrian access to transit stops. There is also a need to improve bus stop comfort and safety by providing shelters.

The Town Center transit stops see the city’s highest daily transit boardings (390 boardings, based on the average spring 2014 transit data). Many transit riders use the Town Center parking lot as an unofficial Park & Ride. A 300 space Park & Ride is planned for the Town Center and is anticipated by 2024.

Given current demand and projected growth in the region, significant transit changes are planned that will impact Lake Forest Park:

- New Link Light Rail stations will open at NE 145th Street and NE 185th Street near I-5 in Shoreline by 2023.
- By 2024, Bus Rapid Transit (BRT) service will operate between the NE 145th Street station to UW Bothell, with service continuing at lower frequencies to Woodinville. This will include completion of BAT lanes along SR 522.
- A Rapid Ride will operate on SR 522 from Woodinville to the U District by 2025.
- An Express Bus from Woodinville to the Roosevelt Light Rail Station, South Lake Union, and First Hill in Seattle is planned for the 2025 network.
- Frequent bus service from Kenmore to the NE 185th Street Light Rail Station via SR 522 and SR 104 is planned for the 2025 network.
- By 2024, BRT service will operate from the Lynnwood Transit Center to the Burien Transit Center via I-405 and SR 518. While this project will not run through Lake Forest Park directly, it will influence travel patterns.

Figure 4. Public Transit Currently Serving Lake Forest Park



Source: King County Metro System Map: Northwest Area

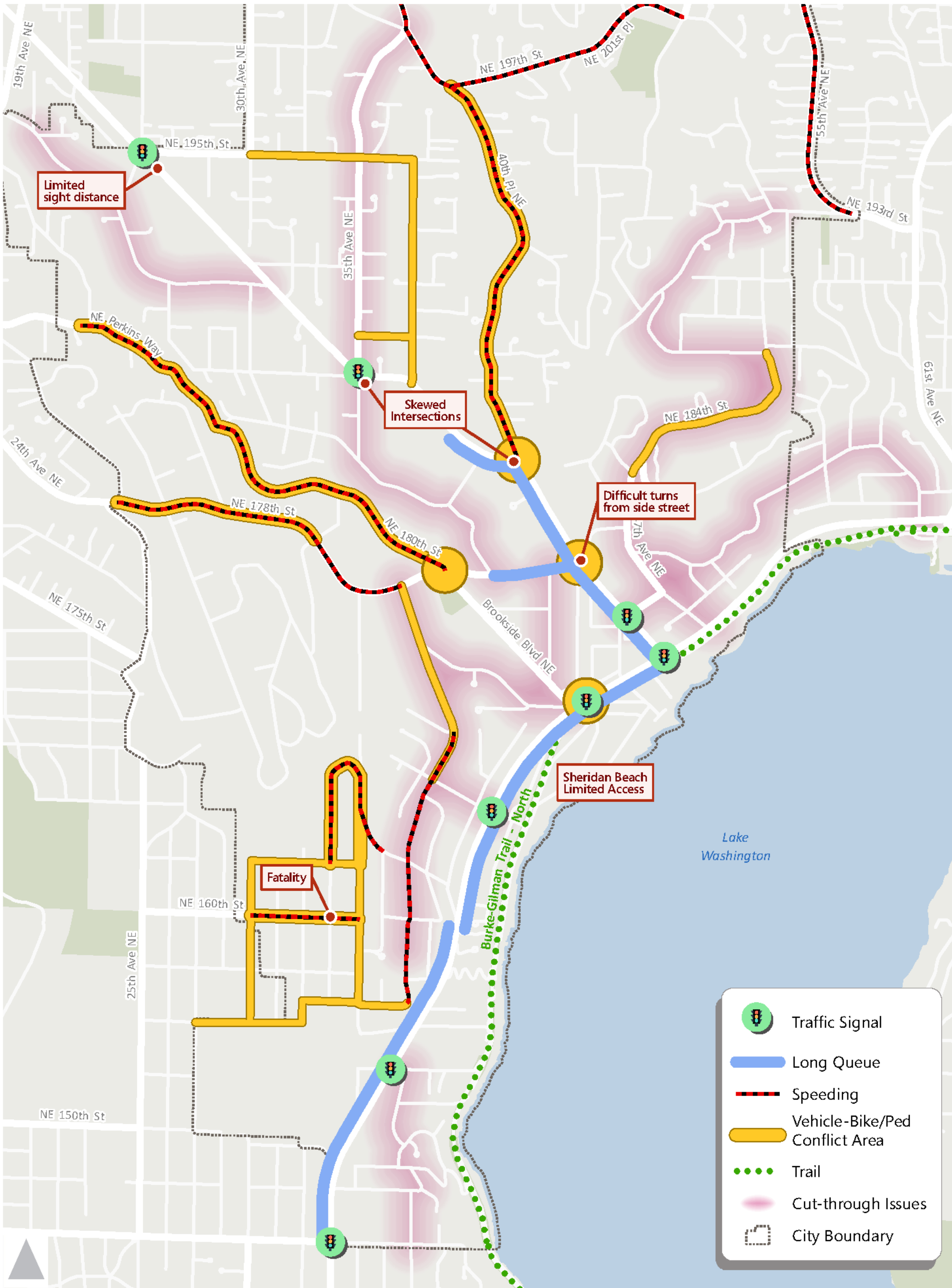
Table 1. Transit Routes Currently Serving Lake Forest Park

Route	Service Area	Service Hours
308	Downtown Seattle–Horizon View	Weekdays, Peak hour/direction only
309	Downtown Seattle–Kenmore	Weekdays, Peak hour/direction only
312	Downtown Seattle–Cascadia Community College	Weekdays, Peak hour/direction only
331	Shoreline Community College–Kenmore P&R	Weekday & weekends, all day
342	Shoreline P&R–Bothell–Renton	Weekdays, Peak hour/direction only
372	University District–Woodinville P & R	Weekday, all day
522	Downtown Seattle–Woodinville P&R	Weekday and weekends, all day

Overall Findings

Figure 5 provides a high-level overview of major stakeholder input, as they relate to providing safe streets in Lake Forest Park.

Figure 5. Overview of Initial Safe Streets Concerns



Public Engagement Summary

April 2017

Introduction

Safe Streets Project

The City of Lake Forest Park is leading an effort called "Safe Streets" to make its streets safer for all users and to improve connections to transit and amenities like the Burke-Gilman Trail, Interurban Trail, parks, and schools. Through this process, we hope to accomplish four goals:

- Address key conflicts between pedestrians, cyclists, and motorists.
- Develop an enhanced Capital Improvements Program (CIP) that includes specific projects ranked according to priority.
- Conduct a robust public engagement process to ensure the community has ownership in the solutions identified.
- Increase safe connections to transit and amenities.

There is a concurrent project happening, called "Safe Highways," which is looking at the two state highways (SR 522 and SR 104) and how to make them safer, more accommodating to transit, and more walkable and bikeable. The Safe Streets project is separate and is looking at all the other local streets in Lake Forest Park. The Safe Streets project was initiated by City staff in the fall of 2016 and is being led by a project team of City and consultant staff. The project builds on past City planning efforts including the Strategic Plan, Comprehensive Plan, and Legacy 100-Year Vision.

Outreach to Community Members

The project team conducted a series of stakeholder interviews in January and February 2017 to learn about challenges and opportunities regarding safety and access on Lake Forest Park streets. Interviewees included City Councilmembers, the Mayor, Police Department staff, Public Works staff, and three school principals. The stakeholder interviews helped inform the public engagement efforts and initial project ideas. A summary of the stakeholder interviews is available on the project website: www.lfpsafestreets.com.

This led to a public outreach process in February and March 2017 to identify community priorities. Community members had the opportunity to share their ideas at an open house, at a meeting with Block Watch leaders, through an online comment form on the project website, and by contacting Neil Jensen, the City's project manager. Through this process, participants provided information on the types and locations of transportation safety issues that currently exist and helped identify high priority transportation improvement projects. A summary of public engagement efforts and what we heard is provided in the following section.

Public Engagement Activities

Open House

The City held on open house on March 21, 2017 to hear community members' ideas for how to make its streets safer and improve connections. In order to encourage broad attendance and participation, the City spread the word about the open house in a number of ways, which included:

- Sharing event information on the project and City websites, the City's newsletter, Facebook, Twitter, the City's web newsflash, Next Door, and the Shoreline Area News;
- Contacting Brookside, Lake Forest Park, and Briarcrest Elementary Schools and asking them to share event information with student families and staff;
- Contacting over 15 community organizations and asking them to share event information with their members;

Approximately 70 people participated in the lively open house. The event began with people informally viewing posters and sharing initial thoughts on projects needed to improve street safety. City and consultant staff then gave a presentation on the project and 21 draft transportation improvement projects that could be used for capital project planning. Following the presentation, participants worked in small groups to prioritize their top five projects, coming to consensus on the best way for the City to use limited resources. Groups placed dots on table maps, using a green dot for their top priority project and red dots for their remaining top four priorities. At the end of the exercise, each small group reported out to the larger group, and the facilitator created a composite map capturing the results.

The composite map revealed projects that the majority of open house participants considered high priority (i.e. projects that received a green or red dot), as well as new projects for the City to consider. The results of the mapping exercise from the open house are provided in Table 1.

Open house participants were enthusiastic about the possibility of addressing some of their street safety issues. As one woman expressed at the end of the event, the method of shared identification of priority projects was extremely effective and successfully highlighted where the city should target its resources.



Block Watch Meeting

The project team met with Block Watch "Captains" on Monday, March 27 following the open house. Approximately 20 community members participated. After a brief presentation by the project team, the Block Watch Captains participated in the same mapping exercise from the open house. The results of the mapping exercise were similar to those from the open house, though a few new project ideas were proposed. The results of the mapping exercise from the Block Watch meeting are provided in Table 1.

Online Comment Form

An online comment form was available on the project website from February 13th through April 1st for community members to provide feedback on the Safe Streets project. The comment form posed the following questions:

- What are some of the challenges with Lake Forest Park's streets today? Are there specific locations that feel unsafe?
- What specific locations/safety improvement projects should the City prioritize?

Over 100 submittals were received. Input received through the comment form is captured in the public comment summary at the end of this document.

Mapping Exercise Results

The combined results of the mapping exercise from the open house and Block Watch meeting are provided in Table 1 on the following page. The top ranked projects in the table are those considered highest priority by the greatest number of event participants. Feedback from the online comment form and stakeholder interviews also supported several of these projects.

Projects are ranked in order of number of dots received, with green dots listed first because they represent participants' top priority projects. Red dots indicate other high priority projects identified by participants. The projects are keyed to the identification numbers in the draft list of transportation safety improvement projects, which is attached at the end of this summary. Project ideas generated by participants that are not on the draft list are marked as "NEW" in the table.

It is important to note that the project ideas listed in Table 1 are still subject to City vetting and engineering feasibility. The public input we received will play a crucial role as the City and project consultants evaluate the projects in April 2017, but not all ideas discussed during the outreach process will be feasible. The project consultants will present their professional recommendations to City Council in May or June 2017.

Table 1. Combined mapping exercise results

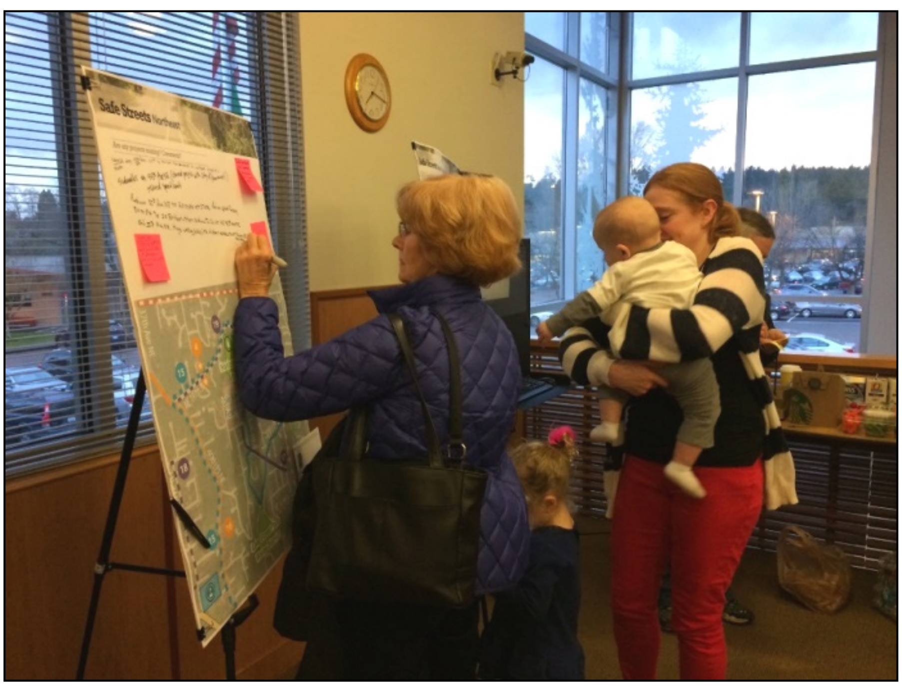
Rank	ID #	Description	Green Dots	Red Dots
1	6	Safe routes to school near Brookside Elementary (sidewalk/path on 37th Ave NE)	5	4
2	9	Improvements at intersection of NE 178th St, NE 180th St, Brookside Blvd NE	3	6
3	11	Bike/pedestrian improvements on NE Perkins Way. Participants generally favored widening the street rather than converting to a 1-way street.	1	5
3	18	Safe routes to school near Lake Forest Park Elementary (sidewalk/path on Walking Wednesday routes)	1	5
5	7	Sidewalk/path on NE 178th St from 33rd Ave NE to City border	1	1
5	21	Sidewalk/path on 55th Ave NE to improve Linwood Park access	1	1
5	NEW	Traffic calming on 37th Ave NE from NE 178th St to NE 156th St and on NE 156th St	1	1
8	16	Sidewalk/path on 40th Pl NE from NE 185th St to NE 197th St	1	0
9	4	Speed warning signs at five locations that experience frequent speeding (with additional location requests on NE Perkins Way and NE 187th St)	0	8
10	5	Bike/pedestrian improvements to connect dead ends on 35th Ave NE	0	3
11	2	Safe routes to school near Briarcrest Elementary (sidewalk/path on Walking Wednesday routes)	0	2
11	8	Traffic calming on NE 178th St from Brookside Blvd NE to City border	0	2
11	14	Sidewalk/path on NE 187th and NE 184th St from NE 187th St to NE 178th St	0	2
11	NEW	Combination of projects 15 and 16	0	2
11	NEW	General 37th Ave NE speed control/traffic calming	0	2
16	3	Safe routes to school near 3 schools - Briarcrest, Shorecrest, Kellogg (sidewalk/path and traffic calming)	0	1
16	12	Bicycle improvements on 40th Pl NE, 35th Avenue NE, NE 182nd Street, and Brookside Boulevard NE	0	1
16	13	Improve pedestrian safety on 35th Ave NE and NE 182nd St	0	1
16	15	Bicycle access improvements on NE 197th St and 40th Pl NE to Burke-Gilman	0	1
16	NEW	Combination of projects 2 and 3 (both Safe Routes to School)	0	1
16	NEW	Combination of projects 15, 16 and 19 (pedestrian improvements on NE 197th St)	0	1
16	NEW	Reengineer intersection of 37th Ave NE and NE 165th St to help ensure motor vehicles stop	0	1
16	NEW	Traffic calming on Lago Pl NE from 15th Ave NE to NE 185th St Sound Transit Station	0	1
16	NEW	Reduce cut through traffic on 39th Ave NE	0	1
16	NEW	Sidewalks in the street gap near Project 12 just west of SR 522	0	1
16	NEW	Forest Park Dr traffic calming and pedestrian improvements	0	1
16	NEW	McKinnon Creek Trail connection	0	1

Public Comment Summary

The following is a summary of public comments heard during the open house, the Block Watch meeting, via the online comment form, and via email. Comments are not listed in any particular order.

General Comments

- Speeding, cut-through traffic, and/or insufficient pedestrian and bicycle amenities are creating conflicts between street users.
- The City needs safer, better pedestrian and cyclist access to popular amenities like the shopping center, Burke-Gilman trail, public transit stops, parks, and more.
- The City is evolving and growing, and where some roads were once quiet enough to walk the shoulder, they now need safer separation for pedestrians and cyclists.
- Students need safe routes to school. Traffic calming, sidewalks/pedestrian paths, and safe crossings are needed in key locations.
- There is an interest in implementing traffic calming projects in targeted locations.
- Roadway impediments, such as overgrown vegetation and garbage bins, affect pedestrian/cyclist safety and level of comfort.
- Transportation improvements should be done in a manner that respects the environment.
- Use resources wisely, making improvements in the highest hazard areas in the most cost-efficient manner possible.



Sidewalks

- Sidewalks are most needed along roads used by children walking to school, including schools not located within Lake Forest Park.
- Sidewalks are needed (or should be extended) in the following locations:
  - At the intersection of 25th Ave NE and Forest Park Dr NE, where there is a school bus stop
  - Along 30th Ave NE, north of NE 195th St
  - Along 34th Ave NE from NE 165th St to NE 160th St
  - Along 35th north of Ballinger Way NE, particularly north of NE 195th St where the road turns into 37th Ave NE and leads into Mountlake Terrace
  - Along 35th Ave NE from NE 160th St to NE 156th St
  - Along 36th Ave NE where the road curves and turns into NE 158th Pl heading to Briarcrest, where there is currently a blind turn for both pedestrians and drivers
  - Along 37th Ave NE next to Lake Forest Park Elementary, from NE 165th St to NE 178th St, from NE 189th Pl to NE 192nd St, from NE 188th St to NE 195th St, from NE 165th St to Brookside Blvd NE
  - On the sharp corner at 37th Ave NE and NE 156th St due to lack of visibility caused by trees and a blind curve
  - At the intersection of 37th Ave NE and NE 156th St, where there is a blind turn
  - Along 40th Pl NE from Ballinger Way NE to NE 197th St
  - Along 44th Ave NE toward Town Center
  - Along 53rd Ave NE between NE 187th St and NE 184th St
  - Along 55th Ave NE, including from Briar to Linwood Park
  - Along NE 160th St from 35th Ave NE to 25th Ave NE
  - Along NE 162nd St from 35th Ave NE to 37th Ave NE
  - Along NE 175th St from 47th Ave NE toward Town Center
  - Along NE 178th St
  - Along NE 180th St/NE Perkins Way
  - Along NE 182nd St
  - Along NE 184th St
  - Along NE 187th St
  - Along NE 188th St between 37th Ave NE to NE 195th St
  - Along NE 197th St toward Horizon View Park, and around Horizon View Park in general
  - Along SR 104
  - Along SR 522 from NE 165th St to Ballinger Way NE
  - Along Ballinger Way NE, including between Town Center and Lake Forest Park Elementary
  - Along Forest Park Dr NE, where sidewalk is not continuous
  - Along at least one side of every neighborhood street

- On either side of Grace Cole Nature Park

- Install a railing separating the walkway from cars on 37th Ave NE because children might not be visible to drivers.
- Last year, there was a traffic fatality on NE 160th St, and we lost an amazing young woman. Many people do not feel safe walking around this neighborhood and would feel safer is there was a sidewalk on at least one side of the street.
- Consider installing a curb to protect the walking path on 37th Ave NE between NE 165th St and NE 178th St.
- If cost is an issue, it would be preferable to have many pedestrian paths rather than just a handful of sidewalks.
- Consider installing speed limit signs in the middle of the road on 37th Ave NE near Lake Forest Park Elementary (like the ones installed on 35th Ave NE south of Ballinger Way NE) as an interim solution until sidewalks can be built.

Pedestrian Crossings

- The biggest pedestrian-vehicle conflict area in the City is crossing SR 522 at Brookside Blvd NE. This is a major transit transfer area. One solution could be to construct a pedestrian sky bridge across SR 522. This would also increase connectivity with the Burke-Gilman Trail.
- Crossings are needed at/on:
  - 29th Ave NE and NE 178th St
  - 39th Ave NE and NE 165th St for children walking to school
  - Ballinger Way NE & 35th Ave NE
  - Ballinger Way NE & NE 178th Street
  - Ballinger Way NE between the north driveway entrance to the Town Center and NE 178th St
  - The north driveway entrance to the Town Center on Ballinger Way NE near the Windermere Building and Lake Forest Park Bar & Grill.
- Crossings should be improved at:
  - The intersection of 40th Pl NE, Ballinger Way NE, and NE 184th St
  - NE 170th St and Brookside Blvd NE
  - Bothell Way NE at NE 165th St (consider blinking yellow caution lights a block before the intersection, or a pedestrian overpass to link the neighborhoods with the Burke-Gilman Trail)
  - Bothell Way NE and Beach Dr NE, where drivers in the bus-only lane making right turns do not make a full stop at crosswalk
  - Town Center and access to Burke-Gilman Trail (consider a pedestrian overpass)

Traffic Signals and Signage

- Install signage to:
  - Reduce non-local traffic cutting through at 35th Ave NE and NE 182nd St
  - Restrict left turns at 39th Ave NE and Bothell Way NE from 6am-10am on weekdays
  - Replace the light-up "actual speed" sign that was removed from NE 160th St and 35th Ave NE
  - Provide drivers with speed warnings along NE 197th St toward Horizon View Park
  - Restrict turns for drivers and give pedestrians priority
  - Create more and better-marked crosswalks on Ballinger Way NE
- Install four-way stops at:
  - NE 178th St and 28th Ave NE
  - NE 178th St and Brookside Blvd NE
- Install stop lights:
  - On 25th Ave NE at the boundary with Shoreline
  - For people trying to get on Ballinger Way NE from 40th Pl NE
  - At NE 178th St and Ballinger Way NE to make it safer to cross for pedestrians and reduce congestion for drivers
- Install stop sign/traffic circle:
  - At 34th Ave NE and NE 163rd St
  - Near NE 160th St, 33rd Ave NE and 34th Ave NE
  - At the hairpin turn on NE 162nd St and 35th Ave NE
  - At the east end of the alley behind Albertsons
  - At the intersection of Beach Dr NE and Shore Dr NE
- Drivers ignore stop signs at/on:
  - The intersection of 25th Ave NE and Forest Park Dr
  - NE 178th St at triangle with 47th Ave NE ("do not enter private road" sign might be confusing drivers)
  - 37th Ave NE (particularly at NE 162nd St and NE 165th St)
  - 35th Ave NE
  - NE 180th St, NE 178th St, and Brookside Blvd NE
- At the end of 49th Pl NE / NE 187th St where it meets the intersection of NE 187th Pl / NE 193rd St, install a center line curb for 50 feet or so before the stop sign to compel drivers to slow enough to make a safer left turn onto 49th Pl NE.
- Prohibit left turns from NE 178th St onto Ballinger Way west bound. This should be a right turn only (at least during commuting hours).

Traffic Calming

- Traffic calming is needed at/on:
  - 33rd Avenue NE near the cemetery entrance
  - 34th Avenue NE
  - Cedar Way/37th Ave NE entering Lake Forest Park
  - 37th Ave NE, particularly next to the high school
  - 38th Ave NE and SR 522
  - 44th Ave NE
  - 47th Ave NE, coming down the hill from NE 184th St
  - NE 156th St from 37th Ave NE and 35th Ave NE to 33rd Ave NE and NE 155th St, due to high volume of cut-through traffic from Bothell Way
  - NE 160th St, where children walk to and from school
  - NE 165th St and 41st Ave NE
  - NE 167th St and 33rd Ave NE
  - NE 170th St and the intersection with 45th Ave NE
  - NE 178th St west of Ballinger Way NE
  - NE 178th St east of Ballinger Way NE from 47th Ave NE to the Kenmore border
  - NE 180th St between the intersection of Brookside Blvd NE and NE 178th St and the first bend in NE 180th St west of the intersection
  - NE 182nd St to 35th Ave NE, due to high volume of cut-through traffic
  - NE 187th St on top of the hill
  - NE 197th St going to Horizon View Park (install permanent pylons separating the road from the shoulder on north side of NE 197th St)
  - Lago Pl NE
  - Forest Park Dr, including the intersection with 25th Ave NE
  - Uphill from Brookside Elementary School
  - The Briarcrest/Sheridan Heights border (drivers speed on NE 160th St, NE 158th St, 35th Ave NE and 34th Ave NE)
  - Zone 7, due to the high number of blind turns
  - In the Town Center itself. There has been a large increase of vehicles speeding through the Town Center at unsafe speeds to avoid a signal.
- Consider employing:
  - Traffic circles/roundabouts
  - A planter at First Park Dr and 25th Ave NE (offset it toward 25th Ave NE)
  - Speed enforcement cameras at Ballinger Way NE and Bothell Way NE and on SR 104 and WA 522
  - Warning lights embedded in the street
- Adjust speed limits by:
  - Reducing the speed limit on 55th Ave NE

  - Standardizing arterial street speeds
  - Adopting the Vision Zero speed limits that Seattle recently established (20 mph for residential streets)
  - Increasing the speed limit on Bothell Way NE to 45mph
- Make sure the City's traffic calming program is available to residents.
- Speed bumps and stop signs seem more efficient than roundabouts.

Cyclists

- Install a bike lane:
  - Along 35th Ave NE north of Ballinger Way NE, and from there south along Ballinger Way NE to the lake
  - Along NE 180th St/NE Perkins Way
  - Along Ballinger Way NE
- Install a curb to separate the bike lane from sidewalk on NE 195th St (where it curves north to 30th Ave NE).
- Install a sign on NE Perkins Way to indicate to motorists that the road is a scenic bicycle route and bicyclists should be given priority.
- Install bike parking in the lower level of the Lake Forest Park Center.
- Install sharrows on 40th Pl NE.
- Mark all streets with sharrows.
- All drainage grates should have the slots perpendicular to the flow of bicycle traffic.
- Cyclists run red lights and stop signs at Ballinger Way NE and Bothell Way NE and NE 165th St.
- Storm debris that accumulates on Ballinger Way NE is dangerous for cyclists.
- 55th Ave NE is narrow and harrowing for cyclists.
- Keep motorized bicycles off the Burke-Gilman Trail.
- Enforce speed limits and stop signs on Burke-Gilman Trail. Numerous pedestrians have been hit by cyclists.
- Sponsor events to help make Lake Forest Park the bicycle capital of the Puget Sound.
- There aren't many conflicts between pedestrians/bicycles and motor vehicles on SR 104.

Lighting

- LED street lights are needed around Horizon View Park.
- Consider LED lights like those in Edmonds.
- Do not use LED street lights on 37th Ave NE.
- Use bulbs with low lumens and warm coloring on dark sections of the Burke-Gilman Trail (e.g. between Town Center and NE 165th St).
- If unable to provide pedestrian lighting, dim street lighting.
- Street lights are needed:
  - At 25th Ave NE and 26th Ave NE (because the turn on to 26th Ave NE is blind)

- Along 35th Ave NE (north of Ballinger Way NE) for both drivers and pedestrians
- Along 40th Pl NE
- Along NE 160th St from 35th Ave NE to 25th Ave NE for pedestrians
- At corners at the Ballinger Way NE and NE 175th St intersection (to make pedestrians more visible to drivers)

Trails

- McKinnon trail is an essential connection between Horizon View Park, Town Center, and bus service on SR 522.
- A trail is needed to replace the downhill lane on NE 180th St along the creek so that pedestrians, kids, and cyclists can safely connect between Interurban and Burke-Gilman Trails.
- A pedestrian path is needed from the walkway that connects 39th Ave NE to Bothell Way NE and connection with bridge (through/around Chevron station).
- Add a connection between the public easement at the north end of 39th Ave NE and Town Center.

Landscaping

- Sidewalks should be permeable where possible.
- Incorporate stormwater improvements into upgrades when possible.
- Vegetation along NE 160th St is overgrown and forces pedestrians and cyclists to walk in the street.
- Clear all vegetation that impedes visibility and lighting.

Parking

- At Brookside Elementary School, cars park on the east side of 37th Ave NE, causing parents and children to walk in the street.
- Put car parking in the new park at NE 178th St and 37th Ave NE, across the street from Brookside Blvd NE.
- Consider the interrelationship between demand for parking and traffic safety.
- Parking for commuters and those connecting to bus and light rail is insufficient in the Lake Forest Park mall area.

Other

- At Ballinger Way NE and Bothell Way NE, make changes to the intersection geometry to reduce conflicts between users.
- Redesign the intersection of NE 187th Pl and 49th Pl NE and NE 193rd St where there is a hairpin turn.
- Distracted drivers migrate over the white line at NE 178th St between 28th Ave NE and 33rd Ave NE.
- Ballinger Way NE, Bothell Way NE, and NE 145th St should be targeted for increased vehicular movement, rather than local or arterial streets.
- Reconsider restricting access from Bothell Way NE onto 47th Ave NE; recent improvements at this intersection have helped immensely and residents know how to safely use this street.
- Don’t cut off traffic from side streets, which will have a negative impact on locals. A better solution is to ensure cars maintain safe speeds.
- The intersection of Brookside Blvd NE and SR 522 is confusing and extremely dangerous.
- Neighbors from Sheridan Terrace and Sheridan Heights are concerned about safe access to buses on SR 522.
- Bicycle and pedestrian improvements should occur simultaneously.
- Don’t lose the character of streets.
- Consider using reflective shoulder striping.
- Conduct a study to determine which roads are most used by pedestrians to focus improvements.
- Increase police presence, speed monitoring, and ticketing to slow driving speeds.
- An educational campaign is needed to help reduce speeds. Widely distribute waterproof yard signs saying “20 is plenty” like they have in Seattle.

Lake Forest Park

SAFE HIGHWAYS REPORT

March 2018

Prepared by

FEHR PEERS

With support by

PERTEET

3SQUAREBLOCKS

Lake Forest Park SAFE HIGHWAYS Accessible Efficient Complete

Contents

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Executive Summary

The City of Lake Forest Park is a desirable suburban community that over 13,000 residents call home. True to its name, Lake Forest Park is defined by its proximity to Lake Washington and its forested, park-like ambiance. However, Lake Forest Park is also defined by two major highway corridors that traverse the community: Bothell Way (SR 522) and Ballinger Way (SR 104). While these corridors connect Lake Forest Park residents to jobs, services, and other regional opportunities, they also divide the community by their sheer size, traffic volumes, and outdated designs, which offer little in the way of accommodations for those not travelling in a car. Further, the same corridors connect the region's north and northeast areas to drivers who do not necessarily know they are coming through our community.

In 2016, the Lake Forest Park City Council adopted a Strategic Plan, which identified the need to proactively plan the SR 522 and SR 104 corridors to improve safety and community mobility.

This Strategic Plan goal came at a fortuitous time. In November 2016, regional voters passed Sound Transit 3, a $54 billion package to expand transit in the Puget Sound through 2041. Sound Transit 3 includes funding to improve SR 522 to accommodate planned bus rapid transit (BRT) service by 2024.

This Safe Highways Study is a product of the City's Strategic Plan. The Study documents preferred cross-sections and treatments along the SR 522 and SR 104 corridors. It is the City's intention that this Study's recommendations be informative to Sound Transit in the planning of the SR 522 corridor, identification of non-BRT improvements to seek other regional investments, and provide a starting point for regional investment along SR 104.

Guiding Principles

To guide this process, including the evaluation and selection of preferred corridor improvements, the Project Team began by establishing a set of guiding principles. These guiding principles are divided into three groups:

- Principles for the **overall project** apply to both corridors and how the Project Team conducts this Study.
- Principles for **SR 522** are specific to achieving the ultimate vision of a future BRT corridor that is also a community asset.
- Principles for **SR 104** focus on realizing a corridor vision that improves safety and mobility while maintaining rural character.

Recommendations

The Safe Highways Study synthesizes the outcomes of a nine-month process, which included document review, technical analysis, stakeholder interviews, interaction with a Technical Advisory Committee, and three community meetings. The findings of this report summarize community input and the Project Team's recommendations in the following areas:

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- SR 104 cross-sections & intersection layouts
- SR 522 cross-sections & 145th Street/SR 522 intersection layout
- Non-motorized access to transit investments
- Additional considerations to achieve community goals, not tied to specific locations

Project Background

The City of Lake Forest Park is a desirable suburban community that over 13,000 residents call home. True to its name, Lake Forest Park is defined by its proximity to Lake Washington and its forested, park-like ambiance. However, Lake Forest Park is also defined by two major highway corridors that traverse the community: Bothell Way (SR 522) and Ballinger Way (SR 104). While these corridors connect Lake Forest Park residents to jobs, services, and other regional opportunities, they also divide the community by their sheer size, traffic volumes, and outdated designs, which offer little in the way of accommodations for those not travelling in a car. Further, the same corridors connect the region's north and northeast areas to drivers who do not necessarily know they are coming through our community.

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Sound Transit 3

Sound Transit 3 identifies funding to implement BRT between the 145th Street light rail station in Shoreline and the University of Washington, Bothell campus with potential lower frequency service to Woodinville. Sound Transit estimates that this eight-mile BRT service could generate up to 10,000 daily riders. Along SR 522, the project looks to provide continuous BAT lanes and seven pairs of stations, some in Lake Forest Park and others at points east in Kenmore and Bothell. The corridor would also feature three park & ride garages, one of which is assumed to be at the Lake Forest Park Town Center. The BRT service, which would run on 10-minute headways through Lake Forest Park, would be in place by 2024.

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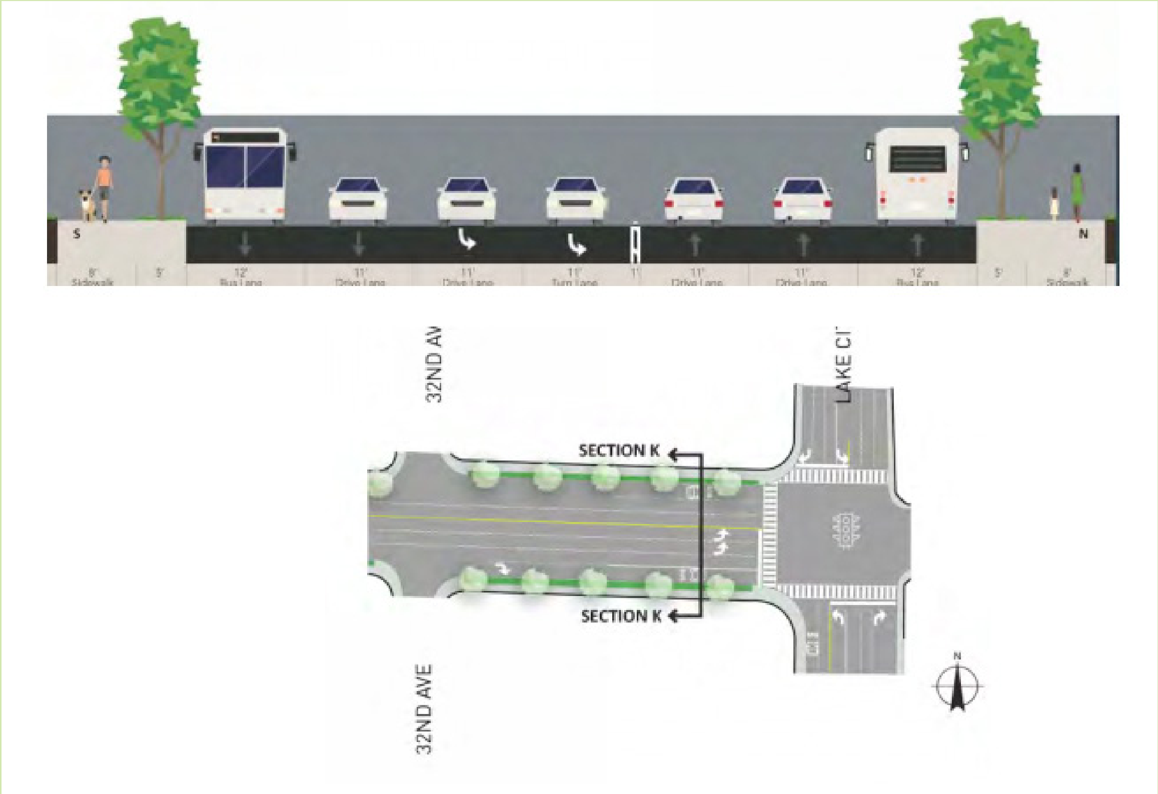
145th Street Multimodal Corridor Study

The City of Shoreline led a multimodal corridor study of 145th Street (SR 523), which connects to SR 522 at the southwest edge of this study area. Sound Transit 2 will provide a light rail station just north of 145th Street at 5th Avenue by 2023. The 145th Street study considered future improvements for pedestrian, bicycle, and transit connections along the corridor to improve access to the proposed Link light rail station. Proposed improvements included widening of 145th Street at the SR 522 signal to increase capacity and improve signal timings. The preferred street cross-section is shown in **Figure 1**.

Figure 1. Preferred Concept for NE 145th Street/SR 522



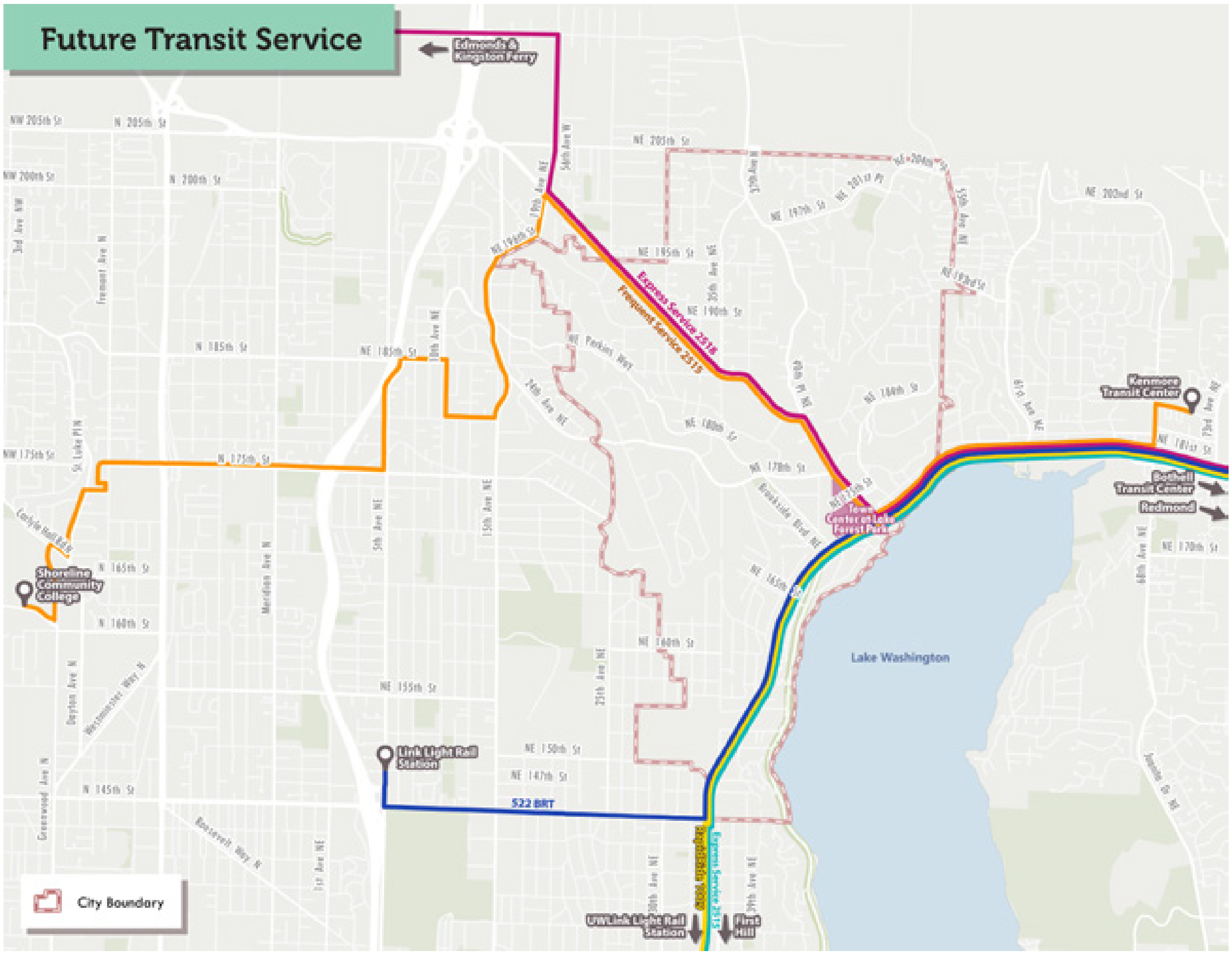
Source: 145th Multimodal Corridor Study, City of Shoreline, November, 2016

Metro Connects

King County's Metro Connects is a long-range vision for transit service within the county that was adopted in January 2017. The plan includes several routes within the Safe Highways Study area, including a Rapid Ride service line between the light rail Station at the University of Washington, Seattle campus and the Bothell Transit Center along SR 522. A new frequent service route is also planned between Shoreline Community College and the Kenmore Transit Center by 2025. The route would use SR 522 and SR 104. The Metro Connects plan also proposes an express route between the Edmonds/Kingston Ferry Terminal, Bothell, and Redmond, which would run along both SR 522 and SR 104 by 2040.

The planned new routes within the study area are shown in **Figure 2**.

Figure 2: Planned King County Metro Service Routes



Source: Metro Connects, King County Metro, 2017

Strategic Plan and Big Five Initiatives

Lake Forest Park's 2016-2020 Strategic Plan outlines the short- and mid-term priorities that will be delivered by the City to achieve its long-term goals and vision. The document provides an overview of the City's vision and values as well as the goals, services, and initiatives intended to help the City realize them. Goals outlined in the Plan include:

- Mobility
- Healthy Environment
- Community Vitality

- Public Safety and Access to Justice
- Accountable and Engaged Government

The Strategic Plan laid the foundation for five major projects—also known as the “Big Five”—that are intended to master plan the city’s near term infrastructure and planning priorities. This Safe Highways Study is one of the Big Five. The other four include:

- Town Center Vision
- Safe Streets Study
- Healthy Creeks
- Parks, Recreation, Open Space and Trails Plan

Town Center Vision

As part of the $54 billion Sound Transit 3 package, Sound Transit will plan and build a BRT system in Lake Forest Park, better connecting the City to the region. It will include a stop at Town Center, 25 blocks of sidewalks along SR 522, and a park-and-ride garage likely in the vicinity of Town Center. This investment presents an opportunity for the Lake Forest Park community to shape the long-term vision for the heart of Lake Forest Park.

In early 2018, the City will be learning about the community's vision for its future by holding interviews with representatives from a number of Lake Forest Park neighborhoods, hosting Community Meetings, facilitating a workshop series, and hosting public open houses. The Town Center Vision will capture the community's long-term interests and serve as a framework to help the City Council develop policies regarding land use, zoning, and connections within Town Center.

Safe Streets

Initiated in Fall of 2016, the Safe Streets effort focused on making Lake Forest Park’s streets safer for all users and improving connections to transit and key amenities, such as parks, schools, trails, and retail. The final report, adopted by City Council in July 2017, recommends ten public realm investments identified by the community, which are broken into two priority tiers. Safe Streets did not address SR 522 and SR 104 specifically, but several of the project recommendations will provide safer connections to transit along these routes for people traveling on foot or by bicycle. A summary map from the project is in **Figure 3.**

Lake Forest Park
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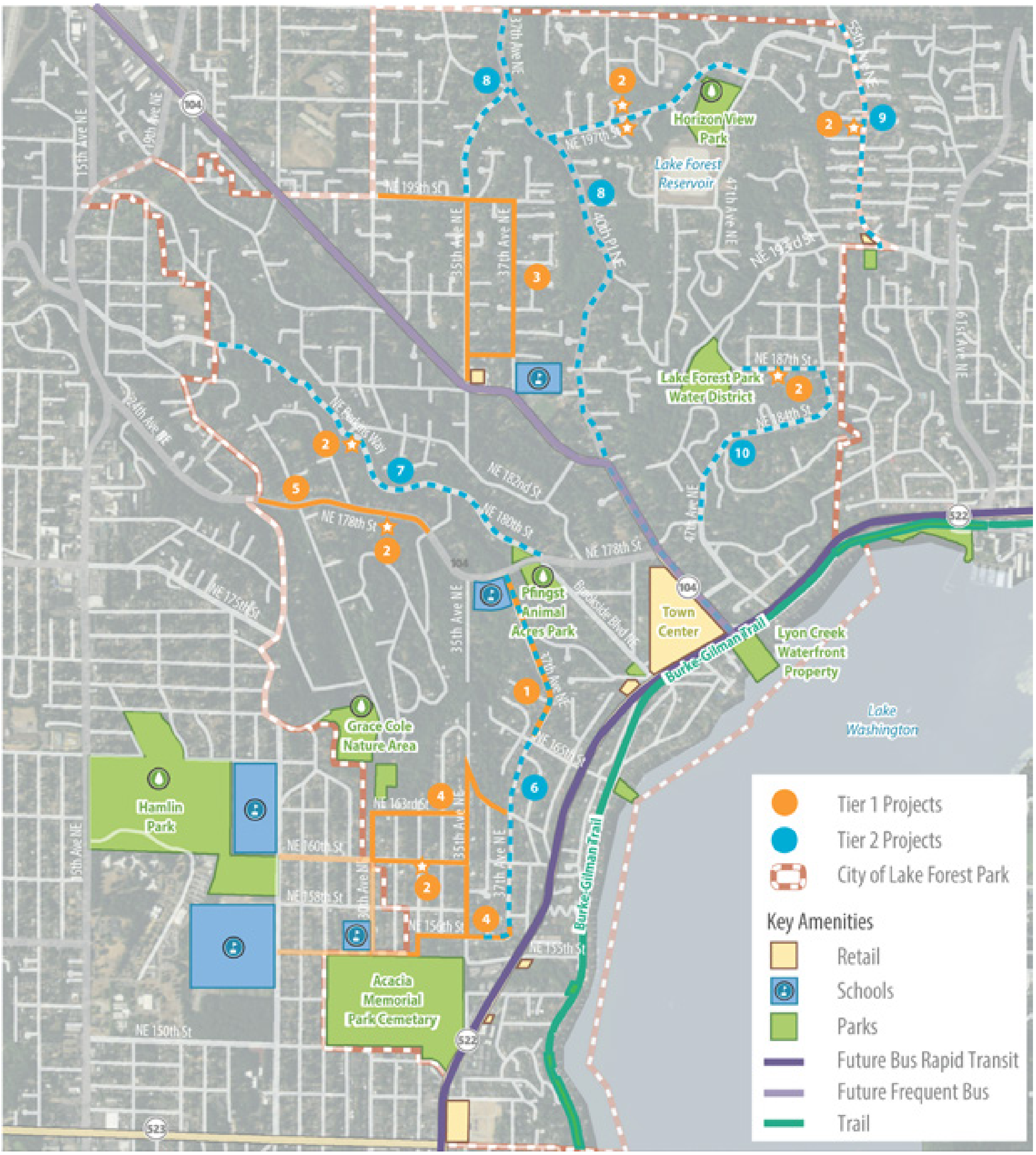
Figure 3. Safe Streets Project Recommendations

Source: Safe Street Study, City of Lake Forest Park 2017.



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Healthy Creeks

Lyon Creek is impacted by aging and inadequate infrastructure and severe fish passage barriers. In 2015, the City replaced a cluster of culverts and rebuilt one-half mile of streambed in the lower reach of Lyon Creek. The Healthy Creeks Study tackles the middle reach of Lyon Creek. The completed study has spun off the following projects:

- The Lyon Creek culverts at 35th Avenue NE, NE 185th Street, and SR 104 are undersized and create a barrier to fish passage. With flood reduction grant funds from King County and the Washington State transportation budget, the City is redesigning and planning to replace these culverts to improve stream health while maintaining critical infrastructure.
- Another culvert at 178th has been studied and its replacement is being designed by a King County Flood Control District grant.

Parks, Recreation, Open Space and Trails Plan

The Parks, Recreation, Open Space, and Trails Plan is assessing how well the City's parks, open spaces, and recreational programs are serving the community and proposing capital improvements to meet evolving needs.

Project Process

Technical Advisory Committee

The Safe Highways project benefited from expertise of a Technical Advisory Committee (TAC), which was comprised of volunteers from the following organizations:

- City of Shoreline
- City of Kenmore
- City of Mountlake Terrace
- City of Seattle
- WSDOT
- Merlone Geier Partners (Town Center Owner)
- Sound Transit
- King County Metro

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The TAC met six times over the course of the project. Their role was to provide technical advice, from the perspective of their representative organizations or as transportation planning/engineering professionals.

During the meetings, the project team shared cross-section, intersection, and non-motorized access concepts and asked TAC members to provide input on potential fatal flaws and/or opportunities that could be leveraged with each investment. Summaries of the TAC meetings are included in **Appendix A**.

Interviews

In the late spring of 2017, the Project Team conducted a series of interviews to gain a better understanding of the two corridors. While these interviews were not comprehensive in terms of the stakeholders consulted, they provided information on the opportunities and constraints along the corridors, as well as regional efforts that should be considered. The interviews were conducted with the community and stakeholder groups listed below:

- TAC members
- Lake Forest Park Elementary
- Third Place Commons
- NW Kidney Center
- Residents (3)
- Lake Forest Park Stewardship Foundation
- Sheridan Beach Club
- Presbyterian Church
- Peruvian Consulate
- Third Place Books
- Windermere Realty
- Acacia Cemetery

A summary of the interview findings is included in **Appendix B**.

Council Involvement

The Lake Forest Park City Council, as the body that authorized this study, has been very engaged in reviewing recommendations and ensuring that community voices are heard. Between June 2017 and February 2018, the Council heard six status updates on the Safe Highways Study. Councilmembers also attended the three open houses and helped with outreach to specific neighborhoods with an interest in the project. Presentations made to Council in June through December 2017 are included in **Appendix C**.

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Community Meetings

The Project Team facilitated three community meetings over the course of the project:

- **SR 104 Focused Meeting:** October 18th, 2017
- **SR 522 Focused Meeting:** November 14th, 2017
- **SR 104 & SR 522 Focused Meeting**: December 4th, 2017

The meetings included an introductory presentation by the Project Team and stations where community members could engage in one-on-one conversations about concepts and provide detailed input. All of these meetings were advertised through a variety of online methods (City website, community calendar, City email list, Social Media accounts). The third meeting was also advertised with a postcard sent to all Lake Forest Park residences. Summaries of public input received at each of the community meetings are included in **Appendix D**.

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Join us for the third Open House!
SR 104 & SR 522

Monday, December 4
6:00 - 8:00 PM
Brookside Elementary
17447 37th Ave NE
lfpsafehighways.com

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Timeline

The following timeline shows the schedule for completing the Safe Highways Study. The study began in early May 2017 with draft recommendations for Council available in early February 2018.

Development of Guiding Principles

To guide this process, the Project Team established a set of guiding principles. The value of the guiding principles is to develop a set of the foremost values sought by the study and to also use them to measure the success of the outcomes. These guiding principles were first developed by the Project Team, vetted by the TAC, and eventually heard by the City Council. The guiding principles are divided into three groups:

- Principles for the **overall project** apply to both corridors and how the Project Team conducts this Study.
- Principles for **SR 522** are specific to achieving the ultimate vision of a future BRT corridor that is also a community asset.
- Principles for **SR 104** focus on realizing a corridor vision that improves safety and mobility while maintaining rural character.

Overall Project

- Engage the community and respect neighborhoods

- Recognize each corridor’s role in regional mobility and local mobility access
- Coordinate with state, regional entities, and neighboring cities to identify mutually beneficial solutions
- Create equitable corridors that provide safe and inviting travel for all people, regardless of mode, age, or ability

SR 522

SR 522 Today

- Address safety for all modes
- Complete BAT lanes and full sidewalk connections to support both BRT and local access
- Minimize impacts on neighboring properties (e.g. right-of-way, access, noise, visibility)
- Improve non-motorized access to transit and crossing opportunities to enhance local access
- Create a corridor identity/character and enhance the natural environment
- Be a leader in identifying innovative solutions, particularly at the Bothell Way/145th Street intersection

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SR 104

SR 104 Today

- Address safety for all modes
- Maintain the corridor's unique identity and natural landscape
- Take a phased approach that provides benefits over time
- Consider draw on city's financial resources in selecting design solutions, as well as positioning improvements for regional, state and federal investment
- Protect natural environment and encourage low impact design approaches
- Plan corridor to discourage neighborhood cut-through traffic
- Minimize impacts on neighboring properties (e.g. right-of-way, access, noise, visibility)

As described in the following sections, these guiding principles provided a framework for the evaluation and selection of preferred corridor improvements.

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SR 104 Corridor

SR 104 Cross-Sections

Tree-lined SR 104 today.

The SR 104 corridor connects Lake Forest Park to Shoreline, Mountlake Terrace, and Edmonds, including the Kingston Ferry Terminal. While this winding, tree-lined route is appreciated for its natural beauty, the corridor's curves, non-standard intersections, blind driveways, and inadequate multimodal facilities can make it potentially hazardous. As a regional state route and important local connection, the SR 104 corridor carries between 17,500 and 21,500 daily vehicles, and these volumes are expected to grow to between 19,400 and 23,800 daily vehicles within 20 years. Through Lake Forest Park, the majority of the corridor is lined by single-family housing, but the Town Center, Lake Forest Park Elementary, multifamily apartment complexes, and small businesses are also key features. Given all of these uses, SR 104 provides surprisingly few amenities for people traveling by any mode except by car. As the host community of this regional highway facility, it is up to the City of Lake Forest Park to seek better.

Existing Conditions, Opportunities & Challenges

- The **corridor cross-section** is generally one lane in each direction with turn pockets at major intersections. The right-of-way width varies from 60 feet to 90 feet depending on the segment. Numerous single-family homes have driveway access on SR 104, and weekly garbage collection occurs on the shoulder of SR 104.

Wide SR104 shoulder where weekly garbage collection occurs.

A transit stop next to the wide SR 104 shoulder.

- **Non-motorized facilities** to encourage walking and biking through the corridor are lacking. There is generally a sidewalk or asphalt paved walking path of varying quality on the north side of SR 104 with some short segments of sidewalk or paved path on the south side of SR 104, typically near a transit stop or major intersection. While portions of the corridor are missing dedicated space for people to walk, people are still walking in the shoulders to reach transit stops and final neighborhood destinations. There are no bicycle facilities on this corridor, yet it is the most direct route for cyclists to reach destinations like the Town Center, high-frequency transit stops along SR 522, and the regional Burke-Gilman Trail. The topography between uphill neighborhoods, the Town Center, and the lake also makes cycling along the corridor a challenge.

- Existing weekday average **daily traffic volumes** range from 17,500 near the north end of City limits to 21,500 near the Town Center, with volumes expected to grow to 19,400 and 23,800 by 2036. The speed limit is 30 miles to hour (MPH) and increases to 40 MPH in the blocks approaching Shoreline. Both existing and future forecasted AM and PM peak hour operations at intersections were analyzed.

- Study intersections **not meeting the LOS E standard today**: NE 178th Street; 40th Place NE

- Study intersections that **will not meet the LOS E standard in the future**: SR 522; NE 178th Street; 40th Place NE

- The **collision history** on the corridor is highest near the SR 522 junction, which is logical as this segment has the higher traffic volumes. Throughout the corridor a higher number of collisions occur at major intersections.

- **Transit service** provides connections to Horizon View, Shoreline City Center/Aurora Village, Shoreline Park & Ride, and Bellevue. Most of this service is peak hour and peak directional service only. Highest transit ridership is near the Town Center. Future service plans includes more frequent service and express service on SR 104.

- Overhead **utilities** are located close to the either side of the roadway. Existing stormwater system will need to be improved, modified, or undergrounded with widening or intersection realignment.

- Options for **intersection improvements** near commercial establishments need to consider right-of-way constraints, topography, roadway geometry, turning movements, as well as impacts to residences at other locations, including access.

Additional detail on the existing conditions, opportunities, and constraints are documented in the Planning Context Report, which is available in **Appendix E**.

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Alternatives considered

Cross-section options developed to meet community goals include the following:

- **Option 1: Buffered Bike Lanes** – Provides dedicated space for people driving, walking, and biking, though the completion of sidewalks on both sides of SR 104 and bike lanes on each side of SR 104, which are separated from vehicular traffic by a two-foot painted buffer. Of the cross-section options considered, this option requires the most right-of-way.
- **Option 2: Multi-Use Trail** – Provides a shared, multi-use trail for people to walk and bike that is fully separated from vehicular traffic on SR 104. This is a narrower option than buffered bike lanes, but generally wider than the following two options.
- **Option 3: Complete Sidewalks** – This option completes sidewalks on both sides of SR 104, but does not provide bicycle facilities along the corridor, except for improved crossings at key intersections. Under this option, cyclists would continue to use the existing local roads to navigate through the City. This is the narrowest cross-section option considered.
- **Option 4: Hybrid of Multi-Use Trail and Complete Sidewalks** – This option considers provision of a shared-use trail for key portions of the corridor (nearby the Town Center and Lake Forest Park Elementary) that would connect to existing bicycle routes on local intercepting roads. Complete sidewalks would be constructed throughout the entire corridor to serve people walking. The width required by this option matches either the Multi-Use Trail or Complete Sidewalks option, depending on location.

High-Level Feedback

- There is a desire to provide facilities to support **more walking and biking** in the community.
- There is support for a **multi-use trail segment adjacent to the Town Center** (from approximately NE 178th Street to SR 522). This will improve access to attractions such as the Town Center, transit, and a signalized crossing of SR 522 to the Burke-Gilman Trail.
- There are concerns about providing a multi-use trail along the entire length of the corridor. **Separation is needed between people walking and biking**, especially because of the expected difference in travel speeds along the corridor hills.

Recommendation

- The Project Team recommends implementation of the **Buffered Bike Lanes cross-section** along most of the corridor, transitioning to the Multi-Use Trail cross-section (trail on the Town Center side) between NE 178th Street and SR 522.
- This provides a **continuous bicycle facility** and **avoids conflicts between people walking and biking** for most of the corridor, except nearby the SR 522/SR 104 intersection, where conflicts between vehicles and bicycles are viewed to be more hazardous. This concept also includes complete sidewalks on both sides of SR 104 to support walking through the corridor. **Figure 4** illustrates this recommendation.

- In developing this concept, the Project Team worked with King County Metro to **develop bus stop treatments concepts** that would be consistent with the Buffered Bike Lane Cross-Section. These bus stop concepts are shown in **Figure 5**.
- This recommendation is also **consistent with community feedback** received by the community (see **Appendix D**).

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Figure 4. Recommended SR 104 Cross-section Plan

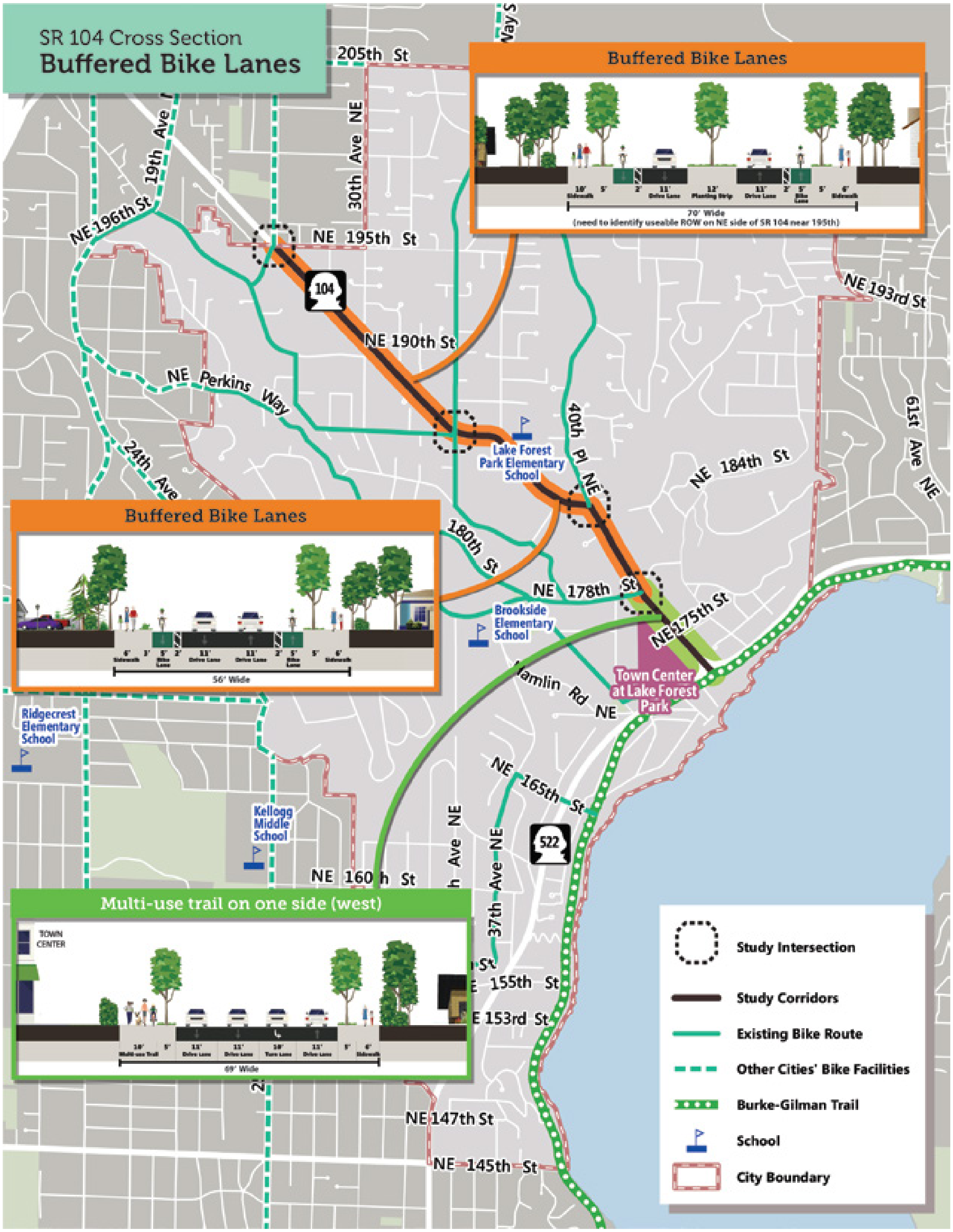

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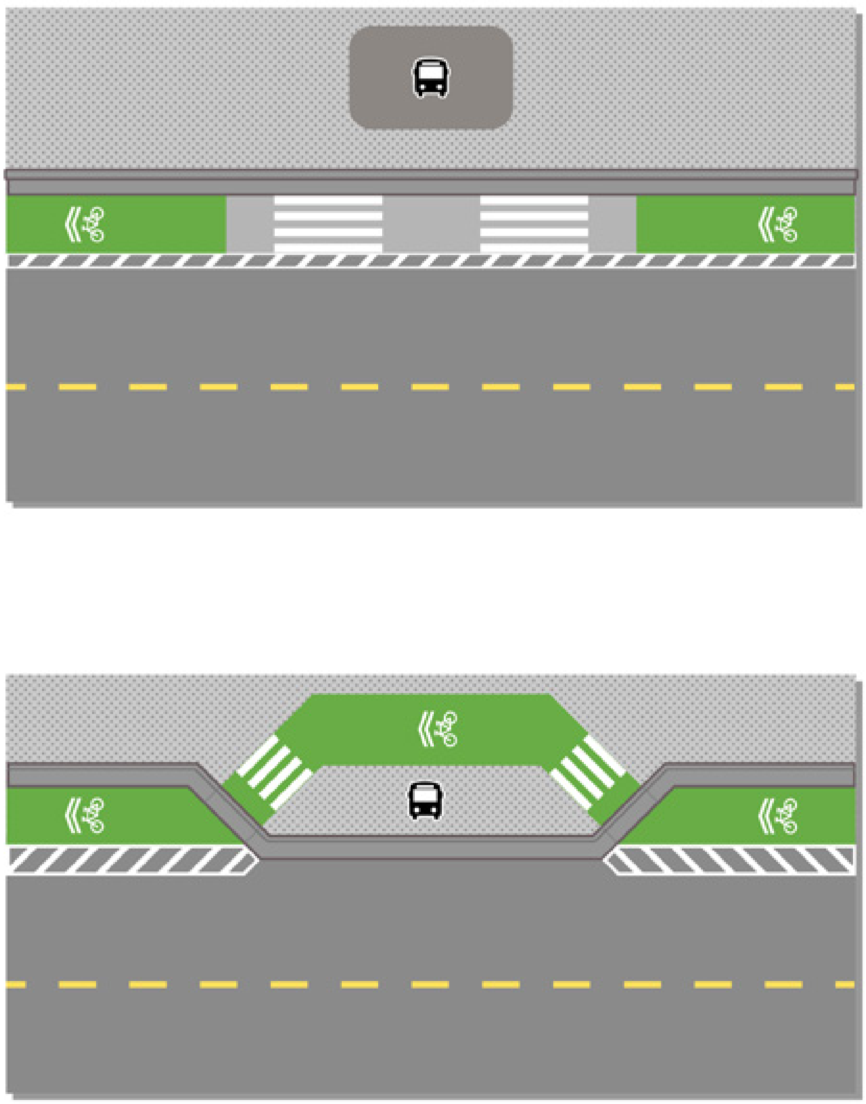
Figure 5. Bus Stop Treatment Concepts

SR 104
Bus Stop Treatment Concepts



SR 104 Intersections

The study intersections evaluated along SR 104 are mapped in **Figure 6**. The following section describes the existing and planned conditions at each intersection, the options developed, and the recommended intersection plan. Detailed roundabout operation results for each study intersection are shown in **Appendix F.**

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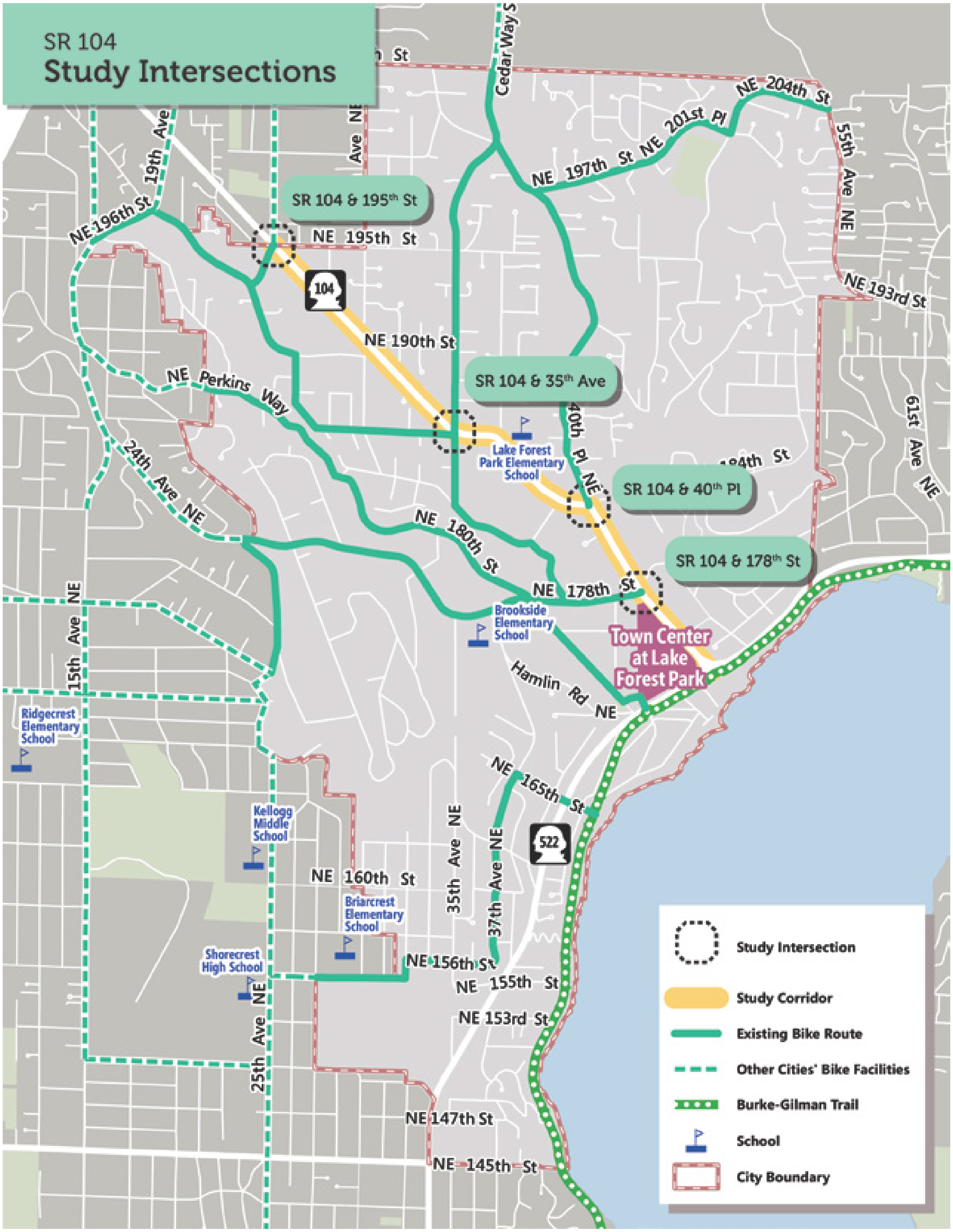
Figure 6. SR 104 Study Intersections



NE 195th Street & SR 104

Background Information

This intersection is currently a five-leg signalized intersection with a right turn bypass from northbound SR 104 onto NE 195th Street. There is a stream crossing under NE 195th Street that then runs alongside 25th Avenue NE, crossing SR 104 south of the intersection. The intersection slopes downhill from north to south, and both NE 195th Street and the north leg of 25th Avenue NE have steep grades as they tie into the intersection.

Existing Conditions, Opportunities & Challenges

- The **five-legged intersection's operations** are LOS D (AM) and LOS C (PM). Even with anticipated growth along SR 104, future operations are similar.
- Surrounding **land use** includes single-family homes and multi-family housing. Pedestrian crossings are long and curb ramps are in poor condition.
- **Fourteen total collisions** have been recorded in the past three years. About half of the collisions were from vehicles making left-turns and not granting right-of-way. No collisions involved a pedestrian or cyclist.
- A **creek on the east side** and **topographic challenges** on the west side of the intersection limit the proposed intersection reconfiguration options.

Pedestrians waiting to cross near NE 195th Street intersection.

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Alternatives Considered

Roundabout Alternative

A roundabout was evaluated for the intersection. The proposed layout evaluated is shown on **Figure 7.**

Figure 7. Roundabout Alternative, NE 195th Street & SR 104

Roundabout alternative features more of a peanut shape to accommodate the five legs and geometrics of the connecting roads.

The roundabout would replace the existing five-legged signal controlled intersection. Due to the number and angles of the roundabout approaches, a roundabout option at this intersection would likely be oblong, creating a peanut shape to reduce impacts to the adjacent properties.

The roundabout concept removes the signal maintenance costs, and reduces pedestrian crossing distances at each leg. However, overall walking distances around the intersection would increase, due to the need to cross multiple legs for what is now a single pedestrian movement.

Right-of-way impacts are extensive in this option and walls would be needed to avoid greater impacts. This option does not impact the building to the north, but requires significant walls on the west, east and south sides, and requires re-grading each of the approaches. This option would also have significant

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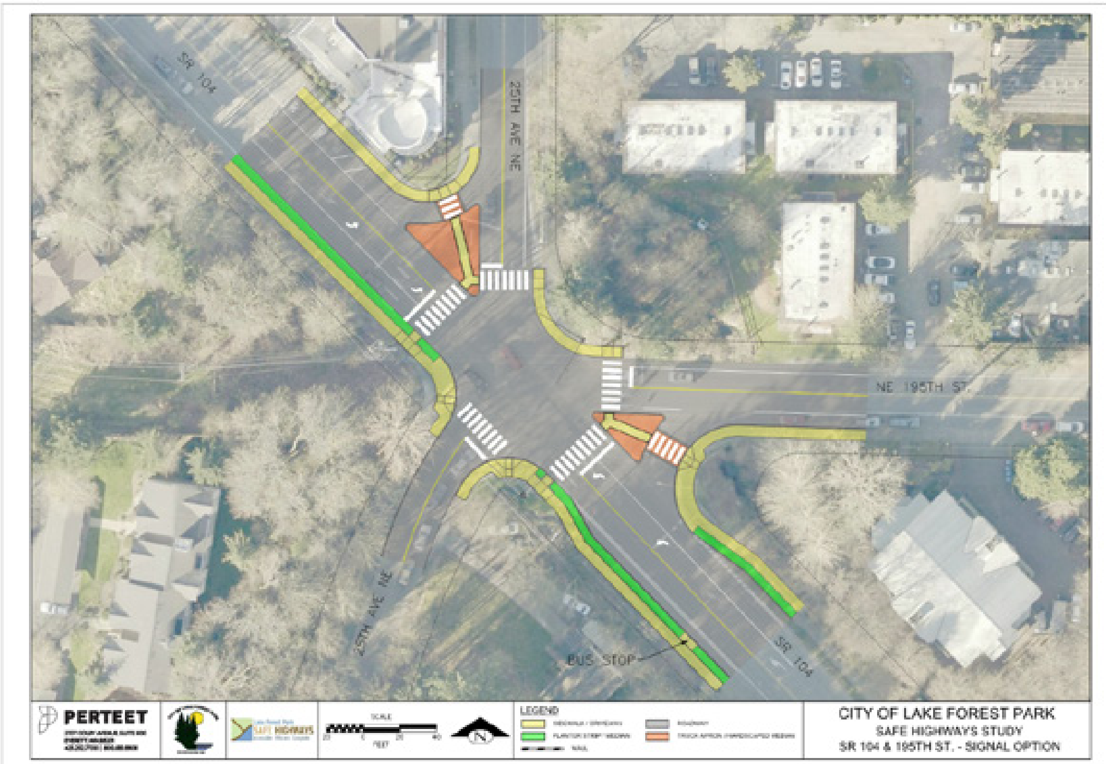
stream impacts, as the culvert crossing the east leg of NE 195th Street would need to be replaced and extended to accommodate the roundabout footprint.

Signalized Alternative

An improved signalized intersection was also evaluated. The proposed layout is shown on **Figure 8**.

Figure 8. Improved Signalized Alternative, NE 195th Street & SR 104



The improved signalized option makes the intersection more compact and realigns pedestrian crossings.

The signalized alternative adds a pedestrian refuge island on the north corner of the intersection and reduces the curb return radii on the south leg to reduce pedestrian crossings lengths. This option requires reconstruction of the north corner and the north leg of 25th Avenue NE. While this alternative avoids impacts to culverts, existing walls and culverts are outdated and would likely be replaced as part of construction. This signalized option minimizes impacts to neighboring properties, right-of-way, and access.

Adding a pedestrian refuge island on the northwest corner provides pedestrians with shorter crossing distances and greater visibility, increasing the safety of pedestrians in the intersection, and reducing the amount of “flashing don’t walk time” allocated in the signal timing. The realignment of the northwest legs improves sight distance, although the southbound right-turning vehicles would have more than one approach to check before executing a right turn on red. Stop bars are shifted closer to the center of the

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intersection, reducing the crossing distances for vehicles entering the intersection, increasing vehicle safety and reducing yellow and red signal times, which benefit operations.

Traffic Operations Analysis

The operational analyses of the proposed alternatives are summarized in **Table 1**.

Table 1. Operations Analyses of the Existing Intersection and Alternatives Considered for SR 104 & NE 195th Street

	AM Peak Hour		PM Peak Hour	
	LOS	*Delay (s)*	*LOS*	*Delay (s)*
Existing (No-Build)	D	40	C	32
Future 2036 Operations				
No Build	D	43	D	42
Roundabout Alternative	B	13	C	27
Signalized Alternative	D	39	D	54

From an intersection LOS standpoint, the roundabout alternative provides the lowest overall delay as it reduces the amount of time side street minor approaches must wait before entering the intersection. The signalized improvement option sees higher vehicle delays than the roundabout as it must allocate green time among all five legs.

Recommendation

- The Project Team recommends the **improved signalized intersection option**.
- While this option sees higher vehicular delays than the roundabout option (although still within City and WSDOT standards), it is more compact requiring **fewer impacts on adjacent properties and streams**.
- Additionally, the signalized option's compact footprint allows for **more direct pedestrian crossings**. By comparison, the large radius of the roundabout option would require pedestrians to make a circuitous route around the roundabout, often crossing more than one leg to get to their desired route.
- This option also received the **most community support** at the open houses and online comment forms.

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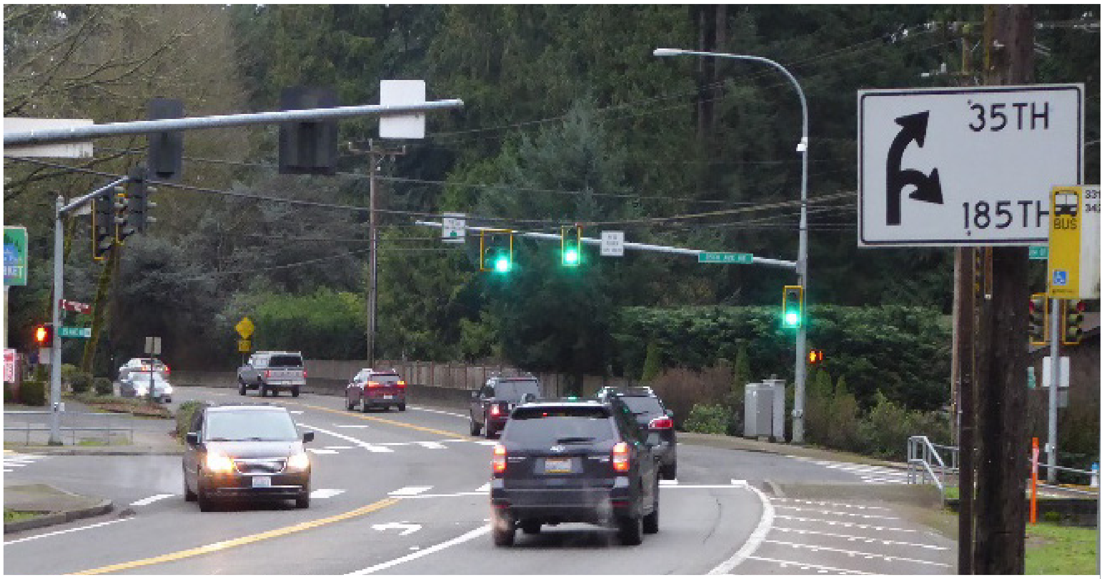
35th Avenue NE & SR 104



Approach to 35th Ave NE Intersection. Street sign shows the sharp angle of intersection legs.

This is another a five-leg signalized intersection. NE 185th Street and 35th Avenue NE approach SR 104 from the south, creating a long pedestrian crossing and confusing geometry for drivers. Lyon Creek crosses under the northwest leg of the intersection, daylights between SR 104 and NE 185th Street, and then crosses beneath NE 185th Street. A culvert replacement for the NE 185th Street crossing and stream realignment has been an identified need for this intersection. Buildings are located close to intersection approach legs, and driveways are not well delineated.

Existing Conditions, Opportunities & Challenges

- The **five-legged intersection's operations** are LOS D (AM) and LOS C (PM). Even with anticipated growth along SR 104, future operations are similar. Collected turning movement volumes showed that traffic volumes on NE 185th Street are relatively low, and consolidation with the southern 35th Avenue leg is feasible.
- Surrounding **land uses** include a market with driveways close to the intersection, some service buildings, a school, and a collapsed culvert with repair plans under way. Proposed plans would need to consider culvert designs and stream restoration needs.
- Any proposed concepts should consider **pedestrian crossings**, especially for students destined for Lake Forest Park Elementary.
- **Nineteen collisions** have occurred at this intersection in the past three years; mostly rear-end collisions due to driver inattention. The remaining collisions involved hitting an object (utility pole, guardrail, fence, post), which involved speeding and/or driving under the influence (DUI). No collisions involved a pedestrian or cyclist.

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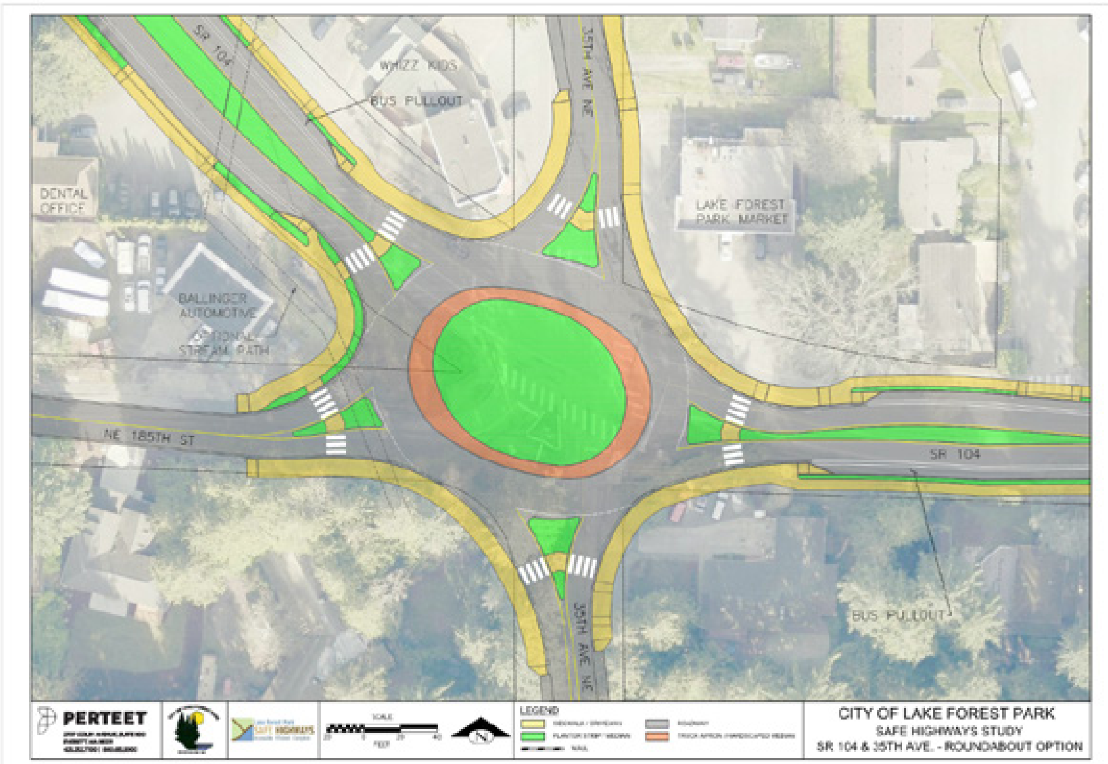
Alternatives Considered

Roundabout Alternative

The roundabout alternative is shown in **Figure 9**.

Figure 9. Roundabout Alternative, 35th Avenue NE & SR 104



The roundabout alternative includes a large footprint and oblong shape to accommodate access to all five legs of the existing intersection.

The roundabout would replace the existing five-way signal controlled intersection and provides full access to and from NE 185th Street. Due to the number and angles of the roundabout approaches, a roundabout option at this intersection would likely be oblong, creating an oval shape to reduce impacts to the adjacent properties to the north while also providing the needed separation between NE 185th Street and 35th Avenue NE. The roundabout concept removes the signal maintenance costs, and reduces pedestrian crossing distances at each leg. However, overall walking distances around the intersection would increase, due to the need to cross multiple legs for what is now a single pedestrian movement.

Future transit plans include improved bus service through the intersection, specifically using the eastbound (SR 104) through, southbound (35th Avenue NE) left, and westbound (SR 104) right turning movements. These movements were modeled in AutoTurn to ensure they could accommodate an articulated bus.

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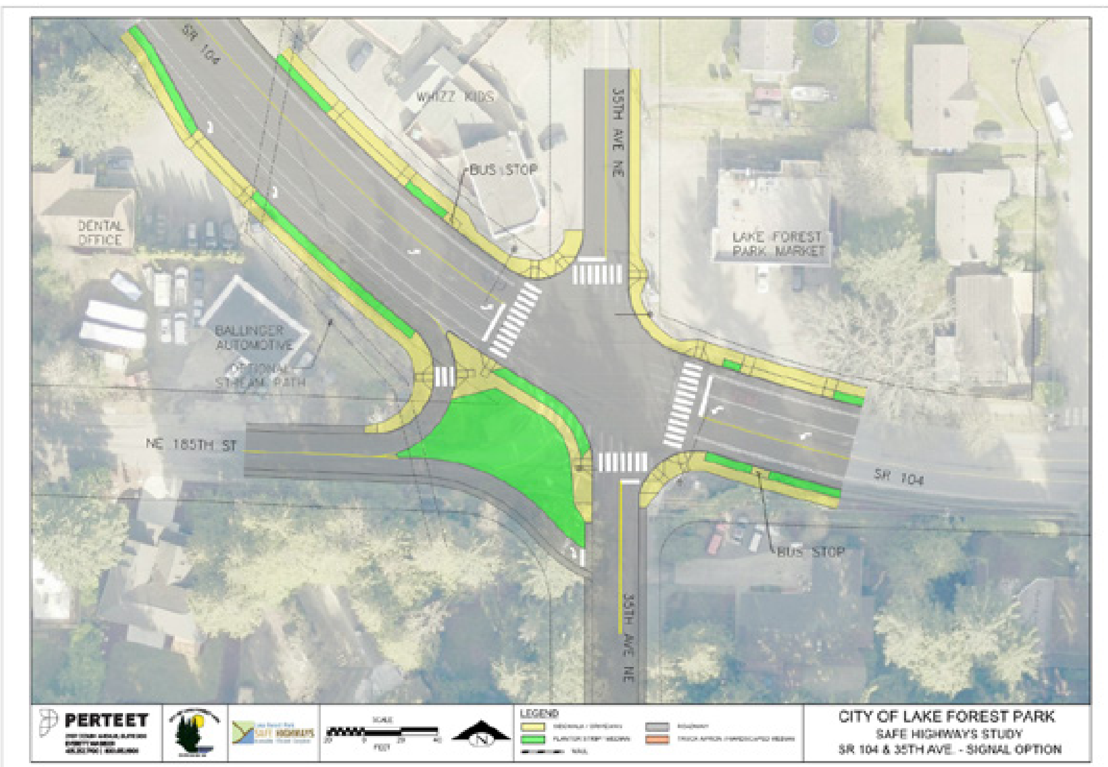
This option would impact businesses due to loss of parking, reduced access, and potentially the need for full property acquisition. Specifically, this alternative affects the access and parking for the property on the northeast corner (Lake Forest Park Market). There are also significant impacts to the property west of the intersection, between SR 104 and NE 185th Street (Ballinger Automotive), as well as the parking at the daycare (Whizz Kids) north of SR 104.

Signalized Alternative

The improved signalized alternative, which consolidates access points to create a four-legged intersection, was also evaluated. The layout for this alternative is shown in **Figure 10**.

Figure 10. Improved Signalized Alternative, 35th Avenue NE & SR 104



The improved signalization alternative eliminates direct access from NE 185th Street to create a four-legged intersection.

The proposed signalized improvement eliminates direct access from the NE 185th Street approach to create a four-leg intersection. Under this alternative, NE 185th Street can be accessed from southbound SR 104, but exits onto 35th Avenue NE. This option creates green space between SR 104 and NE 185th Street and a pedestrian refuge between NE 185th Street and 35th Avenue NE, and reduces the crossing length of 35th Avenue NE.

The proposed layout of the intersection minimizes impacts to adjacent properties, requiring minimal right-of-way acquisition.

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Traffic Operations Analysis

A summary of the operational analysis is shown in **Table 2**.

Table 2. Operations Analyses of the Existing Intersection and Alternatives Considered for SR 104 & 35th Avenue NE

	AM Peak Hour		PM Peak Hour	
	LOS	*Delay (s)*	*LOS*	*Delay (s)*
Existing (No-Build)	D	42	C	34
Future 2036 Operations				
No-Build	D	48	D	42
Roundabout Alternative	B	13	B	14
Signalized Alternative	C	25	C	23

While both alternatives are expected to operate within standards, the roundabout alternative does experience less delay than the signalized alternative.

Recommendation

- The Project Team recommends the **signalized intersection option**.
- While the roundabout alternative operates with less vehicle delay, the signalized option **requires substantially less right-of-way**, resulting in fewer impacts to adjacent properties and the stream.
- Moreover, the improved signal alternative's more compact footprint provides the opportunity for a **safer pedestrian environment** (which is particularly important adjacent to the school).
- The **reclaimed green space** west of the intersection provides an opportunity to daylight the creek and otherwise repurpose this space for other community uses.
- This option also received the **overwhelming community support** at the open houses and online comment forms.

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40th Place NE & SR 104

Background Information

This is a skewed, four-legged intersection with stop control for the southbound (40th Place NE) and westbound (NE 184th Street) approaches. The geometry of the intersection is problematic for many users, including misaligned legs that lead to confusion over which route is SR 104, and lack of sight distance which makes turning left onto SR 104 and pedestrian crossings hazardous. Moreover, the intersection lacks amenities for those choosing to walk or bike.

Existing Conditions, Opportunities & Challenges

- Surrounding **land uses** are mostly single-family homes with driveways onto SR 104. Proposed changes will need to consider neighborhood access.
- The stop-controlled intersection has **misaligned legs and can be confusing to navigate**. For drivers heading north on SR 104, 40th Place NE can be viewed as the natural through movement, rather than northbound SR 104, which requires drivers to bear left. Left turns from the side streets onto southbound SR 104 are especially difficult due to limited sight distance. The intersection operates at LOS F today and will further degrade in the future.
- Moreover, the **corner between 40th Place NE and NE 184th Street is very wide** with no pedestrian landing or marked crosswalk between the two approaches. The curb ramps on 40th Place NE are located 40 feet from the intersection, adding to the confusion of where to cross the stop controlled approaches.
- There is **no pedestrian crossing** of SR 104.
- The **angle of intersection legs and topography** pose challenges for any proposed improvements.

- **Thirteen collisions** have been reported in the past three years; seven collisions were vehicles hitting an obstruction. About one-third of the collisions involved speeding. One collision involved a cyclist nearby (not intersection related), however no additional data was provided.

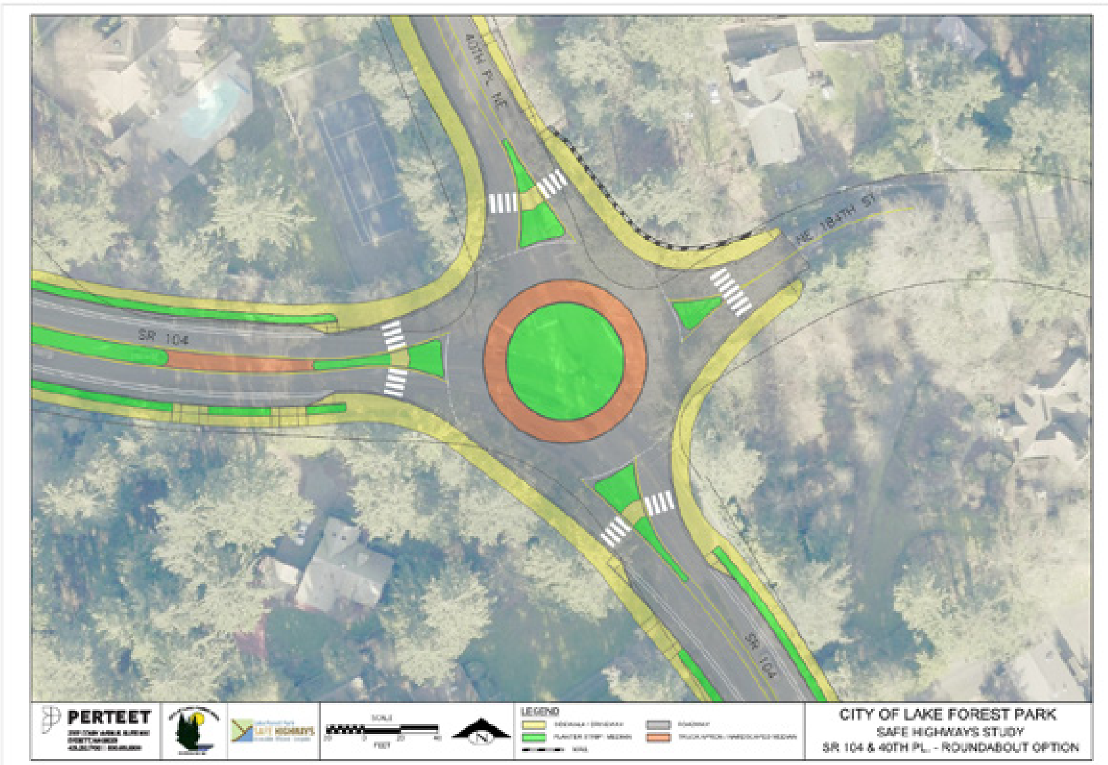
Looking up 40th Place NE at SR 104. There is a sharp curve to continue through on SR 104.

Alternatives Considered

Roundabout Alternative

The roundabout alternative is shown in **Figure 11.**

Figure 11. Roundabout Alternative, 40th Place NE & SR 104



The roundabout option provides safe side street access, as well as pedestrian crossing opportunities.

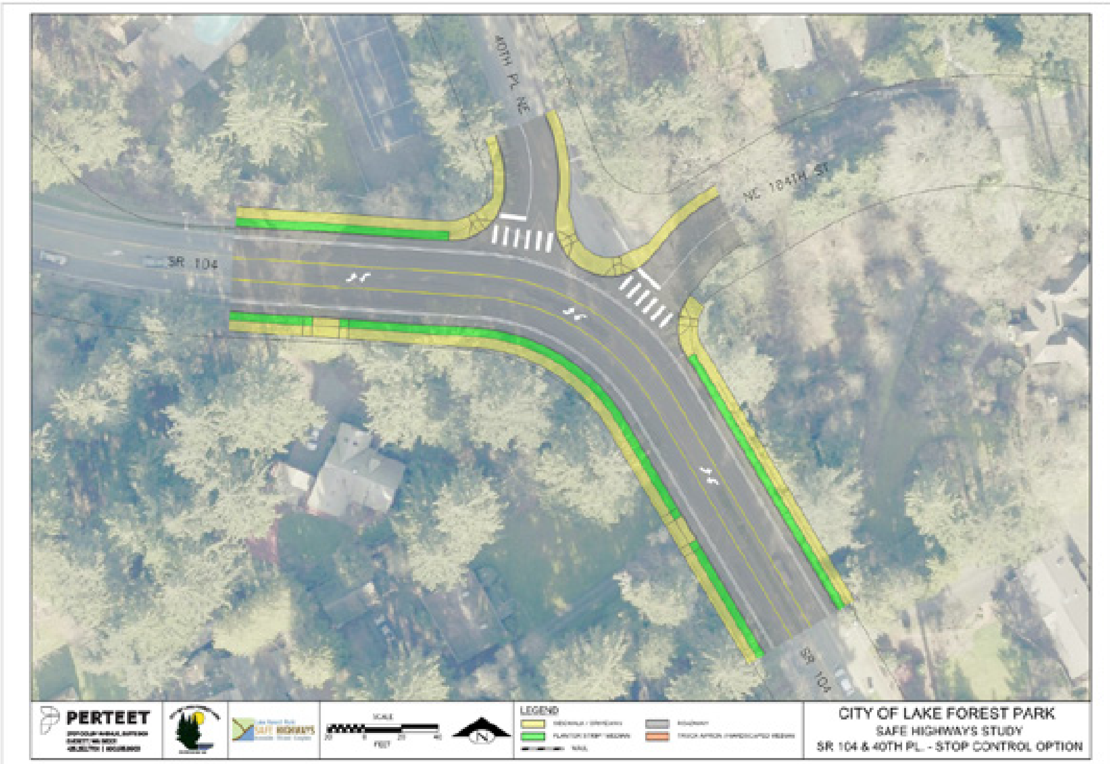
This option is a traditional four-leg single lane roundabout. Southbound through movements on SR 104 would make a right turn at the roundabout, and northbound through movements would be left turns. A short retaining wall may be needed on the northeast corner to minimize right-of-way impacts. Each adjacent property would maintain one point of access in and out of their driveway from SR 104 in both directions.

The roundabout provides pedestrian crossings for all legs, improved and more predictable traffic flow through the intersection, adequate sight distance and clear delineation for vehicles and pedestrians. Right-of-way impacts are greatest along the corners of the intersection as the roundabout footprint is larger than the existing intersection. However, existing buildings would not be impacted by the roundabout footprint.

Two-Way Stop Controlled Alternative

An alternative which considers more modest changes to the existing intersection is shown in **Figure 12**.

Figure 12. Two-Way Stop Controlled Alternative, 40th Place NE & SR 104



This Alternative considers more modest changes to the existing intersection, including more pronounced pedestrian crossings of 40th Place NE and NE 184th Street. This option does not provide a pedestrian crossing of SR 104.

This option preserves the existing traffic control at the intersection. The proposed changes better delineate the approaches of 40th Place NE and NE 184th Street by installation a curb and pedestrian area between the two legs. This shortens the pedestrian crossings of the side streets and makes them more pronounced, but does not provide for any crossing on SR 104.

The improved delineation of the side street approaches provides improved intersection sight distance by improving alignment of the legs with the intersection. The footprint of the proposed improvements is similar in size to the existing condition therefore there are minimal impacts to the adjacent properties.

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Traffic Operations Analysis

The operational analysis for this intersection is summarized in **Table 3**.

Table 3. Operations Analyses of the Existing Intersection and Alternatives Considered for SR 104 & 40th Place NE

	AM Peak Hour		**PM Peak Hour**	
	LOS	*Delay (s)*	*LOS*	*Delay (s)*
Existing (No-Build)	F	>100	F	85
Future 2036 Operations				
No-Build	F	>100	F	>100
Roundabout Alternative	C	15	B	14
Improved Stop Control	F	>100	F	>100

For two-way stop controlled (TWSC) intersections, the level of service is measured by the worst stop controlled approach. As the mainline (SR 104) does not experience any delay, it is not considered. While constructing a roundabout at the intersection would introduce some delay into the through movements on SR 104, that delay is well within the operations standards set by WSDOT and the City.

Recommendation

- The Project Team recommends the **roundabout option**.
- While the roundabout does introduce some delay for the mainline through movements, the **delay for the side street approaches is greatly reduced**.
- The roundabout alternative offers the **opportunity to provide pedestrian crossings** of SR 104 as well as delineated crosswalks for the side street approaches.
- Moreover, the roundabout design may offer the ability to **calm traffic speeds along SR 104**.
- This option also received the **overwhelming community support** at the open houses and online comment forms.

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NE 178th Street & SR 104

Background Information

The east and west legs of NE 178th Street are offset – the west leg intersecting SR 104 approximately 100 feet south of the east leg. Both legs of NE 178th Street are side-street stop controlled. While the west leg allows full access, a median was constructed at the east leg to prohibit left turns from NE 178th Street to southbound SR 104 (left turns from southbound SR 104 to the east leg of NE 178th Street are permitted). Both legs of NE 178th Street have steep grades intersecting SR 104. During the morning peak hours, queues from the SR 104 and SR 522 intersection often spill back into this intersection. Due to the grades and existing vegetation, there is limited sight distance on the eastbound approach, and many vehicles edge into SR 104 before entering traffic flow.

Existing Conditions, Opportunities & Challenges

- This **offset and side-street stop controlled intersection** is located north of the Town Center. The southern intersection with the west leg of NE 178th Street operates at LOS E in the AM peak hour and LOS F in the afternoon, with operations expected to further degrade as traffic grows in the future. The high delays are related to the difficulty making a left-turn onto northbound SR 104. The northern intersection with the east leg operates at LOS B/C and will continue to in the future. This portion of the intersection doesn't see as high of delays due to the restriction on turning left onto southbound SR 104.
- **Twenty collisions** were reported in the past three years; half of them related to left turns from eastbound NE 178th Street to northbound SR 104. One bicycle involved collision occurred because the bicyclist did not grant right-of-way to the vehicle. One severe collision involved a speeding vehicle headed southbound and colliding with a fence.
- While sidewalks are on both sides of SR 104 in this area, there is **no marked pedestrian crossing** at this location.

Alternatives Considered

Roundabout Alternative

Preliminary traffic analysis shows that a two-lane roundabout would be needed to provide sufficient capacity during the AM and PM peak hours. Due to the terrain and the proximity of homes to the intersection, a multi-lane roundabout would result in up to six complete property takes, and would require a 10-to-20 foot wall along the north corner.

A single lane roundabout would function operationally for most of the day, outside of the peak hours. A concept was developed to determine the impacts and evaluate the additional benefits of a roundabout at this location. The evaluated roundabout alternative is shown in **Figure 13**.

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Figure 13. Roundabout Alternative, NE 178th Street & SR 104

Figure 5. An oblong, peanut shaped roundabout could accommodate demands at the NE 178th Street intersection during most of the day, but not the peak hours.

Due to the offset between the approaches of NE 178th Street, a roundabout at this intersection would likely be oblong, creating a peanut shape to incorporate both sides of NE 178th Street into one cohesive intersection. Despite reducing the diameter of the roundabout to the lower end of single lane roundabout diameters (110 foot inscribed circulating diameter), a single lane roundabout would still require extensive retaining walls due to the existing topography which would impact homes resulting in multiple full property takes.

Additionally, if queues from the SR 522/SR 104 intersection spill back into the roundabout (as can happen during the peak hours), approaches would be unable to operate. For these reasons, the roundabout does not seem to be a viable alternative.

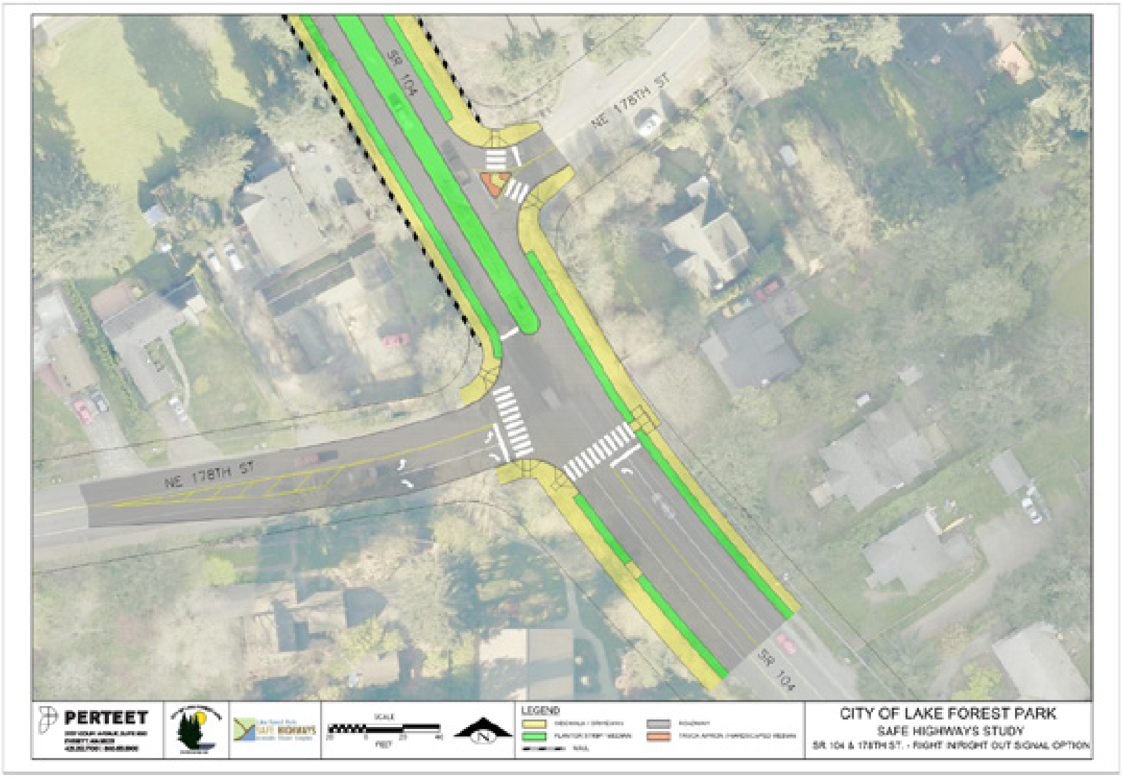
Signalized Alternative

Three potential layouts were considered for the signalized intersection alternative.

Signalized Alternative 1: NE Leg Right-In/Right-Out Only Option

The first signalized alternative is shown in **Figure 14**.

Figure 14. Signalized Alternative 1



This option signalizes the west leg of NE 178th Street and makes the east leg right-in/right-out only.

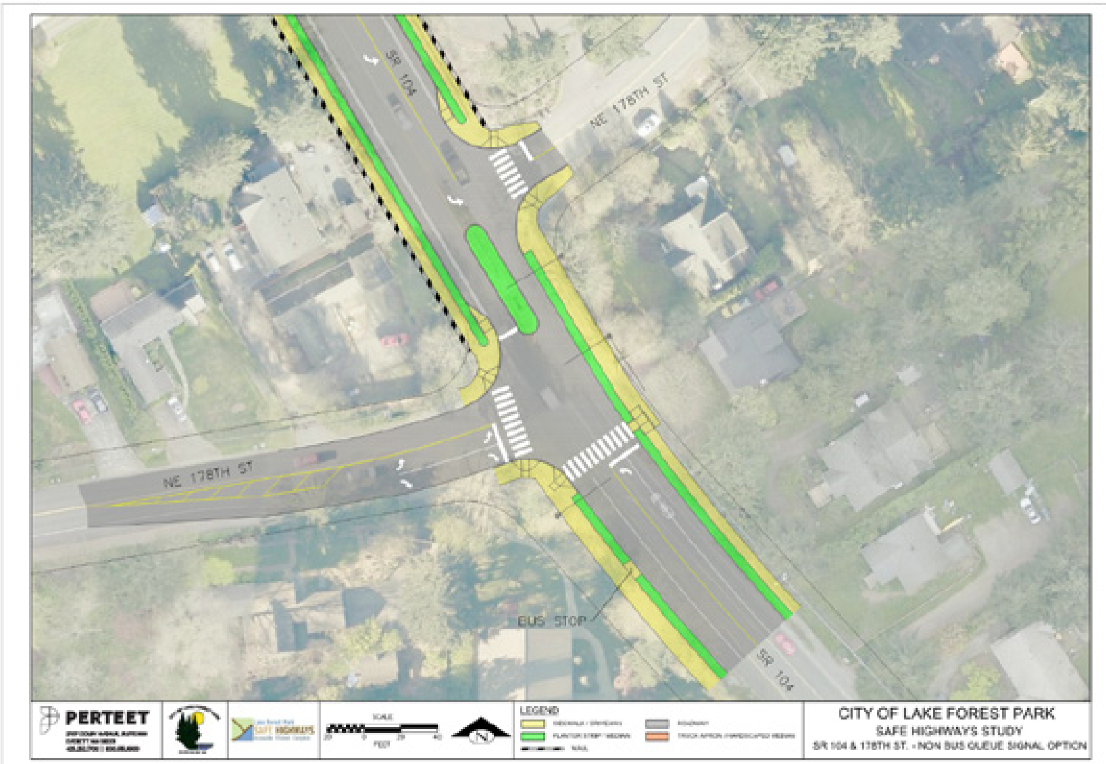
This option would turn the intersection into a signalized three-leg intersection and would reconfigure the East leg of NE 178th Street approach to be right-in/right-out only and stop controlled. This reduces the number of possible movements at the intersection and increases safety for vehicles turning in and out of the higher-volume west leg of NE 178th Street. This option would also create signalized pedestrian crossings where NE 178th Street (west leg) intersects with SR 104.

Signalizing the eastbound approach of NE 178th Street provides for protected left-turn movements and improves the safety for turning vehicles. Restricting the westbound leg to right-in/right-out access will reduce angle type collisions by removing the southbound left-turn movement from SR 104. The restricted access requires vehicles to detour southbound on SR 104 to NE 175th Street as either left-turns or U-turns. Alternative routes connecting to the neighborhood to the east of the intersection are limited.

Signalized Alternative 2: Southbound Left Turn Access Permitted Option

The second signalized alternative considered is shown in **Figure 15**.

Figure 15. Signalized Alternative 2



This option signalizes the west leg of NE 178th Street and retains left-in access to the east leg.

This is similar to the previous signalized option, but would retain left-in access from southbound SR 104 to the east leg of NE 178th Street, providing that movement with a signal phase. Retaining walls would be required on the east and west sides, north of the signalized intersection to minimize right-of-way impacts this alternative has the similar advantages to the previous signalized alternative, but with slightly better operations, due to green time given to the southbound left-turn.

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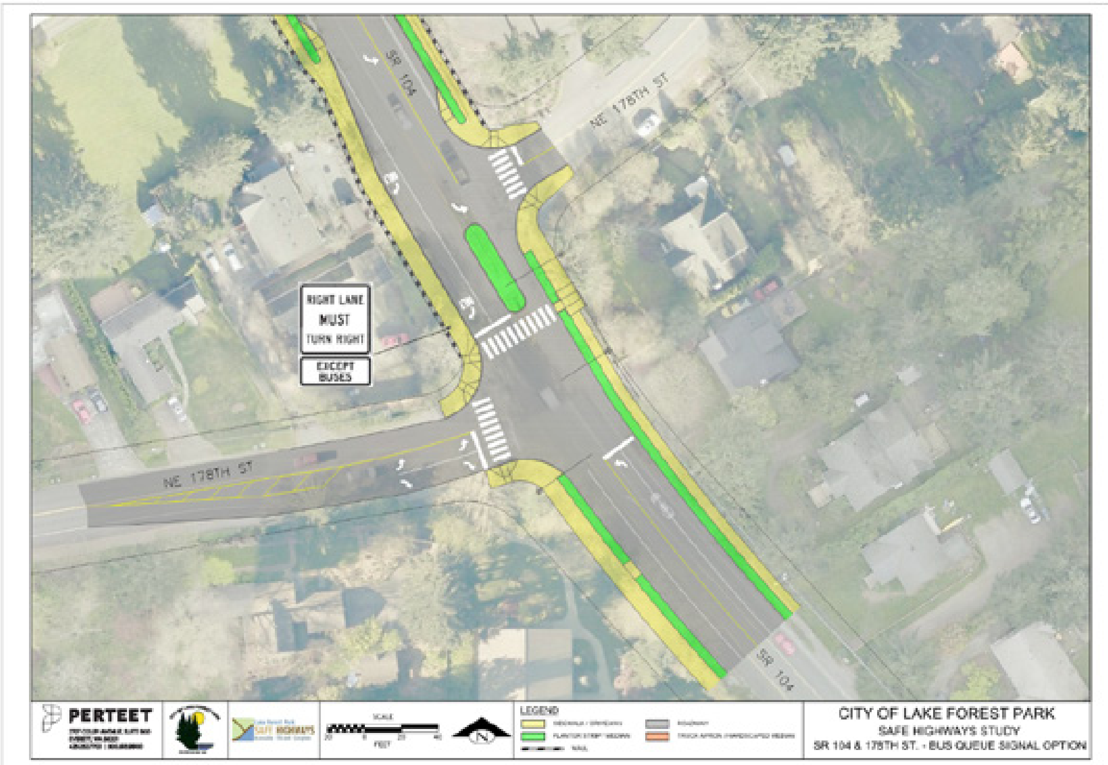
Signalized Alternative 3: Bus Queue Jump Option

The final signalized alternative considered is shown in **Figure 16**.

Figure 16. Signalized Alternative 3



This option signalizes the west leg of NE 178th Street, retains left-in access to the east leg, and provides a southbound right-turn lane that can also serve as transit queue jump.

This option is similar to the previous signalized alternative, but adds a southbound right-turn lane that can also be used as a queue jump for southbound buses. This would allow buses to avoid the queue created by the signal, and access the planned stop south of the intersection.

Relative to what's on the ground today, operations would be slightly improved due to the addition of a southbound right-turn lane. However, there is not a high demand for southbound right-turn movements so the improvement is fairly small.

This option also considered moving the pedestrian crossing to the north leg of the intersection, resulting in a more central pedestrian crossing. However, the pedestrian crossing movement would then conflict with the eastbound left-turn movement, further reducing the operations of the signal.

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Traffic Operations Analysis

A summary of the operational analysis is shown in **Table 4**.

Table 4. Operations Analyses of the Existing Intersection and Alternatives Considered for SR 104 & NE 178 Street

	AM Peak Hour		PM Peak Hour	
	LOS	*Delay (s)*	*LOS*	*Delay (s)*
Existing (No-Build)	E	49	F	>100
Future 2036 Operations				
No-Build	F	>100	F	>100
Roundabout Alternative	F	98	F	53
Signalized Alternative 1	E	71	C	30
Signalized Alternative 2	E	61	C	32
Signalized Alternative 3	E	79	C	30

A single lane roundabout was considered for this analysis. While the roundabout did show some improvement over the future no-build conditions, it did not meet LOS standards. A multilane roundabout was also considered but still operated at LOS F in the morning peak hour due to the conflict of the southbound traffic on SR 104 and the high eastbound right-turn volume.

The second signalized alternative had the best operational performance. For this alternative, the pedestrian movements are able to cross at the same time as the eastbound left-turn phase.

Queuing was also considered to evaluate the need to a shared right-turn and transit lane southbound. Queues from the signal at SR 104 and SR 522 are expected to spill back to the intersection of NE 178th Street during the AM peak hour. Southbound queues at NE 178th Street are minimal. Therefore, the bus lane would not by-pass many vehicles and the bus would likely get caught in downstream queues from SR 522, limiting the benefit it would provide.

Recommendation

- The Project Team recommends **Signalized Alternative 2**.
- This option **maintains southbound left-turn access from SR 104** to the east leg of NE 178th Street, which is a highly valued connection by the community.
- The Project Team **did not see a high value in providing the southbound right turn/queue jump** given its lack of operational benefits and high costs.

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- Due to the size of roundabout required to function in this location, the associated impacts to the adjacent properties, and the poor operational performance, a **roundabout is not recommended** for this location.

SR 522

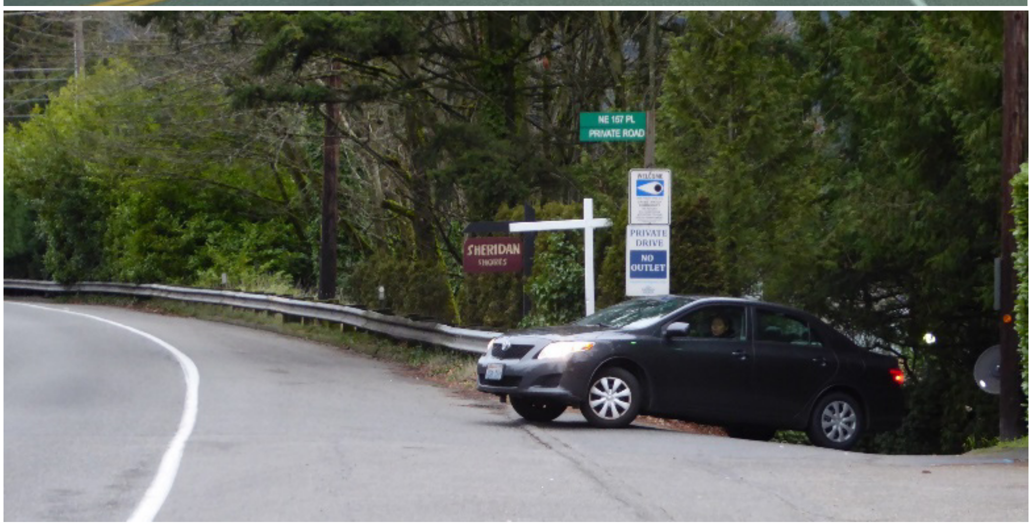
SR 522 Cross-section

State Route 522 is a major artery connecting Seattle with the Eastside with more than 50,000 weekday trips through Lake Forest Park. Carrying approximately 20 percent of all cross-lake trips, it is fittingly labeled as a “highway of statewide significance.” It is also identified as a freight corridor connecting US 2 with I-5. It is this heavy usage of SR 522 that makes it an appealing location for BRT: it goes where people want to go. At the same time, SR 522 serves as a main travel route for Lake Forest Park residents, but it bisects the community, separating most residents from amenities along Lake Washington and the Burke-Gilman Trail.

Existing Conditions, Opportunities & Challenges

- **Along a large portion of the corridor are single-family homes with driveway access only on SR 522.** Weekly garbage collection occurs on the shoulder of SR 522 for residents along the east side of the corridor. In some areas residents park vehicles on the gravel roadway shoulder. Widening to add BAT lanes could impact access to these homes. More dense multi-family housing and retail/services are at the south end of the corridor south of NE 153rd Street.
- **Frequent and express King County Metro and Sound Transit routes serve this corridor.** The BAT lane is complete southbound through the corridor, however a northbound BAT lane is not present between just north of NE 145th Street to just south of the Town Center. Portions of this section have a two-way center left turn lane that could be reallocated to make space for the northbound BAT lane.
- **Topography poses challenges.** The roadway is cut into the hillside so the west side homes are generally at a higher elevation than SR 522. On the east side, the grade drops towards the water.
- **Major sidewalk gaps.** No sidewalks exist north of 38th Avenue NE to just south of the Town Center (except for short segments near transit stops), making it unsafe for people to walk along SR 522 through this length. People can walk and bike on the Burke-Gilman trail parallel to the corridor, but access is limited because of steep slopes towards the water and limited signalized crossings.
- **The corridor is congested during peak hours.** Vehicles frequently queue southbound in the AM peak period and northbound in the PM peak period. Transit vehicles stopping in-lane just south of NE 145th Street block the southbound through lane, causing queue spillback and potential signal failures.

- **Overhead utilities are located close to the side of the roadway**. Downed trees due to wind can disrupt power lines and service.



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Alternatives Considered

Three alternative cross-sections were developed to meet the guiding principles listed earlier in this document. All of these cross-sections anticipate completion of the BAT lanes in both directions, provision of sidewalks on both sides of SR 522, and enhanced access control. These cross-sections vary in terms of their treatment in the center of SR 522 – either a median or center turn lane. The concepts are described below and shown in **Figure 17**.

- **Concept 1:** Complete sidewalks, BAT lanes, turn lane
- **Concept 2:** Complete sidewalks, BAT lanes, wider median
- **Concept 3:** Complete sidewalks, BAT lanes, narrower median

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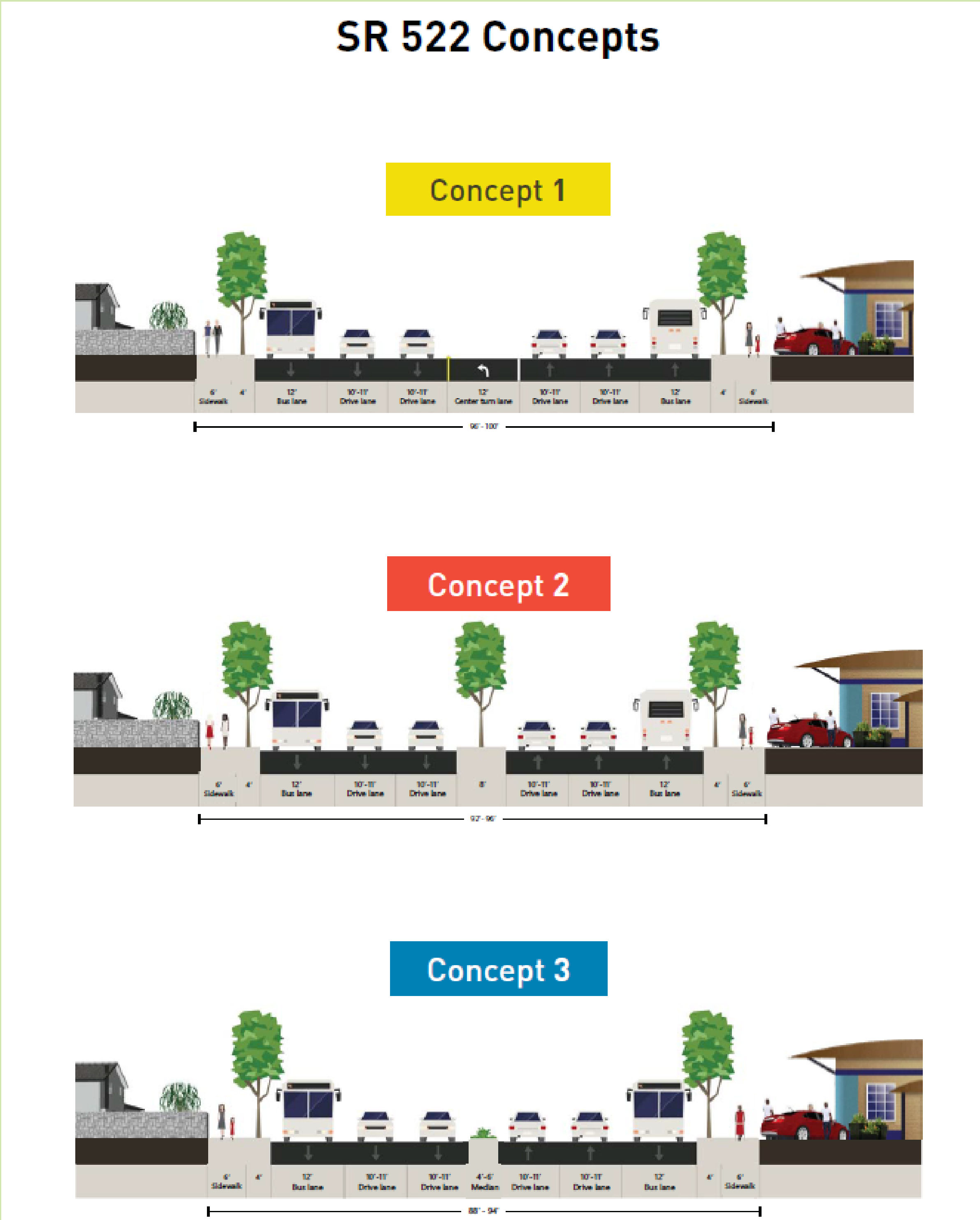
Figure 17. Concepts Considered



Three cross-section concepts for SR 522.

High-Level Feedback

The Project Team received extensive feedback on the proposed SR 522 cross-sections, which is summarized in the **Appendix D**. Unlike SR 104, where there was a fair amount of community consensus for the Buffered Bike Lane Alternative, there is no community consensus on the appropriate cross-section treatments for SR 522. Notably, the need for sidewalks and the removal of two-way left turn lanes spurred passionate community debate.

One group that has been particularly vocal in its viewpoints about appropriate treatments for SR 522 has been the Sheridan Beach Community Club (SBCC). The Club is comprised of residents of the Sheridan Beach and Sheridan Heights neighborhoods, which are adjacent to SR 522 through a portion of the study area. The following items were repeated by members at both the community meetings and submitted online to the project website:

- Minimize impacts to private property, including considerations like access and noise
- Maintain as much greenery as possible – walls and more urban treatments are not the character of Lake Forest Park
- Do not include sidewalks on both sides of the street. Between 39th Avenue NE and Lake Forest Park Animal Hospital (approximately 41st Avenue NE), want sidewalk on the eastside of SR 522 only
- Maintain two-way-left-turn lane access wherever possible
- Consider noise levels/sound mitigation where appropriate
- Reduce speed limit on SR 522 to 35 MPH

One criticism of this effort was that it did not include a full survey to better understand existing right-of-way lines and noise analysis to identify noise impacts along SR 522. To this end, the Club has requested that Sound Transit perform a full survey and noise analysis early in its study.

Recommendation

The recommended cross-sections for SR 522 were developed through an iterative process that included incorporating feedback from members of the community, TAC, City staff, as well as professional input from the Project Team. The Project Team recommends cross-sections along SR 522, as depicted in **Figure 18**.

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Figure 18. Recommended SR 522 Cross-section Plan

There are other components of the Project Team's SR 522 recommendations that are worth noting here:

- **New Signals:** The recommended cross-section plan (**Figure 17**) shows two new signals along the corridor at NE 149th Street and 39th Avenue NE. These signals are proposed to provide safe pedestrian crossings, neighborhood access (including U-turns), and help manage platoons of traffic, as they are assumed to be enabled with intelligent transportation systems capabilities. The Project Team modeled these signal locations and found they did not have a detrimental impact on overall traffic operations, while greatly assisting neighborhood access and making SR 522 less of a barrier for the community.
- **47th Avenue NE Closure:** The Project Team recommends that Sound Transit take a closer look at the need for direct access from 47th Avenue NE onto SR 522. Many community members have identified this location as hazardous from a sight distance perspective. With the re-design of SR 522, this access point should be re-evaluated from a safety and access perspective.
- **Community Character**: One of the guiding principles for the SR 522 corridor was to "Create a corridor identity/character and enhance the natural environment." The selection of treatments along SR 522 should consider this principle, including the placement of public art, the design and placement of walls, materials selected, and introduction of trees and other natural elements such as "living walls" into the corridor.
- **Speed Reduction:** One item that has near consensus from the Lake Forest Park community is the desire to reduce speeds to 35 MPH along SR 522. While this corridor is a state route, it functions more as a City arterial. The introduction of BRT and Rapid Ride are expected to draw more pedestrian traffic to the corridor, as well as vulnerable users. Speed reduction has documented safety benefits. It also reduces road noise, another key interest of Lake Forest Park residents who live nearby the corridor.
- **Noise Abatement:** Until noise analysis is performed, it is unclear the extent to which BRT improvements on SR 522 will lead to noise impacts. Community input indicated a heightened awareness of road noise and the desire for full mitigation of any noise impacts. Methods discussed with the community include sound walls, use of quiet pavements, increased greenery,

and speed reduction. Sound Transit should consider these approaches, as well as others, in treating any noise impacts related to the BRT project.

- **Community Safety:** As the SR 522 corridor is modified to accommodate regional BRT, key features of the roadway, including lane widths, driveway intersections, shoulder, and retaining walls will be updated. With these changes, the City supports the inclusion of additional safety features, including walls and/or barriers, if needed to protect adjacent households.
- **Full Survey**: Many of the concerns raised by the Sheridan Beach Community Club would be addressed by performing a thorough survey of the SR 522 corridor to accurately identify right-of-way lines. The Project Team supports the recommendation to perform that survey early in Sound Transit's process.

SR 522 & 145th Street Intersection

The intersection of SR 522 and 145th Street is an important pinch point that significantly impacts the function of the overall corridor, and has specific relevance to future function of planned BRT. As an intersection that straddles the jurisdiction of several agencies, including WSDOT, Seattle, Shoreline, King County, and Lake Forest Park, any solutions proposed will likely need to receive approval from a variety of agencies. It is recommended that Lake Forest Park be active in regional forums and in direct communications to promote the preferred intersection configuration.

Existing Conditions, Opportunities & Challenges

As the intersection of two busy state routes (SR 522 and SR 523) at the gateway of Seattle's Lake City, Shoreline, and Lake Forest Park, this intersection experiences high vehicle demands during much of the day. The intersection serves as an important connection to I-5 for much of the North Shore, and will also be an important route to Shoreline's light rail station, when service begins in 2023.

The intersection will also serve as a transfer point for transit services including the Sound Transit BRT (east-west on 145th Street to north-south on SR 522) and King County Metro Rapid Ride (north-south on SR 522). There is severe congestion that occurs during both commute periods. During the PM peak hour the intersection operates at LOS E, and is expected to worsen in the future absent future capacity improvements.

Many of the concerns voiced by the community regarding this intersection centered around the function of the downstream in-lane bus stop. Currently, the bus is able to jump the southbound queue from SR 522 at NE 145th Street, cuts in front of the traffic, and then stops in-lane blocking southbound traffic just south of the intersection. Concerns indicated that there was no way to get around the bus, and several community members told of close calls with rear-ends and or side swipe type crashes as vehicles try to merge around the stopped bus.

Addressing this intersection is challenging for multiple reasons including:

- Limited right-of-way and building set-back.
- High left-turn demand to and from the west leg of NE 145th Street.

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- Capacity constraints south of 145th Street where the roadway becomes Lake City Way.

As described earlier in this document, the City of Shoreline led a multimodal corridor study of 145th Street in preparation for light rail service that will be accessible from a station nearby 145th Street & 5th Avenue by 2023. The 145th Street study considered future improvements for pedestrian, bicycle, and transit connections along the corridor and proposed widening 145th Street at the SR 522 signal to increase capacity and improve signal timing. Specifically, these improvements included widening the westbound leg to allow for dedicated dual left-turn lanes, which allows for more efficient signal phasing.

Alternatives Considered

A guiding principle for the SR 522 corridor is to "Be a leader in identifying innovative solutions, particularly at the Bothell Way/145th Street intersection." As such, the Project Team evaluated further improvements to this intersection beyond those proposed in the 145th Multimodal Study. All three of the alternatives assume the widening of the west leg (145th Street) and signal rephrasing proposed by Shoreline. In addition, these improvements look to address the specific bus/car conflicts identified by the community. All three alternatives described below were developed in conjunction with King County Metro to improve bus service, the pedestrian experience, and vehicle safety and operations around the stops.

Stop Configuration Alternative 1: Shift Stops South

The first option is shown in **Figure 19**.

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Figure 19. Option 1, NE 145th Intersection

This alternative shifts the southbound bus stop on Lake City Way further away from the 145th Street intersection.

This option retains a stop location on the south leg of the intersection, but shifts it further south, so that vehicles would have more warning that the bus is stopping, and have more opportunities to move around the bus when stopped.

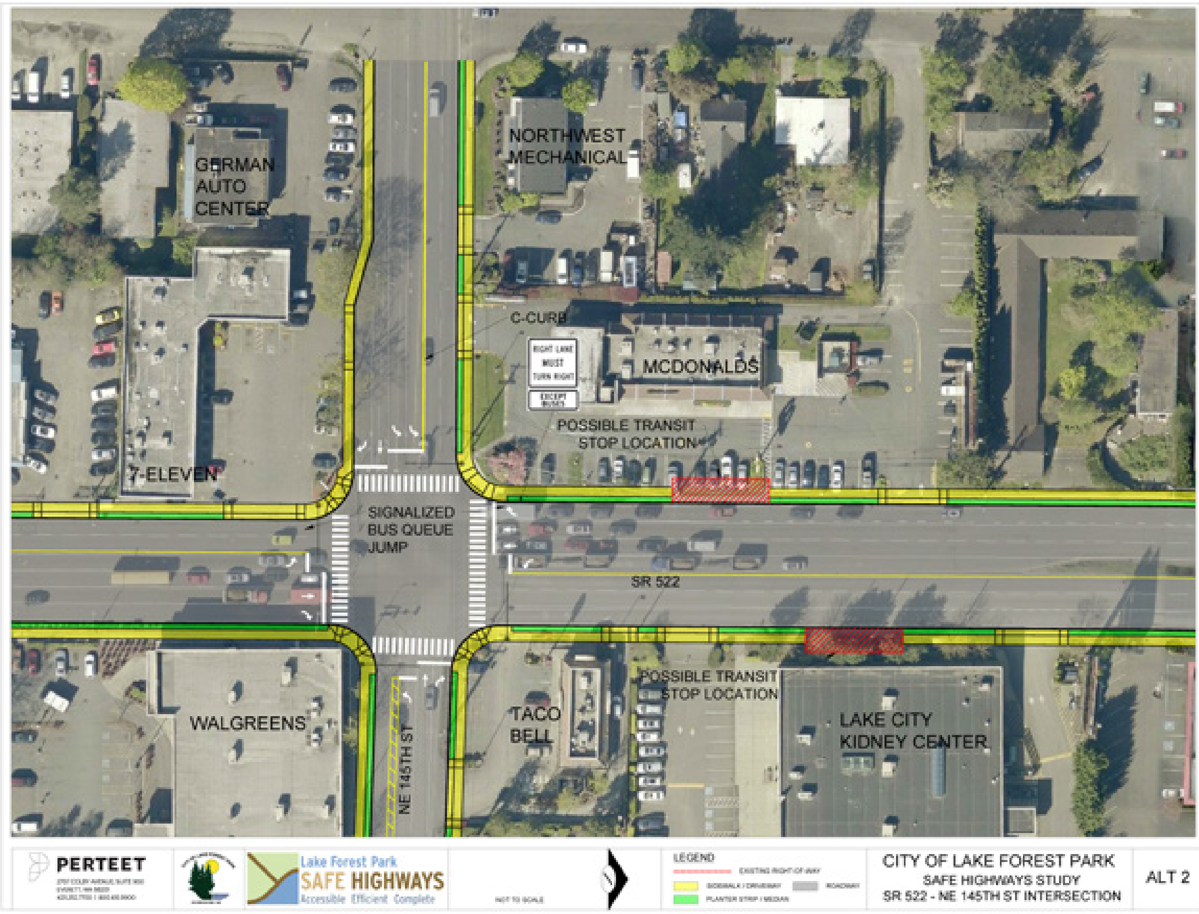
One downside of this configuration is that it does not provide a co-located stop for the Sound Transit BRT, which turns right at NE 145th Street. Pedestrian connections transferring between routes would require crossing an arterial to make a connection.

There are also limited locations for the stop to be located south of its existing location. Due to existing driveway access and lack of building setbacks there would likely be additional property acquisition required to relocate the stop. Moreover, the City of Seattle has raised the concern that moving the bus stop south may lead to jay walking by pedestrians who do not want to travel out of direction between their bus stop and their destination.

Stop Configuration Alternative 2: Relocate Stop to BAT Lane North of NE 145th Street

This stop configuration is shown in **Figure 20**.

Figure 20. Stop Configuration Alternative 2



This option moves the southbound bus stop to the nearside of 145th Street, which could serve both southbound King County Metro routes and westbound BRT services.

This stop configuration allows the bus to stop in a BAT lane north of 145th Street, without impacting downstream through traffic. Both King County Metro Rapid Ride and Sound Transit lines could use this stop, removing the need for pedestrians to cross NE 145th Street for transfers. A transit queue jump would be installed as part of this improvement to allow the bus to shift into the through lane southbound in advance of general-purpose traffic.

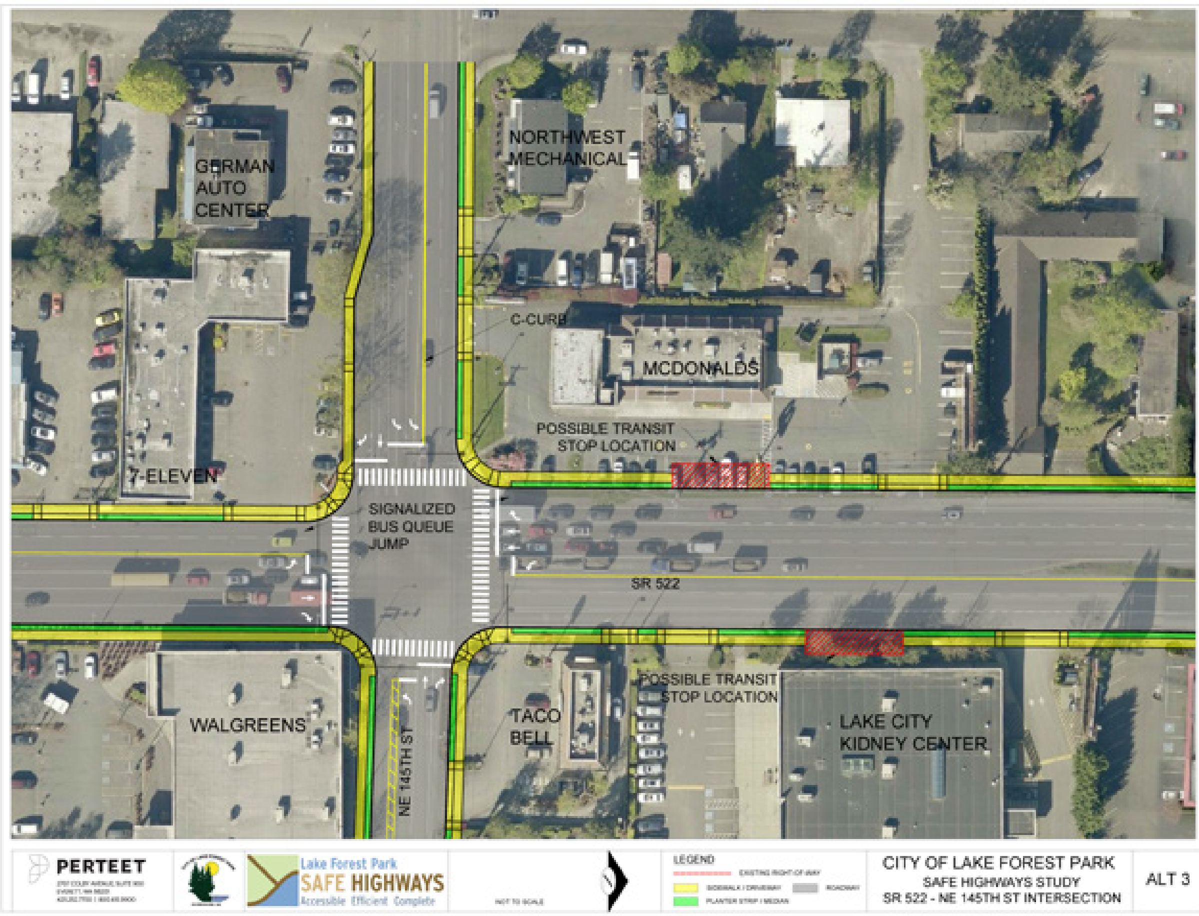
The configuration would have some impacts to the property northwest of the intersection (currently home to McDonalds), but these would be limited to areas adjacent to the stop to allow for the Rapid Ride fare payment hardware and shelter to be installed.

The southbound right-turn is a high demand movement at this intersection. Locating the bus stop north of the intersection increases the southbound queue due to right-turning vehicles not being able to access the right-turn lane upstream of the bus stop. Additionally, the bus would stop within the right-turn lane, blocking right-turn on red and right-turn overlap movements. These conflicts could potentially add southbound delays.

Stop Configuration Alternative 3: Adding a Southbound Transit Lane

This stop configuration is shown in **Figure 21**.

Figure 21. Stop Configuration Alternative 3



This option widens the north leg of the intersection to provide a transit lane that is separate from the right-turn lane.

This configuration also moves the transit stop north of the NE 145th Street intersection, but adds a transit only lane southbound. Both King County Rapid Ride and Sound Transit BRT could use the proposed stop, allowing for easy transfers. The additional lane southbound would increase the crossing length for pedestrians crossing the north leg of SR 522.

Since the buses would have their own lane, the southbound right-turn lane would not be blocked by the proposed stop location. A separate bus phase would be needed to manage southbound through and right-turning buses. As such, southbound right-turn on red movement would be prohibited, as buses would be approaching from the right as drivers are looking to the left for conflicting traffic. The separate bus phase would allow the bus to avoid the southbound queues for both through movements and right-turn movements, while not blocking right-turning movements. While this is a fairly unusual configuration that needs to be further studied prior to implementation, a similar set up exists at the intersection of Spring Street and 6th Avenue in Seattle. The Project Team modeled intersection operations for all three concepts and found this option to provide the lowest delay for all users of the intersection.

Significant property impacts are expected due to the space required to build an additional lane. The impacts would most likely affect the parking on the McDonalds property northwest of the intersection.

Recommendation

- The Project Team recommends **Stop Configuration 3**.
- This configuration provides the **best overall intersections operations**, as it results in the shortest southbound queue, since it does not block downstream through movements or southbound right-turn movements.
- This configuration also offers the ability to collocate the BRT station with King County Metro services, which provides the **best pedestrian environment and supports transit transfers**.
- However, it should be noted that this is by far the **most expensive option**, as it has significant property impacts.
- The **placement of the transit-only lane outside of the right-turn lane is unusual**, but not unprecedented in the region. Adequate signage and traffic control would be necessary to ensure driver understanding of how the how the intersection functions.
- Given the importance of this intersection to the overall function of the corridor, the Project Team believes that the **operational benefits offered by this option warrant the additional cost** and challenges related to intersection configuration. Input received at the open houses and online also indicated that this is the community-preferred option.

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Non-Motorized Access to Transit

The purpose of this section is to increase mobility options for the local community and make it easier to walk and bike to transit stops on SR 522. These improvements are identified to enhance and support local ridership on the planned Sound Transit BRT.

Existing Conditions, Opportunities & Challenges

Observations of the existing conditions include:

- **Challenging topography.** Steep grade changes exist from the north side of SR 522 to the south side of SR 522 near the water and the Burke-Gilman Trail. This makes it difficult to bike and walk to/from transit on SR 522.
- **City streets provide indirect routes.** Curving local roads with unconnected street ends can require lengthy, circuitous routes to access SR 522. There is a potential to formalize existing footpaths or explore new street connections.
- **Limited crossing locations.** Signalized crossings of SR 522 are limited to five locations: SR 104, NE 170th Street, NE 165th Street, NE 153rd Street, and NE 145th Street. There are large sections where no crossings are feasible, and almost the entire corridor north of NE 38th Avenue NE to the Town Center have no sidewalks.
- **Town Center.** A plan to redevelop the Town Center is underway. This plan can help inform and implement improvements near the Town Center, where the highest transit ridership Citywide exists.

Alternatives Considered

Numerous non-motorized project ideas were considered throughout this process, stemming from conversations held during the Safe Streets process, interviews with stakeholders, ongoing discussions with City Staff, input heard at the three Safe Highways open houses, comments submitted through the project website and via email, and professional judgement and connectivity analysis (see **Appendix G**). This report focuses on non-motorized projects that would make it safer and easier to walk or bike to bus stops along SR 522, whereas the Safe Streets effort had a broader focus on non-motorized projects Citywide.

The project team brought 12 initial project ideas to the Lake Forest Park community at the November 14, 2017 Open House on SR 522. Nine new project ideas emerged from this meeting, which were then brought back to the community at the December 4, 2017 Open House. The project ideas outlined below (and included in **Figure 22**) represent the compilation and synthesis of the input received on non-motorized access to transit in Lake Forest Park.

Please note that additional engineering study is needed prior to design and construction of any of the projects listed in this plan.

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Figure 22. Non-Motorized Project Map

Non-Motorized Access to Transit Projects considered in the Safe Highways Study.

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Project 1a. Multi-Use Path on SR 104

This project would add a physically separated multi-use path, like the Burke-Gilman Trail, on SR 104 from NE 178th Street to SR 522 to provide an all ages and abilities facility for bicyclists, pedestrians, skaters, wheelchair users, and joggers that is separate from vehicle traffic. This report also recommends signalizing the NE 178th Street & SR 104 intersection to provide a designated crossing for people walking and biking, as well as providing sidewalks and buffered bike lanes north of NE 178th Street, as discussed in the section on SR 104.

This project would serve as a key connection between the Burke-Gilman Trail and Interurban Trail, as well as from Lake Forest Park neighborhoods to transit stops on SR 522 and the Town Center.

An example of how a multi-use path could look on SR 104

Project 1b. 44th Avenue NE Pedestrian/Bicycle Route

Instead of the multi-use path along SR 104 proposed in Project 1a, this community-proposed project would create a route behind the Town Center for people walking and biking through a combination of sidewalks, bike lanes and/or sharrows. Improvements would be made on NE 178th Street, 44th Avenue NE, Brookside Boulevard, and NE 170th Street. This would encourage crossing SR 522 at Starbucks instead of the intersection at SR 104. It is important to note that between 2012 and 2017, there were two collisions between a motor vehicle and cyclist at the intersection of 44th Avenue NE and NE 178th Street – both of which involved the motorist turning left onto 44th Avenue NE from NE 178th Street. This should be carefully considered if the City moves forward with designing this project.

Existing conditions on 44th Avenue NE
Sources: Google Maps 2017; threepullpa.com

Sidewalk with landscape buffer and bike lane

Example of a sharrow

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Project 2. Town Center Pedestrian Connections

This project would provide a designated pedestrian path into the Town Center from the NE 170th Street bus stop in front of Starbucks. The exact route is to be determined, but it would follow desired pedestrian routes. This project would require coordination with the Lake Forest Park Central Subarea Plan process and Merlone Geier, the Town Center Owner.

Examples of pedestrian path in parking lot and wayfinding
Sources: Cyburbia.org user Dan; Oran Viriyincy Flickr; Google Maps 2017

Existing conditions at bus stop

Project 3a. SR 522 / SR 104 At-grade Crossing Improvements

As a near term project, modify the existing crosswalks at the SR 104/SR 522 intersection to improve the crossing experience for people walking and biking to/from bus stops, the Town Center, and the Burke-Gilman Trail. Treatments could include enhanced crosswalk striping, signal phasing, and widening the curb ramp and sidewalk on the island to better accommodate people walking and biking. The City should explore opportunities to shorten the crossing distance by potentially narrowing the general purpose travel lanes to 10-11 feet.

Existing conditions at the intersection of SR 522 and SR 104.
Source: Google Earth 2017

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Project 3b. Pedestrian/Bicycle Bridge at the Town Center

As a long term project, pursue funding to build a pedestrian and bicycle bridge over SR 522 that connects the Town Center to the Burke-Gilman Trail and bus stop on the east side of SR 522. At a larger scale, this project will also provide better connections to the neighborhoods and the Interurban Trail. This project would require coordination with the Central Subarea Plan process and WSDOT.

Example of a pedestrian/bicycle bridge in Shoreline.
Source: Otak

Project 4. SR 522 / NE 170th Street Crossing

Improve the existing crossing of SR 522 at NE 170th Street. This crossing serves one of the most frequently used bus stops in the City. Improvements could include:

- Enhanced crosswalk striping
- Add sidewalk and curbs to the gas station corner, providing an expanded waiting area for people on foot and bike
- Improved signal phasing
- To further reduce conflicts people walking across SR 522 and left turning vehicles, consider modifying the signal to add a protected eastbound left turn from the driveway adjacent to Starbucks to northbound SR 522

Further recommendations for improving walking and biking conditions on NE 170th Street are described below.

Existing conditions at the intersection of SR 522 and NE 170th St.
Source: Google Earth 2017

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Project 5. Brookside Elementary Safe Routes to School

Add a sidewalk on 37th Avenue NE from just south of NE 178th Street, where the existing sidewalk ends, to NE 165th Street. Given this project's proximity to Brookside Elementary, it is preferable to include a landscaped buffer to provide additional pedestrian safety. This project will provide a grade separated, contiguous route between the bus stops on SR 522 at NE 165th Street, Brookside Elementary, and Pfingst Animal Acres Park, making it easier and safer for people of all ages to walk to public transit. (This is Project #1 in the Safe Streets report.)

Existing conditions on 37th Avenue NE

Sidewalk with landscaping buffer.
Source: threepullpa.com

Project 6. 37th Avenue NE Traffic Calming

Incorporate traffic calming measures on 37th Avenue NE between NE 178th Street and NE 156th Street, as well around the corner onto NE 156th Street. Specific treatments have not been selected, but can include traffic circles, chicanes, a raised intersection at NE 165th Street, speed humps, or other proven traffic calming measures after further engineering evaluation.

37th Avenue NE is designated as a bike route between the Interurban Trail and Burke-Gilman Trail, and traffic calming would help make this route more accommodating to cyclists of all ages and abilities and people walking to bus stops. This project could also remove parking on one side of the street to help minimize conflicts and provide space for traffic calming improvements. (This is Project #6 in the Safe Streets report.)

Existing conditions on 37th Avenue NE during morning/evening commutes

Example of a traffic circle. Source: Re:Streets

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Project 7. Briarcrest Safe Routes to School Sidewalks

Provide the following improvements to create safer routes to schools for Briarcrest Elementary, Kellogg Middle School, and Shorecrest High School. These improvements designate walking areas along routes that have historically seen conflicts between modes. Coupled with traffic calming, they make it easier and safer for people of all ages to walk or bike to public transit. (This is part of Project #4 in the Safe Streets report.)

- A sidewalk in the following locations:
  - 35th Avenue NE (NE 162nd Street to NE 160th Street)
  - NE 162nd Street (35th Avenue NE to 37th Avenue NE)
  - NE 156th Street/37th Avenue NE (35th Avenue NE to NE 157th Street)
- Traffic calming measures, such as chicanes/bulb outs, speed humps, or traffic circles on 35th Avenue NE and NE 162nd Street

Sidewalk with landscaping buffer.
Source: threepullpa.com

Bulb outs and speed humps.
Source: Payton Chang

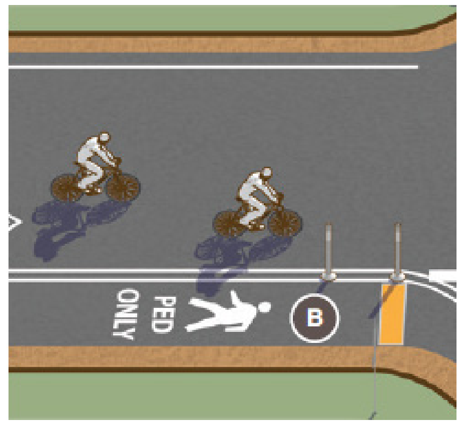
Project 8. Briarcrest Safe Routes to School Walking Paths

Provide the following improvements to create safer routes to school for Briarcrest Elementary, Kellogg Middle School, and Shorecrest High School.

- A painted pedestrian walking area in the following locations:
  - NE 160th Street (Potential for an upgrade as Phase 2)
  - 35th Avenue NE (NE 160th Street to NE 156th Street)
  - "Walking Wednesday" Routes
    - NE 163rd Street
    - 30th Avenue NE
    - NE 155th Street/NE 156th Street to 35th Avenue NE
- Traffic calming measures, such as chicanes, speed humps, or traffic circles along NE 160th Street

This project requires collaboration with the City of Shoreline, who would be responsible for completing walkways that link to Lake Forest Park school property. The City may also consider lowering the speed limit on NE 160th Street and potentially other streets. (This is part of Project #4 in the Safe Streets report.)

Existing conditions on Walking Wednesday route



Painted pedestrian walking area.
Source: FHWA, Small Town and Rural Multimodal Networks

Project 9. NE 155th Street Trail Connection

Formalize the existing, informal pedestrian/bicycle trail that connects 35th Avenue NE and NE 155th Street and add lighting for safety. While the existing dirt path is accessible for some people, others such as those in wheelchairs cannot easily navigate it. This project provides more direct pedestrian/bicycle connections to bus stops along SR 522.

Existing informal trail looking west to 35th Avenue

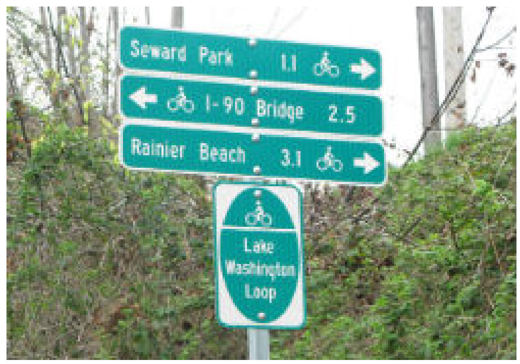
Existing informal trail looking east to the intersection of NE 155th/SR 522

Project 10. Burke-Gilman Trail Wayfinding

Add wayfinding signage along the Burke-Gilman Trail and at SR 522 BRT stops that provides information on the best route to access transit stops, the Town Center, Burke-Gilman Trail, and Interurban Trail.

This project will help ensure people walking and biking know the safest and most direct route to or from transit.

Currently, there is no signage to identify which trail access point and route is the fastest, has the fewest hills, or is safest for children. Likewise, if you arrive by transit to the Town Center, it is not clear how to best access the Burke-Gilman Trail.



Example wayfinding signage.
Sources: LADOT; SDOT

Project 11. Hamlin Road Sidewalks

Upgrade the existing walking path with extruded curb to a wider, full sidewalk with landscaping buffer on Hamlin Road (Brookside Boulevard to 37th Avenue NE). Additionally, clear sight distance obstructions (e.g. vegetation) at the intersection of Hamlin Road and 37th Avenue NE to make people walking more visible to motor vehicles.

Existing extruded curb on Hamlin Road.
Source: Google Maps 2017

Sidewalk with landscaping buffer.
Source: washingtoncountyinsider

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Project 12. 41st Avenue NE Trail Connection

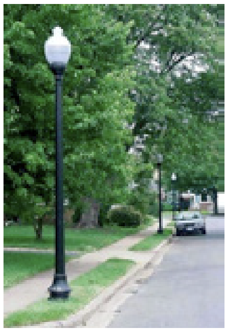
Pave the existing, informal, dirt pedestrian/bicycle trail that connects 41st Avenue NE to the Burke Gilman Trail, enabling people to walk on the Burke Gilman Trail to access the Town Center.

Existing informal trail looking toward the Burke Gilman Trail.
Source: Google Maps 2017

Project 13. 39th Avenue NE Pedestrian Improvements

Add sidewalks and lighting on 39th Avenue NE east of NE 165th Street, as well as on the walking path near the Veterinary clinic that connects 39th Avenue NE to SR 522. This would be an alternative walking route to SR 522 for accessing the Town Center.

Existing conditions on 39th Ave NE.
Source: Google Maps 2017



Sidewalk and lighting example.
Source: avgreenteam.wordpress.com

Project 14. SR 522 Crossing Improvements at NE 165th Street

Improve the pedestrian crossing of SR 522 at NE 165th Street. There is some community support for a pedestrian bridge or underpass at this location. However, if an overpass or underpass is not possible, provide improvements at-grade. Potential at-grade improvements include high-visibility striping, signal timing revisions (e.g. five second pedestrian lead similar to the signal at NE 170th Street), and a wider painted area for people walking, as shown in the photo below.

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Existing conditions NE 165th St.
Source: Google Maps 2017

Example of wide crosswalk striping.
Source: FHWA

Project 15. Staircase Improvements

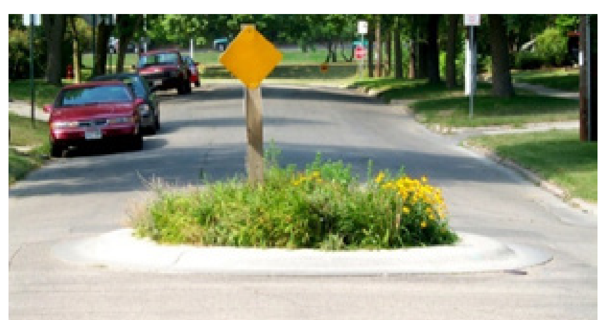
Provide maintenance and improved lighting at the existing staircases off SR 522 near the 39th Avenue NE southbound bus stop, and off NE 165th Street north of 39th Avenue NE. (It is important to note that these staircases run through private property, so this project is not fully in the City's control.)

Existing staircases off NE 165th St and SR 522 near 39th Ave.
Source: Google Maps 2017

Project 16. Southeast City Traffic Calming

Provide traffic calming to discourage cut through traffic on 35th Avenue NE/38th Avenue NE, NE 148th Street, 37th Avenue NE, and NE 153rd Street. Specific treatments have not been selected, but could include traffic circles, speed humps, or other proven traffic calming measures after further engineering evaluation.

Existing conditions at 37th Avenue NE & NE 150th Street
Source: Google Maps 2017



Example of a mountable traffic circle.
Source: City of Madison

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Project 17. NE 147th Street Sidewalks

Due to community concerns regarding cut through traffic and speeding on NE 147th Street, extend the sidewalk on NE 147th Street east of SR 522 to 37th Avenue NE. This area will likely see redevelopment given recent City upzoning, so there will be an increasing need for sidewalks on this corridor.

Existing conditions on 147th Street looking east.
Source: Google Maps 2017

Project 18. Shore Drive Safety Improvements

Several community members expressed concern about the blind corner at the intersection of Shore Drive NE and Beach Drive NE. There is a lack of clarity for drivers regarding who has the right of way – Shore Drive or Beach Drive. Moreover, cars parked north of this intersection on Beach Drive NE hinder visibility. This is a potential safety concern for people walking, biking, and driving in the area, including people who walk along these routes to access the bus stop at NE 165th Street.

This project would add a yield sign for motorists traveling southbound on Beach Drive NE, the minor street approach. Additionally, this project would prohibit parking adjacent to the Burke-Gilman trail just north of this intersection for 50-100 feet, using red curbs and/or “No Parking” signs. While parking is at a premium near the trail in the summer, these recommendations will help improve safety.

Existing conditions at the intersection of Shore Drive NE and Beach Drive NE.
Source: Google Maps 2017

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Project 19. New SR 522 Signalized Crossings

The SR 522 section of this report recommends adding new traffic signals on SR 522 at NE 149th Street and at 39th Avenue NE. These signals would include a pedestrian phase, marked crosswalks, and a pedestrian refuge island in the center of SR 522. Overall, these crossings will make SR 522 less of a barrier by reducing the distance people will have to walk to access a controlled crossing.

Pedestrian crossing button at a traffic signal, and a traffic signal example.

Project 20. Improve Street Connectivity Through New Street or Trail Connections (unmapped)

Explore opportunities to improve street connectivity between neighborhoods and the Town Center and transit stops. This can include looking at connecting existing street ends and exploring opportunities to create connectivity easements.

For example, several community members expressed a desire for a trail that connects the two street ends of 35th Avenue NE, one of which is west of Brookside Elementary School. This would also connect into 33rd Avenue NE. This connection would provide a more direct route to walk or bike to bus stops along SR 522. Currently, it takes up to 20 minutes to walk from 35th Avenue NE near Brookside to the bus stops at NE 165th Street. This connection would reduce the maximum walking time to 15 minutes. Travel time savings would be even greater with another connection to NE 165th Street.

Example of a trail connection.
Source: J Smith for Visit Philadelphia

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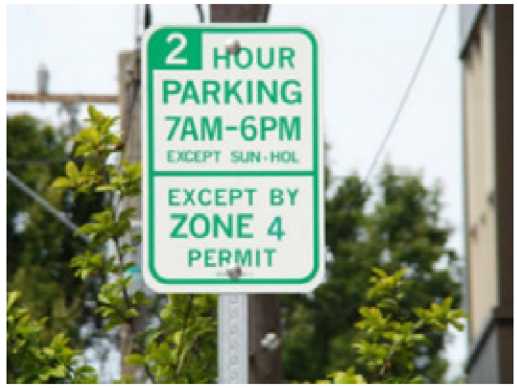
Project 21. Parking Monitoring Program (unmapped)

Implement an on-street parking monitoring program near BRT stops. This can include time-limited parking or Residential Permit Zone parking to discourage “hide-and-ride” behavior.



Residential Permit Zone in Seattle.
Source: Seattle Met

Additional Project Ideas Heard

A few additional ideas were mentioned through the public outreach process that are being explored as part of the Safe Streets effort looking at non-motorized access to the Town Center:

- Project 4 recommends improvements to the intersection of SR 522 & NE 170th Street. Numerous community members have expressed an interest in providing designated facilities for people walking and biking on NE 170th Street and on the street in front of the Fire Station.
- Countless members of the community have requested a sidewalk that connects the Lake Forest Park Animal Hospital to the Town Center, including a designated safe path from the animal hospital to Willows Park, since people currently walk through the Chevron parking lot and jaywalk across Hamlin Road NE to access the pedestrian bridge in the park.
- One community member shared that pedestrians are illegally crossing Beach Drive NE east of SR 104, and cars/bikes do not know to look for them, which is a safety hazard.
- Pedestrian safety improvements are needed at the intersection of 44th Avenue NE & Brookside Boulevard NE. It is a tough corner for pedestrians due to poor sightlines. Community input indicates that cleaning up the vegetation would help improve sightlines.
- Enforcement is needed at the intersection of the Burke-Gilman Trail and NE 165th Street. Cyclists do not stop, and this is a safety hazard.

High-level Feedback

While there was some level of community support for almost all the project ideas described above, some of the projects were more widely supported than others. This section describes the feedback received for these preferred projects at the final Open House on December 4, 2017.

Project 3b – an overpass over SR 522 at SR 104 – received widespread support from the community. Two individuals expressed that they did not support the bridge, as Project 3a is more cost effective, but the majority of participants preferred a bridge to at-grade crossing improvements. This intersection is not

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easy to navigate on foot or bike today, and with the future BRT service, improvements for active transportation users are critical.

Numerous participants also supported **Project 4** – crossing improvements at the intersection of SR 522 and NE 170th Street near Starbucks – as well as creating designated areas for people walking and biking on NE 170th Street. The recent signal timing revision that gives pedestrians a head start walking across SR 522 in advance of vehicle traffic was praised, but many found the intersection still difficult to navigate on foot and bike.

Throughout the Safe Streets and Safe Highways process, **Project 5** has by far received the most support among community members, which would add a sidewalk on 37th Avenue NE from just south of NE 178th Street to NE 165th Street. "This is the street where improvements for walking and biking are most needed," said one Open House participant. This is a key north-south spine in Lake Forest Park, and its proximity to Brookside Elementary and Animal Acres Park, coupled with motorists' tendency to speed downhill on 37th Avenue NE, make this corridor a prime candidate for a sidewalk.

The most controversial topic during the Safe Highways open houses was whether or not to build sidewalks on the west side of SR 522. Some Lake Forest Park residents were strongly opposed to sidewalks on this side, including members of the Sheridan Beach Community Club, while other community members strongly supported having sidewalks on both sides of SR 522. Many felt that **Project 13** was a preferable alternative, since it would provide a quieter, more enjoyable, parallel walking route to the Town Center along 39th Avenue NE. Therefore, Project 13 ranked highly through this process.

As an extension of Project 13, some residents would also like a new pedestrian path that connects from 39th Avenue NE to Hamlin Road NE to avoid having to walk on the section of SR 522 from the Lake Forest Park Animal Hospital to the Town Center that does not currently have sidewalks. Others were not supportive of this idea, as it would require cutting through private property. Despite these differences, there seems to be strong support among Lake Forest Park residents to build a sidewalk that connects the Lake Forest Park Animal Hospital to the Town Center, including a designated safe path from the animal hospital to Willows Park so people do not have to walk through the Chevron parking lot.

Project 14 – SR 522 Crossing Improvements at NE 165th Street – also received widespread support from the community. Many open house participants and nearby residents prefer a pedestrian bridge or underpass at this location to at-grade improvements. Some strongly favored a bridge; others strongly favored an underpass, noting that "an overpass at NE 165th Street would be unsightly." Underpasses can feel dangerous, but can work with good lighting and design. The planned pedestrian underpass in Kenmore was mentioned as a great example. However, if a bridge or underpass is not possible, participants would still like to see at-grade improvements to better connect the Sheridan Heights and Sheridan Beach neighborhoods, as well as provide safer access transit along SR 522.

Recommendation

This report recommends that the City work opportunistically to secure funding to plan, design, and construct as many of the projects highlighted in this section as possible. **Table 6** presents the Project Team's assessment of how each of these projects perform in meeting key objectives of this plan, with the highest performing projects included first. **Table 7** outlines a breakdown of each evaluation criteria.

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Table 5: Project Prioritization Results

Project #	Project Description	Broad Community Support	Positive Impact on Many Users	Location with History of Collisions	Feasible and Achievable	Encourages People to Walk or Bike	Costs Aligned with Budget Constraints	Total
1a	Multi-Use Path on SR 104	5	2	2	1	2	1	13
1b	44th Avenue NE Pedestrian/ Bicycle Route	5	2	2	2	1	1	13
3a	SR 522 / SR 104 At-grade Crossing Improvements	5	2	2	1	2	1	13
4	SR 522 / NE 170th Street Crossing	5	2	2	1	2	1	13
6	37th Avenue NE Traffic Calming	5	1	2	2	1	2	13
8	Briarcrest Safe Routes to School Walking Paths	5	1	2	2	1	1	12
10	Burke-Gilman Trail Wayfinding	5	2	0	2	1	2	12
14	SR 522 Crossing Improvements at NE 165th Street	5	2	1	1	2	1	12
3b	Pedestrian/Bicycle Bridge at the Town Center	5	2	2	0	2	0	11
5	Brookside Elementary Safe Routes to School	5	1	0	2	2	1	11
13	39th Ave NE Pedestrian Improvements	5	1	0	2	2	1	11
19	New SR 522 Signalized Crossings	5	2	0	2	1	1	11
7	Briarcrest Safe Routes to School Sidewalks	5	1	0	2	2	1	11
2	Town Center Pedestrian Connections	5	2	0	1	1	1	10
15	Staircase Improvements	5	1	0	0	2	2	10
18	Shore Drive Safety Improvements	5	1	0	2	0	2	10
21	Parking Monitoring Program	5	1	0	2	0	2	10
9	NE 155th Street Trail Connection	0	0	0	2	2	2	6
11	Hamlin Road Sidewalks	0	1	0	2	2	1	6
12	41st Ave NE Trail Connection	0	0	0	2	2	2	6
16	Southeast City Traffic Calming	0	1	0	2	1	2	6
17	NE 147th Street Sidewalks	0	1	0	2	1	1	5
20	New Street or Trail Connections	0	1	0	1	2	1	5

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Table 6: Project Prioritization Criteria

Multiple community members supported the project during Safe Highways and Safe Streets processes (i.e. something that came up over and over)	5= Yes
	0= No
Project will have a positive impact on many users	2= Impacts a high number of users
	1= Impacts a medium number of users
	0= Impacts a low number of users
Addresses location with a history of collisions	2= High collision location or includes serious bike/ped collisions
	1= History of bike/ped collisions (not serious)
	0= None of above
Project is feasible and achievable	2= Under City control and/or could easily be accomplished in 6 years
	1= May require some coordination and/or would take 7-20 years to accomplish
	0= Not in City's control and/or would take 20+ years to accomplish
Encourages people to walk or bike	2= Exclusive facility (e.g. buffered sidewalk, trail, separated bike lane, RRFB/enhanced crosswalk)
	1= Shared facility (e.g. sidewalk w/o buffer or one side, bike lane, sharrow, non-enhanced crosswalk, wayfinding, ADA improvements)
	0= Other
Project costs are aligned with City budget constraints	2= High (<$100k)
	1= Medium ($100k - $3M)
	0= Low (>$3M)
Total potential score:	**15**

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Additional Recommendations - Citywide

In addition to the numerous recommendations in this report, which are specific to SR 104, SR 522, or locations that are critical for providing non-motorized access to transit services, there are some key community goals that should be considered, which transcend specific geographies.

One of these community goals relates to community character and resilience. Undergrounding of utilities has long been a desire for Lake Forest Park. Overground utilities detract from the park-like atmosphere of the community and sometimes compete for space that could otherwise be used for walking or biking. Beyond these concerns, the number of trees in Lake Forest Park makes overground utilities impractical, as windstorms can take out power for entire neighborhoods multiple times in a season. As such, the City strongly urges that utility undergrounding be incorporated into any corridor construction projects, as this would be the most cost effective time to make this improvement that would benefit Lake Forest Park residents for generations.

The second important community value is being a responsible steward of the environment. With any of the improvements recommended in this report, it is expected that designs will consider their impact on the environment, including impacts on local creeks, storm water runoff, wildlife, and the reduction of trees. Lake Forest Park prides itself on its green ethos – the outcomes of the Safe Highway Study should be no exception.

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Jamas Gwilliam, *Merlone Geier Partners*
Tod McBryan, *Heffron Transportation*

City Staff

Pete Rose
Neil Jensen

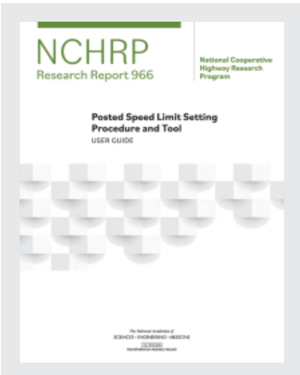
Consultant Team

Fehr & Peers
Kendra Breiland
Carmen Kwan
Chris Grgich
Sarah Saviskas

Perteet
Kurt Ahrensfeld
Amanda Ruksznis

3 Square Blocks
Marcia Wagoner
Rebecca Fornaby

Appendices



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Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, Texas A&M Transportation Institute and Michigan State University Tim Gates; National Cooperative Highway Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

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NCHRP RESEARCH REPORT 966

Posted Speed Limit Setting Procedure and Tool

USER GUIDE

Kay Fitzpatrick
Subasish Das
Michael P. Pratt
Karen Dixon
Texas A&M Transportation Institute
College Station, TX

Tim Gates
Michigan State University
East Lansing, MI

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2021

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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NCHRP RESEARCH REPORT 966

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Kay Fitzpatrick, TTI senior research engineer, was the principal investigator. The authors of this report are:

- Kay Fitzpatrick (TTI).
- Subasish Das (TTI).
- Tim Gates (MSU).
- Michael P. Pratt (TTI).
- Karen Dixon (TTI).

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FOREWORD

By David Jared
Staff Officer
Transportation Research Board

NCHRP Research Report 966 provides a procedure for setting speed limits and a practitioner-ready user manual explaining the speed limit setting procedure (SLS-Procedure). Additionally, it provides an automated version of the SLS-Procedure via a spreadsheet-based Speed Limit Setting Tool (SLS-Tool). The guidebook will be of interest to engineers responsible for making informed decisions about the setting of speed limits.

Several factors are considered within engineering studies when determining the posted speed limit for a speed zone. Currently, the predominant method for setting speed limits uses the 85th percentile speed. This method is viewed as being a fair way to set speed limits based on the driving behavior of most drivers (85 percent), representing reasonable and prudent drivers since the fastest 15 percent of drivers are excluded. The 85th percentile speed is also believed to represent a safe speed that would minimize crashes.

The SLS-Procedure is based on decision rules that consider both driver speed choice and safety associated with the roadway. The SLS-Procedure was designed to be applicable for different roadway types and contexts by having a set of unique decision rules for four combinations of roadway types and contexts: Limited-Access, Undeveloped, Developed, and Full-Access facilities. The SLS-Procedure provides a fact-based, transparent set of decision rules to determine the suggested speed limit for a specific roadway segment.

Under NCHRP Project 17-76, "Guidance for the Setting of Speed Limits," Texas A&M Transportation Institute was asked to investigate factors that influence operating speed and safety through a review of the literature and an analysis of the relationships of speed, safety, and roadway characteristics on urban/suburban streets. That knowledge and a review of existing speed limit setting practices were used to develop the SLS-Procedure and accompanying SLS-Tool. Note that the SLS-Tool is provided in two formats, one with macros and one without. The without macros version is made available for users who are not able to use macro codes on their computers. The research team also conducted several workshops and presentations during the development of the SLS-Procedure, and these presentations provided opportunities to obtain feedback on its potential format.

The SLS-Procedure and SLS-Tool are accompanied by *NCHRP Web-Only Document 291: Development of a Posted Speed Limit Setting Procedure and Tool*, which details the research activities and methods. The SLS-Tool and *NCHRP Web-Only Document 291* are available on the TRB website (TRB.org) by searching for "NCHRP Research Report 966."

CONTENTS

Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

SUMMARY

Posted Speed Limit Setting Procedure and Tool: User Guide

Several factors are considered within engineering studies when determining the posted speed limit for a speed zone. National Cooperative Highway Research Program (NCHRP) Project 17-76 investigated the factors that influence operating speed and safety and used that knowledge to develop the Speed Limit Setting Procedure (SLS-Procedure) so engineers can make informed decisions about the setting of speed limits. The SLS-Procedure was automated with the Speed Limit Setting Tool (SLS-Tool). The SLS-Tool is spreadsheet based and is included with this report for download.

Currently, the predominant method for setting speed limits uses the 85th percentile speed. It is viewed as a fair way to set speed limits based on the driving behavior of most drivers (85 percent), who represent reasonable and prudent drivers since the fastest 15 percent of drivers are excluded. The 85th percentile speed is also believed to represent a safe speed that would minimize crashes. Criticisms of the 85th percentile speed method include a concern that drivers may not see or be aware of all the conditions present within the corridor, and such an approach may not adequately consider vulnerable roadway users such as pedestrians and bicyclists. Other concerns are that drivers are not always reasonable and prudent, or they only consider what is reasonable and prudent for themselves and not for all users of the system; and the use of measured operating speeds to set speed limits could cause increase speed over time (i.e., speed creep). Drivers frequently select speeds a certain increment above the posted speed limit, anticipating that they will not receive a ticket if they are not above that assumed enforcement speed tolerance. Also, most of the early research justifying the use of the 85th percentile speed was conducted on rural roads; therefore, the 85th percentile speed may not be appropriate for urban roads.

The research team considered the breadth of approaches available for the setting of speed limits and the need to develop a methodology that could be used for any roadway type. The research team selected a decision-rule–based procedure for the SLS-Procedure. Given the increased emphasis on designing for the context of the roadway, the research team decided that the SLS-Procedure should be sensitive to context and use the expanded functional classification scheme available in *NCHRP Research Report 855* (*33*). The roadway types and roadway contexts available within the expanded functional classification scheme were collapsed into four Speed Limit Setting Groups (SLSGs): Limited-Access, Undeveloped, Developed, and Full-Access. Unique decision rules were developed for each SLSG.

For the SLS-Procedure, the research team proposed consideration of the measured operating speed as the starting point for selecting a posted speed limit but that the measured operating speed be adjusted based on roadway conditions and consideration of the crash experience on the segment.

The guiding principles developed by the research team for the SLS-Procedure included the following:

- Use a data-driven approach with research-based decision rules.
- Produce consistent results for a given set of conditions.
- Incorporate contemporary policies, guidelines, and practices.
- Consider drivers' speed choice and roadway safety.
- Provide transparency in the decision-making process.
- Consider all roadway types and roadway contexts.
- Vary the decision rules to account for the diverse characteristics of each SLSG.
- Consider agency data and human resource constraints.
- Include inputs and outputs on the same screen to demonstrate the relationship between each roadway characteristic and selection of the suggested speed limit.
- Allow for future modifications to accommodate new knowledge.
- Create efficiencies in the decision process, where possible.

The SLS-Procedure starts with identifying the roadway segment context and type, which determine the appropriate SLSG. For that SLSG, the roadway characteristics and crash potential for the segment are used to identify the speed distribution that should be considered and whether the closest 5-mph increment value or a rounded-down 5-mph increment value should be used.

For this project, the research team focused a portion of the Phase II efforts on collecting data for suburban and urban roads to fill the known research gap for city streets. The developed databases for Austin, Texas, and Washtenaw County/Greater Ann Arbor, Michigan, were used to investigate the relationships among crashes, roadway characteristics, and posted speed limits. The team found that crashes on city streets were lowest when the average vehicle operating speed was within 5 mph of the posted speed limit. Therefore, the research team recommended that the 50th percentile speed be a consideration within the SLS-Procedure, especially for the SLSGs of Developed and Full-Access. The evaluation of the Austin, Texas, and Washtenaw County/Greater Ann Arbor, Michigan, data supported including the following variables within the decision rules: signal density, access density, and undivided median on four-lane (or more) streets. Findings from the literature were also used to develop the decision rules.

Presenting a workshop was a requirement of the research. Members of the research team conducted several workshops and presentations during the development of the SLS-Procedure, and these presentations provided opportunities to obtain feedback on the potential format of the procedure. The presentations with the panel were especially influential in setting the direction for the SLS-Procedure and SLS-Tool.

This project concluded with the development of two products:

- *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide* (this document).
- *Web-Only Document 291: Development of a Posted Speed Limit Setting Procedure and Tool* is available for download from the TRB website (TRB.org) by searching for "NCHRP Research Report 966."

SECTION 1

Introduction

Background

The speed limit is the maximum speed legally permitted for a given roadway segment. Several types of speed limits exist, including statutory speed limit, posted speed limit, school zone speed limit, work zone speed limit, variable speed limit, and advisory speed limit. (Figure 1 illustrates these different types of speed limits).

A posted speed limit could be the same as the statutory speed set by the state legislature or could be an adjustment to the statutory speed limit determined using an engineering speed study. States establish statutory speed limits for specific types of roads—such as freeways, rural highways, or urban streets—which are applicable even if the speed limit sign is not posted.

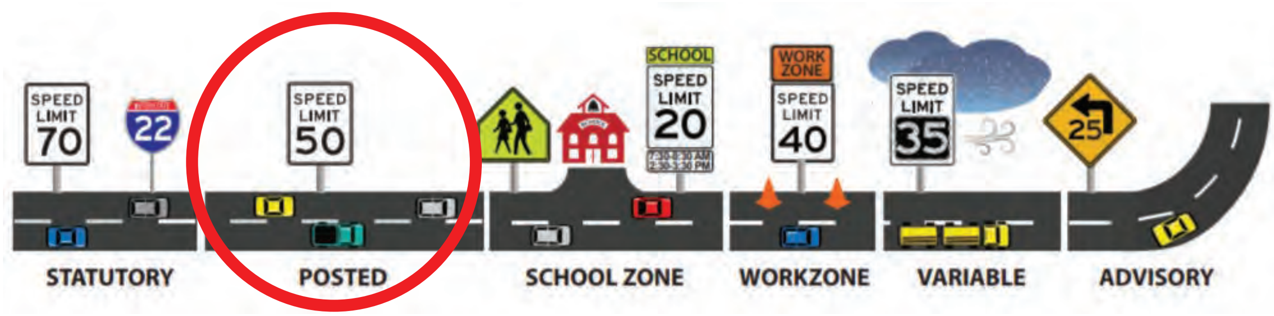
Objective

The National Cooperative Highway Research Program (NCHRP) Project 17-76 research team was tasked with identifying factors that influence a driver's operating speed and then developing a Speed Limit Setting Procedure (SLS-Procedure) and automating the SLS-Procedure with a Speed Limit Setting Tool (SLS-Tool). The SLS-Procedure and SLS-Tool are used to calculate the suggested speed limit for a segment. The goal of the SLS-Procedure and SLS-Tool is to produce an objective suggested speed limit value. Traffic engineers can use the SLS-Procedure and the suggested speed limit generated by the SLS-Tool to communicate with the public or government officials to explain the general procedures behind setting speed limits.

The products developed through NCHRP Project 17-76 focused on posted speed limits and not on other types of speed limits (see Figure 1 for examples). The SLS-Tool is designed to cover the most frequently encountered road designs and settings, though there may be circumstances not covered by the SLS-Tool that will require additional engineering judgment in the selection of the appropriate posted speed limit.

Two products were generated as part of this project:

- *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide* (this document).
- *NCHRP Web-Only Document 291: Development of a Posted Speed Limit Setting Procedure and Tool* (*2*).



Source: Federal Highway Administration, *Speed Limit Basics*, page 1 (*1*).

Figure 1. Examples of speed limits.

Organization of User Guide

This document is the user guide for the SLS-Procedure and SLS-Tool. It contains the following sections:

- **Section 1: Introduction:** provides an overview of the document including the project objectives and the organization of the guide.
- **Section 2: Speed Limit Relationships and Practices:** introduces several basic relationships with regard to speed limits.
- **Section 3: Procedure to Calculate the Suggested Speed Limit:** presents the procedure to develop a suggested speed limit for a corridor.
- **Section 4: Decision-Making Steps Within the Suggested Speed Limit Procedure:** documents the four decision-making steps, which include selecting roadway segment context and type, identifying the appropriate speed distribution, adjusting for safety considerations, and finally calculating the suggested speed limit.
- **Section 5: Variables for Decision-Making Procedure:** discusses each variable used within the decision-making procedure (i.e., the SLS-Procedure).
- **Section 6: Speed Limit Setting Tool:** provides an overview of the SLS-Tool, including data entry requirements, messages that may be generated, and default values if data are not available for one of the variables.
- **Section 7: SLS-Tool Case Study Examples:** presents a case study for each of the four Speed Limit Setting Groups (SLSGs).
- **Section 8: Other Considerations When Setting Posted Speed Limits:** discusses several issues associated with the setting of posted speed limits.
- **Section 9: Related Reference Materials:** lists other reference materials on posted speed limits including links when available.
- **Acronyms and Abbreviations:** lists the acronyms and abbreviations used within this user guide.
- **References:** provides details on the material referenced in this user guide.

SECTION 2

Speed Limit Relationships and Practices

Speed and Crashes

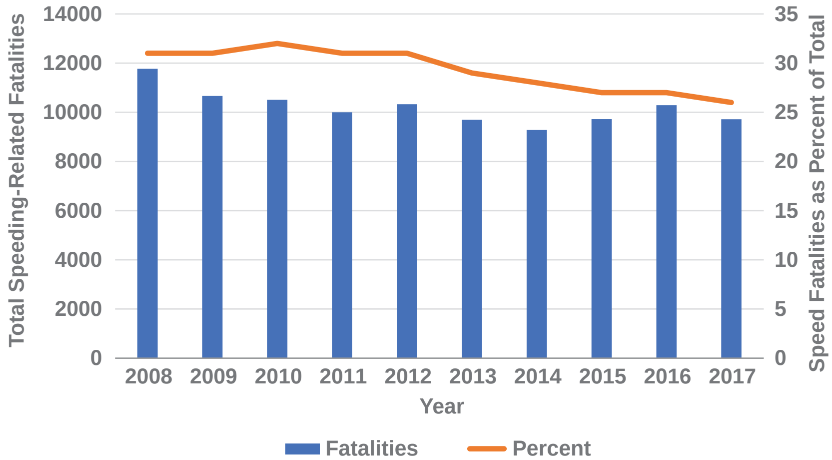
Approximately one-quarter of all traffic fatalities are related to speeding (Figure 2), either traveling in excess of the posted speed limit or driving too fast for the conditions. Although the downward trend is encouraging, speeding continues to be a primary contributor in traffic fatalities.

Ongoing Debate on How to Set a Posted Speed Limit

Several sources are available to aid in evaluating and identifying the appropriate posted speed limits. Many states and cities have their own laws and criteria for setting of speed limits, with some being more detailed than others. The *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) (*4*) provides details on the use of speed limit signs as a traffic control device (TCD), providing details on color, size, retroreflectivity, etc. The MUTCD also provides general advice on variables to consider when selecting the speed limit on a roadway segment; however, specific methods and decision steps are not included. The MUTCD broadly serves as a reference regarding the setting of speed limits; other references and guidelines to provide more detailed criteria for selecting the posted speed limit. This user guide provides such a procedure to calculate suggested speed limits.

Many different approaches are available and used to set a posted speed limit. Within the United States, the operating speed approach based on the 85th percentile speed is typically used. In the operating speed approach, the selection of the speed limit value uses the measured 85th percentile speed for the roadway segment, and in some cases, adjustment factors that consider a number of conditions are also applied.

The driver often plays a key role in the speed limit setting process since the speeds considered when establishing speed limits are typically measured when traffic is flowing freely. During free-flow conditions, drivers select speeds that they believe optimize the tradeoffs between travel time and risk. Basing the speed limit on the 85th percentile indicates a belief that drivers are pretty good at assessing these tradeoffs, and that their judgment is trustworthy in establishing a level where exceeding that speed may be cited by law enforcement. While that may be true, additional conditions could exist that *do not* influence the 85th percentile speed but *do* contribute to crashes. A posted speed limit that is lower than the 85th percentile speed could help to minimize the consequences of those conditions. In addition, the desire to provide roadway corridors that encourage active (non-motorized) transportation should consider the safety and mobility needs of pedestrians and bicyclists when setting posted speed limits. Given these competing preferences, the debate about the best approach to setting speed limits is ongoing.



Source: Data from Insurance Institute for Highway Safety, "Fatality Facts 2017: Yearly Snapshot" (*3*).

Figure 2. Motor vehicle crash deaths involving speeding as a contributing factor, 2008–2017.

This user guide discusses a procedure that can be used to identify a *suggested* posted speed limit for a street or highway segment. The procedure is based on the speed distribution for a segment of current drivers with adjustments for the consideration of safety.

The Consequences of Speed

The release of the recent National Transportation Safety Board (NTSB) report *Reducing Speeding-Related Crashes Involving Passenger Vehicles* (*5*) provides insight into the ongoing challenges related to speeding and examines the causes and trends in speeding-related passenger vehicle crashes along with countermeasures that can prevent these crashes. Such issues include driver speed behavior and the setting of speed limits, data-driven approaches for speeding countermeasures and enforcement, and the use of automated speed enforcement as a deterrent. The report reflects the understanding that addressing speeding involves a continuum of design approaches, countermeasures, and policies all aimed at supporting a community safety plan.

It is well known that speed has an influence on crash severity, particularly in pedestrian crashes, and evidence shows that speed may also influence the number of crashes. The severity increases are not linear with respect to speed and tend to increase more substantially at higher speeds. It is unclear whether knowledge of that on the part of drivers would influence their speed choice. Some transportation professionals and safety experts believe that the 85th percentile should not be the sole factor in determining the speed limit, particularly in urbanized areas. For example, it may be prudent to post speed limits that are lower than the 85th percentile on roadways with pedestrians and/or bicyclist activity. However, if the decision is not based on objective data or accompanied by needed enforcement, education, or infrastructure changes, then slower travel speeds may not be achieved. Drivers often make their personal speed assessment based on their own needs and perceptions and do not necessarily consider other road users.

Challenges with the Relationship Between Posted Speed and Operating Speed

Establishing speed limits is often a complicated task. If speed limits are set with safety as the only consideration, the result will be low speed limits, which is not practical for mobility. The speed limit is generally a policy decision made by elected or appointed officials, typically after considering the recommendations of their agency's traffic engineers but not always, and sometimes without limiting their considerations to 85th percentile speeds. Like most efforts in traffic engineering, setting speed limits involves balancing competing desires and perceptions. One key issue facing the profession is what measurable factors should be considered in making these recommendations and their respective weights pertaining to speed limit. In addition, the process should incorporate the consideration of safety.

Consideration of which roadway and roadside characteristics to include in the decision-making process is central to the discussion related to speed. As illustrated with data for urban streets in Figure 3, the existing *average* operating speed is closer to the posted speed limit than the 85th percentile speed. This supports the observation that the setting of posted speed limits is influenced by more than the 85th percentile speed. Possible factors affecting speed (and safety) include, but are not limited to:

- Crash history including severity consequences.
- Available roadside elements.
- Horizontal curvature characteristics including radius, superelevation, and friction.
- Roadway lighting.
- Adjacent pedestrian and bicycle activity.
- Roadway facility type and context.
- Number of signals.
- Number of access points.
- Type of median.
- Presence of sidewalk.
- Presence of bicyclist facilities.

The linear trendlines in Figure 3 demonstrate a relationship between the posted speed limit and the operating speed. The average and 85th percentile operating speeds are higher when the posted speed limits are higher, or are lower when the posted speed limits are lower. While several roadway characteristics also influence operating speed, the research conducted in this project found that the posted speed limit influences operating speed (*2*), indicating that the number on the sign does matter. Several other studies have also found the posted speed limit

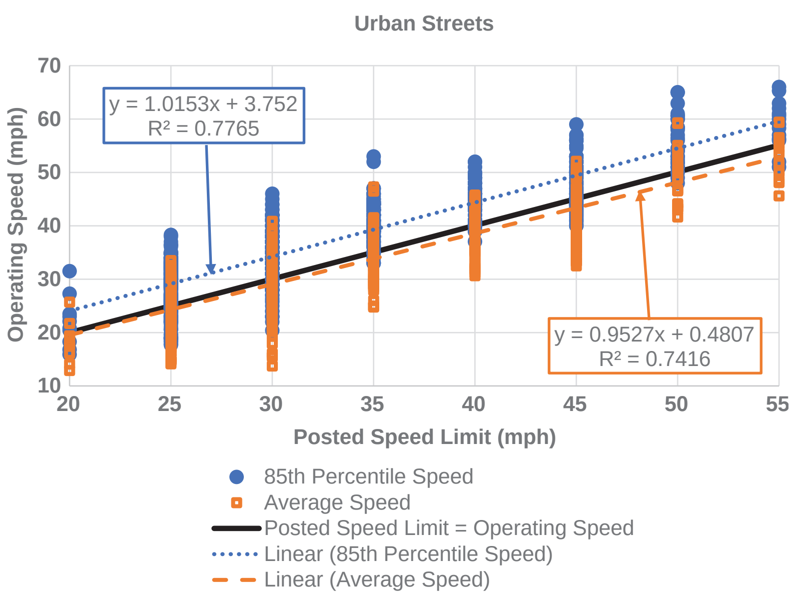


Figure 3. Comparison of operating speeds versus posted speed limits on urban streets.

has a significant effect on free-flow speed on urban streets (*6, 7, 8, 9, 10, 11, 12*), rural two-lane highways (*13, 14, 15, 16*), and rural multilane highways (*17, 18*).

In addition to the safety impacts of speed limits, another area of substantive debate is how much speed limits influence the actual speed selection behavior of drivers. Research has generally shown that speed limit changes result in changes in the observed mean and 85th percentile speeds but are less pronounced than the actual speed limit changes. This has been true for cases where speed limits were decreased (*19, 20*) or increased (*21, 22, 23, 24, 25*).

In one of the most extensive studies in this area, Parker (*26*) conducted a large-scale study from 1985 to 1992 to determine the impact that raising or lowering posted speed limits on non-Limited-Access highways had on driver behavior. At the time of the study, the maximum speed limit on such roadways was 55 mph. Over the duration of the study, states and local authorities raised and lowered posted speed limits on short segments of roadways, typically less than 2 miles in length. Data on driver behavior and crashes were collected from 22 states. These included 100 sites along non-Limited-Access highways where the speed limits were either raised or lowered and 83 control sites where speed limits were not changed. The range of speed limit changes consisted of lowering the speed limit by 5, 10, 15, or 20 mph, or increasing the speed limit by 5, 10, or 15 mph, with only one change made at each site. Interestingly, the difference in operating speed after these changes was less than 1.5 mph on average (*26*).

Kockelman (*13*) found that speed limit increases tend to increase average vehicle speeds. On average, speed increases were generally less than half the amount of the actual speed limit increase. Dixon et al. (*27*) reviewed speed data for 12 rural multilane sites in Georgia to evaluate the effects of repealing the 55-mph national speed limit. The authors found that operating speeds were higher after the increase in the posted speed limit. The evidence cited in the NTSB report (*5*) also indicates that speed limits do have some effect on operating speed, primarily in increasing them and perhaps in reducing them to a lesser extent.

The magnitude of the change in operating speed when there is an increase (or decrease) in posted speed is typically only a fraction of the amount of the actual speed limit change (*13, 28, 29, 30*). For undivided high-speed rural roadways, mean speeds are generally 3 to 5 mph higher for every 10-mph increase in speed limit above 55 mph, with smaller increases at higher speed limits (*13, 28, 29*). In summary, while the research findings indicate a change in the posted speed limit sign can affect operating speeds, it is not as influential as the magnitude of the speed limit value change.

If traffic engineers could actually achieve desired operating speeds merely by setting and posting speed limits, their work would be done. Simply setting speed limits without other corrective measures is rarely likely to achieve target speeds, which is the operating speed intended for drivers to go on a given roadway facility. Granted, setting appropriate speed limits is an essential step in achieving target speeds, so it is critical to improve the methods for recommending them. The overwhelming reality is that there will never be enough law enforcement resources to enforce speed limits, no matter how they are determined. Furthermore, it will require a fundamental change in public opinion before automated enforcement (spot or segment) is adopted on a broad basis.

Achieving Target Speeds Through Roadway Configuration and Traffic Control

The central issue to achieving target speeds involves the configuration and operation of roadways so that target speeds, compatible with context and all roadway users, are chosen by—and not forced upon—vehicle operators. However, much of the roadway context, especially the urban one, has already been established, so a large part of the effort of achieving target speeds involves retrofitting the existing environment. Since only lane width, reallocating the cross section, elements on the roadside such as bus stops or trees, and vertical and horizontal deflections to alter the physical alignment are available, a clear understanding of what combination of those, and in what configurations, achieves target speeds (or at least what greatly influences operating speeds) is needed. Several previous research efforts (*31*) and anticipated research efforts (*32*) offer insights, but a formula for achieving a target speed is currently not available.

Transportation professionals can install the simplest and most straightforward, proven method to achieve target speeds on major streets in urban areas by implementing traffic signal progression. If drivers realize they will have a stop-free, steady, but appropriate speed to travel, then they may be more likely to actually drive the posted speed. For low-speed urban roads and streets that are unsignalized, transportation professionals will have to achieve target speeds through appropriate combinations of physical design features, many of which are now being included in context-sensitive, complete streets.

SECTION 3

Procedure to Calculate the Suggested Speed Limit

Overview

With consideration of the issues discussed, along with research into the relationships among roadway characteristics including posted speed limit, operating speed, and safety, the research team developed a procedure to calculate a suggested speed limit. The procedure starts with identifying the roadway segment context and type. Next, the speed distribution of drivers on that segment is used to identify a potential suggested speed limit that is adjusted with consideration of the crash potential for the segment. Figure 4 illustrates the steps for the procedure. Additional details are provided in the sections that follow. The suggested speed limit procedure applies to posted speed limits. Procedures for setting school zone, work zone, variable, or advisory speeds are not discussed in this document.

Speed Limit Setting Tool

The SLS-Tool was developed to facilitate calculating the suggested speed limit. The tool uses spreadsheets to automate the procedure. A copy of the SLS-Tool is available on the TRB website (TRB.org) by searching for "NCHRP Research Report 966."

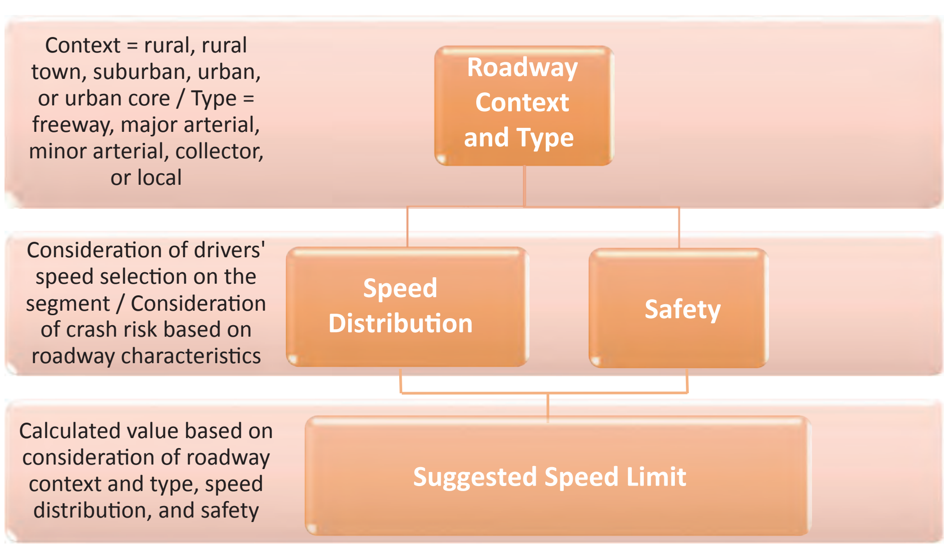


Figure 4. Overview of procedure to calculate suggested speed limit.

SECTION 4

Decision-Making Steps Within the Suggested Speed Limit Procedure

Roadway Segment Context and Type

The initial step in decision-making is identifying the roadway segment content and type. The Expanded Functional Classification System (Expanded FCS) aides in that determination. The Expanded Functional Classification System was developed to replace the existing functional classification scheme in order to facilitate optimal geometric design solutions with consideration of context, road functions, and user needs. The scheme was introduced in *NCHRP Research Report 855* (*33*) and is intended to build upon existing efforts from state departments of transportation that have initiated and implemented a new classification system to address contextual multimodal deficiencies of the existing classification system.

As stated in *NCHRP Research Report 855* (*33*), "the major objective of the Expanded FCS is to provide enhanced information to designers to better inform the design decision process. . . . This enhanced information is provided by increasing the resolution of roadway's design context to enable understanding of the role the roadway plays within the community; identifying the role of the roadway within the local, city, and regional transportation network; and identifying the multiple roadway user groups and their priority within the design corridor."

The goal of the Expanded FCS is to provide practitioners with a practical tool for determining appropriate design criteria and elements to help better understand the impacts of the tradeoffs necessary to balance user needs and safety and to address other community issues. The Expanded FCS and associated design matrix can be used to identify preliminary requirements for proper consideration of roadway context and user needs.

As presented in *NCHRP Research Report 855*, the Expanded FCS considers roadway context, roadway type, roadway users, and overlays. The SLS-Procedure uses the basic roadway context/roadway type matrix. *NCHRP Research Report 855* provides additional information on the Expanded FCS.

Roadway Context

The Expanded FCS includes five distinct contexts. These were determined to represent unique land use that requires different geometric design practices in terms of desired operating speeds, mobility/access demands, and user groups. *NCHRP Research Report 855* (*33*) describes the context categories as follows and provides the illustration shown in Figure 5:

- **Rural:** areas with lowest density, few houses or structures (widely dispersed or no residential, commercial, and industrial uses), and usually large setbacks.
- **Rural Town:** areas with low density but diverse land uses with commercial main street character, potential for on-street parking and sidewalks, and small setbacks.

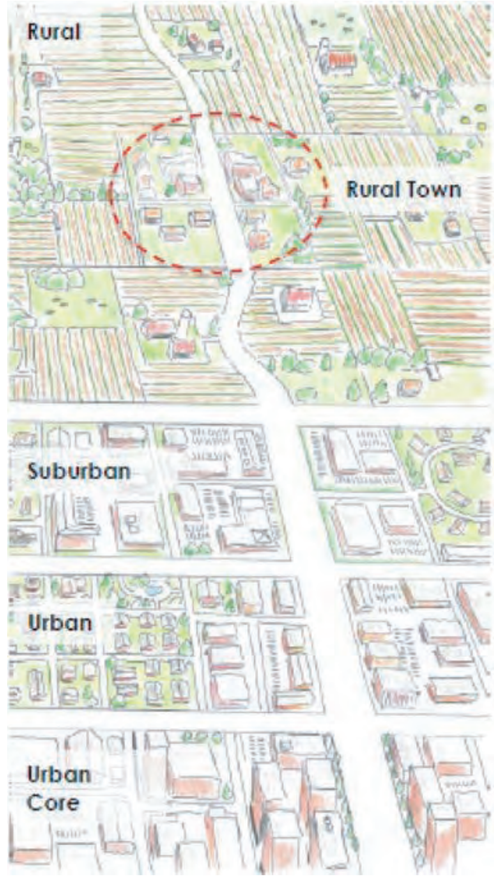


Figure 5. **NCHRP Research Report 855** ***illustration of five roadway contexts. [Source: Transportation Research Board. 2018.*** **NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets.** ***HTTPS://DOI.ORG/10.17226/24775. Reproduced with permission from the National Academy of Sciences. Figure 2, page 3. (*****33*****)]***

- **Suburban:** areas with medium density, mixed land uses within and among structures (including mixed-use town centers, commercial corridors, and residential areas), and varied setbacks.
- **Urban:** areas with high density, mixed land uses and prominent destinations, potential for some on-street parking and sidewalks, and mixed setbacks.
- **Urban Core:** areas with highest density and mixed land uses within and among predominately high-rise structures, and small setbacks.

Table 1 summarizes the primary factors associated with each roadway context.

Roadway Type

The roadway types used in the Expanded FCS are based on their network function and the connectivity they provide among various centers of activity. The roadway types are as follows:

- **Interstates/Freeways/Expressways:** corridors of national importance connecting large centers of activity over long distances.

Table 1. Characteristics of roadway contexts.

Context	Density	Land Use	Setback
Rural	Lowest (few houses or other structures)	Agricultural, natural resource preservation, and outdoor recreation uses with some isolated residential and commercial uses	Usually large setbacks
Rural Town	Low to medium (single-family houses and other single-purpose structures)	Primarily commercial uses along a main street (some adjacent single-family residential uses)	On-street parking and sidewalks with predominately small setbacks
Suburban	Low to medium (single- and multifamily structures and multistory commercial)	Mixed residential neighborhood and commercial clusters (including town centers, commercial corridors, big-box commercial, and light industrial uses)	Varied setbacks with some sidewalks and mostly off-street parking
Urban	High (multistory, low-rise structures with designated off-street parking)	Mixed residential and commercial uses, with some intuitional and industrial uses, and prominent destinations	On-street parking and sidewalks with mixed setbacks
Urban Core	Highest (multistory and high-rise structures)	Mixed commercial, residential, and institutional uses within and among predominately high-rise structures	Small setbacks with sidewalks and pedestrian plazas

Source: Transportation Research Board. 2018. *NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets*. HTTPS://DOI.ORG/10.17226/24775. Reproduced with permission from the National Academy of Sciences, Table 1, page 10 (*33*).

- **Principal Arterials:** corridors of regional importance connecting large centers of activity.
- **Minor Arterials:** corridors of regional or local importance connecting centers of activity.
- **Collectors:** roadways of lower local importance providing connections between arterials and local roads.
- **Locals:** roads with no regional or local importance for local circulation and access only.

Matrix

Table 2 shows the roadway context/roadway type matrix along with the target speed for each context/type combination. Target operating speed is the desirable speed for motorists to travel along a roadway within the particular context/roadway type combination. *NCHRP Research Report 855* grouped the target operating speed into three categories (*33*):

- Low (25 mph and below).
- Medium (30 to 45 mph).
- High (50 mph and above).

NCHRP Research Report 855 provides the following justification for the target speed values:

> The speed used in the Expanded FCS is the target operating speed of the roadway. The rationale for selecting operating speed in the Expanded FCS is the need to recognize the influence of driver desire and expectations. Moreover, the goal is to develop a facility where the operating speed is close to the design speed, resulting in an environment with smaller speed differences among drivers. Smaller speed differentials could improve safety, since they will eliminate discrepancies between design speed and operating speeds, creating a more uniform speed profile among drivers. These speeds need to be considered with both existing and future volumes and contexts.
>
> The limits for each category are based on established practices and extensive research. The speed of 25 mph was considered the limit for the low-speed environments based on current trends of several urban areas to facilitate a speed limit of 25 mph. Indeed, 20 mph is considered the survivability speed for pedestrians and bicyclists in the event of a collision with a vehicle. Such collisions typically result in injuries, and non-drivers have a high chance of surviving when speeds remain at or below 20 mph. As such, speeds of 20 mph or less should be considered in areas of higher pedestrian activity in the urban and urban core environments. Target speeds for urban and rural towns have been designated as

Table 2. Suggested target speed by roadway context and type.

Context and Type	Rural	Rural Town	Suburban	Urban	Urban Core
Limited-Access Freeway	High 50 mph and above	High 50 mph and above	High 50 mph and above	High 50 mph and above	High 50 mph and above
Principal Arterial	High 50 mph and above	Low to Medium 45 mph and below	Medium to High 30 mph and above	Low to Medium 45 mph and below	Low 25 mph and below
Minor Arterial	High 50 mph and above	Low to Medium 45 mph and below	Medium 30 to 45 mph	Low to Medium 45 mph and below	Low 25 mph and below
Collector	Medium 30 to 45 mph	Low 25 mph and below	Medium 30 to 45 mph	Low 25 mph and below	Low 25 mph and below
Local	Medium 30 to 45 mph	Low 25 mph and below	Low 25 mph and below	Low 25 mph and below	Low 25 mph and below

Source: Adapted from Transportation Research Board. 2018. *NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets*. HTTPS://DOI.ORG/10.17226/24775. Reproduced with permission from the National Academy of Sciences, Figure 19 (*33*).

low/medium because of the competing issues within these contexts and the varied pedestrian and roadside environment. The designer should examine the available speed range to select the operating speed most appropriate for all users given the facilities and context. The upper limit for high speeds is based on the American Association of State Highway and Transportation Officials' (AASHTO's) *A Policy on Geometric Design of Highways and Streets* (commonly known as the *Green Book*) (*42*) definition of high-speed roads, which are those with speeds of 50 mph and above. (*33*, page 26)

Speed Limit Setting Groups

The roadway context and type should be considered when identifying a posted speed limit for a facility. While the expanded functional classification matrix has 25 unique combinations of roadway types and roadway contexts (Table 2), there are combinations where a similar decision process would be employed. For example, the setting of posted speed limits for Limited-Access freeways may be the same for suburban or urban freeways. Table 3 shows the SLSGs by roadway context/roadway type and includes the following:

- Limited-Access.
- Undeveloped.
- Developed.
- Full-Access.

Table 3. Suggested SLSGs.

Context and Type	Rural	Rural Town	Suburban	Urban	Urban Core
Freeways	Limited-Access	Limited-Access	Limited-Access	Limited-Access	Limited-Access
Principal Arterial	Undeveloped	Developed	Developed	Developed	Full-Access
Minor Arterial	Undeveloped	Developed	Developed	Developed	Full-Access
Collector	Undeveloped	Full-Access	Developed	Full-Access	Full-Access
Local	Undeveloped	Full-Access	Full-Access	Full-Access	Full-Access

Speed Distribution

The distribution of individual vehicle speeds within the traffic stream is dependent on several factors. Speeds tend to be relatively uniform (i.e., narrowly distributed) during periods of heavy congestion and more broadly distributed during free-flow conditions. Typically, for speed limit setting purposes, the speed distribution should only include free-flowing vehicles. The distribution of individual vehicle speeds may be characterized by variables that include the average, 50th percentile, 85th percentile, standard deviation, and pace of the measured speeds, each of which is defined in Table 4. Figure 6 illustrates key speed terms within a speed distribution plot.

For speed setting purposes within the SLS-Tool, the primary variables of interest related to speed are the 50th percentile and the 85th percentile speed. While not used within the SLS-Tool, minimizing the standard deviation or maximizing the pace (largest percent of vehicles within a 10-mph range) is associated with fewer crashes; therefore, other tools such as enforcement or changes in roadway design could be considered.

Consideration of Geometric Variables, Human Factors, and Safety

Geometry, human factors, and safety are all considerations that are utilized within a set of decision rules for each SLSG to determine the suggested speed limit. The possible suggested speed limit options are as follows, listed in order from highest to lowest speed within the distribution:

- The 85th percentile speed rounded to the closest 5-mph increment (C85).
- The 85th percentile speed rounded down to the nearest 5-mph increment (RD85).
- The 50th percentile speed rounded to the closest 5-mph increment (C50).
- The 50th percentile speed rounded down to the nearest 5-mph increment (RD50).

Table 4. Speed definitions.

Term	Definition
50th percentile (median)	The speed at or below which 50 percent of the total observed values fall in a sample of measured spot speeds.
85th percentile	The speed at or below which 85 percent of the total observed values fall in a sample of measured spot speeds.
Average travel speed	The average speed of the traffic stream over a specified section of highway.
Free-flow speed	The average speed of vehicles on a given segment, measured under low-volume conditions, when drivers are free to drive at their desired speed and are not constrained by the presence of other vehicles or downstream TCDs (e.g., traffic signals, roundabouts, or stop signs).
Operating speed	The operating speed of a road is the speed at which motor vehicles generally operate on that road. In a general sense, the term *operating speed* refers to the speed at which drivers are observed operating their vehicles. The 85th percentile of a sample of observed speeds has been typically used as a descriptive statistic for establishing the operating speed associated with a particular road segment; however, other percentiles have also been used.
Pace	The 10-mph range that contains the greatest percentage of observations, expressed as a percentage of the number of speed measurements within the 10-mph range divided by the total number of speed measurements.
Posted speed	Numeric speed limit value displayed on regulatory speed limit signs.
Space-mean speed	Harmonic mean of several spot speed measurements (or calculated using the average travel times of vehicles measured over a given length of roadway).
Speed	Rate of movement of a vehicle in mph.
Spot speed	Instantaneous measure of speed at a specific location on a roadway.
Standard deviation	Spread of individual speeds around the mean, calculated as the square root of the sum of squares of the deviations of the individual spot speeds from the mean divided by the number of measurements less one.
Statutory speed limit	Statutory speed limits are established by state legislatures and are enforceable by law. Such limits typically vary by highway type (e.g., interstate) or by location (e.g., urban district).
Target speed	The highest speed at which vehicles should ideally operate on a roadway.
Time-mean speed	Arithmetic mean or average of several spot speed measurements (or the average of speeds of vehicles passing a given point along a roadway over a certain time period).

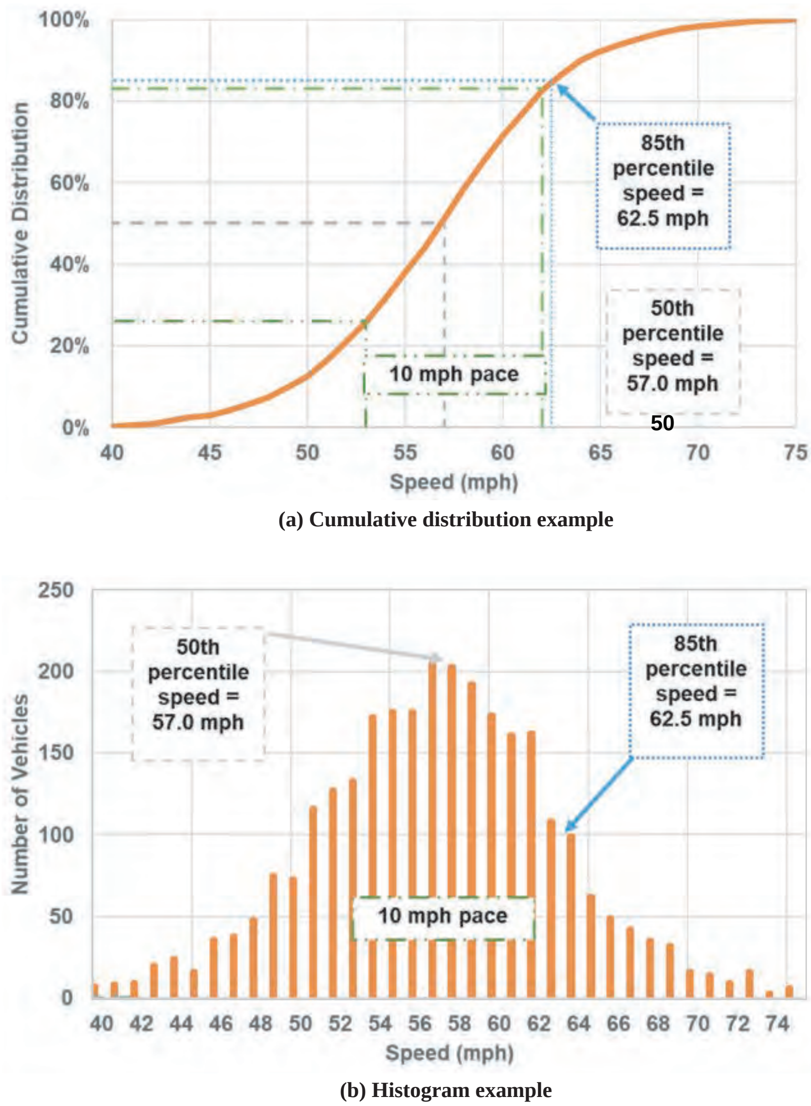


Figure 6. Example illustrations of speed distribution curves.

When the roadway conditions are optimal, the suggested speed limit would reflect the 5-mph increment closest to the 85th percentile speed except for segments within the Full-Access SLSG, where it would reflect the 5-mph increment closest to the 50th percentile speed in recognition of the anticipated users within those facilities. When roadway conditions are not favorable to all users or when crashes are a significant concern, then the suggested speed limit would reflect the 5-mph increment closest to the 50th percentile speed for Limited-Access, Developed, or Undeveloped SLSGs or the 5-mph increment rounded down from the 50th percentile speed for the Full-Access SLSG. An RD85 speed limit is suggested when conditions are between those extremes for Limited-Access, Developed, or Undeveloped SLSGs.

In rare cases, the RD85 will be less than the C50 due to rounding. As an example, if the 50th percentile speed was 58 mph and the 85th percentile speed was 59 mph, then the C50 would equal 60 mph, and the RD85 would equal 55 mph. This situation only occurs when the 85th and 50th percentile speeds are within 1 mph of each other. The results may appear unusual but are accurate given the provided speed data, and hence should be interpreted with caution.

Decision Rules for Each Speed Limit Setting Group

The following sections presents the decision rules for selecting the 5-mph increment that reflects C50, RD85, or C85 by SLSGs.

Crashes are considered by comparing the crash rate [crashes/100 million vehicle miles (MVM)] for the segment with the crash rate for similar road sections in the jurisdiction or, if not available, with crash rates from the Highway Safety Information System (HSIS). KABCO is a crash severity scale where:

- K = fatal.
- A = incapacitating injury.
- B = non-incapacitating injury.
- C = possible injury.
- O = no injury, property damage only.

KABCO includes crashes for all severity levels and KABC includes crashes with fatal or injury severity levels.

Speed Limit Setting Group: Limited-Access

Table 5 provides an overview of the variables along with the variable value that would trigger using C85, RD85, or C50.

Speed Limit Setting Group: Undeveloped

Table 6 provides an overview of the variables along with the variable value that would trigger using either C85, RD85, or C50.

Table 5. Overview of decision rules for Limited-Access SLSG.

Variable	Closest 50th (C50)	Rounded Down 85th (RD85)	Closest 85th (C85)
Average interchange spacing (Inter_spac) expressed as length/number of interchanges in miles (mi) and annual average daily traffic (AADT) (two-way total) in vehicles per day (veh/d)	Inter_spac ≤ 0.5 mi and AADT ≥ 180,000 veh/d	0.5 mi < Inter_spac ≤ 1 mi and AADT ≥ 180,000 veh/d	All other cases
Mountainous terrain as determined by grade in percent and design speed in mph	{Not applicable, see criteria in other cells}	• Design speed ≥ 60 mph and grade > 4% • Design speed ≤ 55 mph and grade > 5%	All other cases
Outside shoulder width (SW) in feet	{Not applicable, see criteria in other cells}	SW < 8 ft	SW ≥ 8 ft
Inside shoulder width (ISW) in feet, number of lanes (N), and directional design-hour truck volume in trucks per hour (trk/hr)	{Not applicable, see criteria in other cells}	• Truck_vol > 250 trk/hr and ISW < 12 ft • Truck_vol ≤ 250 trk/hr, N ≥ 6, and ISW < 10 • Truck_vol ≤ 250 trk/hr, N < 6, and ISW < 4	All other cases
KABCO or KABC crash rate	High	Medium	Low

Table 6. Overview of decision rules for Undeveloped area SLSG.

Variable	Closest 50th (C50)	Rounded-Down 85th (RD85)	Closest 85th (C85)
Access points (non-residential driveways and intersections per mile)	• > 40 access points per mile (divided) • > 30 access points per mile (undivided)	• > 20 and ≤ 40 access points per mile (divided) • > 15 and ≤ 30 access points per mile (undivided)	• ≤ 20 access points per mile (divided) • ≤ 15 access points per mile (undivided)
Number of lanes, median type, AADT combination	{Not applicable, see criteria in other cells}	Four or more lanes with no median (undivided) and AADT > 2000 veh/d	• Four or more lanes with divided median • Two lanes with any median type • Four or more lanes with no median (undivided) and AADT ≤ 2000 veh/d • Any number of lanes/median type combination when AADT ≤ 2000
Lane width (LW)	LW ≤ 9 ft and AADT > 2000 veh/d	9 ft < LW < 11 ft and AADT > 2000 veh/d	• LW ≥ 11 ft and AADT > 2000 veh/d • Any lane width when AADT ≤ 2000
SW	SW < 2 ft and AADT > 2000 veh/d	2 ft ≤ SW < 6 ft and AADT > 2000 veh/d	• SW ≥ 6 ft and AADT > 2000 veh/d • Any SW when AADT ≤ 2000
KABCO or KABC crash rate	High	Medium	Low

Speed Limit Setting Group: Developed

Table 7 provides an overview of the variables along with the variable value that would trigger using C85, RD85, or C50. Table 8 provides the decision matrix for sidewalk presence/width, sidewalk buffer, and pedestrian activity combinations for Developed SLSG.

Speed Limit Setting Group: Full-Access

Table 9 provides an overview of the variables along with the variable value that would trigger using C50 or RD50. Table 10 provides the decision matrix for sidewalk presence/width, sidewalk buffer, and pedestrian activity combinations for Full-Access SLSG.

Table 7. Overview of decision rules for Developed area SLSG.

Variable	Closest 50th (C50)	Rounded-Down 85th (RD85)	Closest 85th (C85)
Signal density	> 4 signals/mile	> 3 signals/mile	≤ 3 signals/mile
Access density	> 60 driveways/ unsignalized intersections per mile	> 40 and ≤ 60 driveways/ unsignalized intersections per mile	≤ 40 driveways/ unsignalized intersections per mile
Number of lanes/ median type [undivided, two-way left-turn lane (TWLTL), or divided]	{Not applicable, see criteria in other cells}	Four or more lanes with undivided median	• Four or more lanes with divided or TWLTL median • Fewer than four lanes with any median type
Bicyclist activity in motor vehicle lane, shoulder, or non-separated bike lane	High	{Not applicable, see criteria in other cells}	Not high
Bicyclist activity in separated bike lane	{Not applicable, see criteria in other cells}	High	Not high
Sidewalk presence/width (none, narrow, adequate, or wide), sidewalk buffer (present or not present), and pedestrian activity (high, some, or negligible)	See Table 8	See Table 8	See Table 8
On-street parking activity	High	{Not applicable, see criteria in other cells}	Not high
On-street parking type	Angle parking present for 40 percent or more of section	• Parallel parking permitted • Angle parking present for less than 40 percent of section	None
KABCO or KABC crash rate	High	Medium	Low

Table 8. Decision matrix for sidewalk presence/width, sidewalk buffer, and pedestrian activity combinations for Developed SLSG.

Pedestrian Activity	Sidewalk Presence/Width	Sidewalk Buffer	Speed Percentage
High	Adequate	Not present	RD85
High	Adequate	Present	C85
High	Narrow	Not present	C50
High	Narrow	Present	RD85
High	None	Not applicable	C50
High	Wide	Not present	C85
High	Wide	Present	C85
Some	Adequate	Not present	RD85
Some	Adequate	Present	C85
Some	Narrow	Not present	C50
Some	Narrow	Present	RD85
Some	None	Not applicable	C50
Some	Wide	Not present	C85
Some	Wide	Present	C85
Negligible	Adequate	Not present	C85
Negligible	Adequate	Present	C85
Negligible	Narrow	Not present	C85
Negligible	Narrow	Present	C85
Negligible	None	Not applicable	RD85
Negligible	Wide	Not present	C85
Negligible	Wide	Present	C85
See text for additional discussion on sidewalk presence/width and sidewalk buffer characteristics.			

Table 9. Overview of decision rules for Full-Access SLSG.

Variable	Rounded-Down 50th (RD50)	Closest 50th (C50)
Signal density	> 8 signals/mile	≤ 8 signals/mile
Access density	> 60 driveways/unsignalized intersections per mile	≤ 60 driveways/unsignalized intersections per mile
Bicyclist activity – in motor vehicle lane, shoulder, or non-separated bike lane	High	Not high
Bicyclist activity – in separated bike lane	High	Not high
Sidewalk presence/width (none, narrow, adequate, or wide), sidewalk buffer (present or not present), and pedestrian activity (high, some, or negligible)	See Table 10	See Table 10
On-street parking activity	High	Not high
On-street parking type	Angle parking present for 40 percent or more of section	• No parking present • Angle parking present for less than 40 percent of section
KABCO or KABC crash rate	High or Medium	Low

Table 10. Decision matrix for sidewalk presence/width, sidewalk buffer, and pedestrian activity combinations for Full-Access Speed Limit Setting Group.

Pedestrian Activity	Sidewalk Presence/Width	Sidewalk Buffer	Speed Percentage
High	Adequate	Not present	RD50
High	Adequate	Present	C50
High	Narrow	Not present	RD50
High	Narrow	Present	RD50
High	None	Not applicable	RD50
High	Wide	Not present	C50
High	Wide	Present	C50
Some	Adequate	Not present	RD50
Some	Adequate	Present	C50
Some	Narrow	Not present	RD50
Some	Narrow	Present	RD50
Some	None	Not applicable	RD50
Some	Wide	Not present	C50
Some	Wide	Present	C50
Negligible	Adequate	Not present	C50
Negligible	Adequate	Present	C50
Negligible	Narrow	Not present	C50
Negligible	Narrow	Present	C50
Negligible	None	Not applicable	C50
Negligible	Wide	Not present	C50
Negligible	Wide	Present	C50
See text for additional discussion on sidewalk presence/width and sidewalk buffer characteristics.			

SECTION 5

Variables for Decision-Making Procedure

Roadway Context

NCHRP Research Report 855 (*33*) provides the following two questions for determining a roadway segment's context category:

- For the most part, does it meet the category's primary factors?
- Does the landscape adjacent to the roadway look similar to the photographs/graphic examples in Figure 7?

Roadway Type

The Expanded FCS roadway types follow basic transportation system functions and are defined based on their network function and connectivity. *NCHRP Research Report 855* (*33*) provides the following key characteristics for each roadway type:

1. **Interstates/Freeways/Expressways:** corridors of national importance providing long-distance travel.
   - Limited-Access.
   - Through traffic movements.
   - Primary freight routes.
   - Possible transit network support.
   - No pedestrian or bicycle traffic.
   - Guided by Federal Highway Administration (FHWA) design standards.
2. **Principal Arterials:** corridors of regional importance connecting large centers of activity.
   - Through-traffic movements.
   - Long-distance traffic movements.
   - Long-haul public transit buses.
   - Primary freight routes.
3. **Minor Arterials:** corridors of local importance connecting centers of activity.
   - Connections between local areas and network principal arterials.
   - Connections for through traffic between arterial roads.
   - Access to public transit and through movements.
   - Pedestrian and bicycle movements.
4. **Collectors:** roadways providing connections between arterials and local roads.
   - Traffic with trips ending in a specific area.
   - Access to commercial and residential centers.
   - Access to public transportation.
   - Pedestrian and bicycle movements.
5. **Local:** all other roads.
   - Direct property access—residential and commercial.
   - Pedestrian and bicycle movements.

Illustration	Description
Rural 	Ranges from no development (natural environment) to some light development (structures), with sparse residential and other structures mostly associated with farms. The land is primarily used for outdoor recreation, agriculture, farms, and/or resource extraction. In a rural setting, there are no or very few pedestrians, bicyclists are most likely of recreational nature, and transit is limited or nonexistent.
Rural Town 	Characterized by low density (low-rise—one or two story—structures) but a concentrated development of diverse uses—residential and commercial. Rural towns are generally incorporated but have limited government services. Rural towns usually have a roadway section that has a main street character (or even a town square) with on-street parking and sidewalks and in some cases bicycle lanes.
Suburban 	Diverse range of commercial and residential uses that have a medium density. The buildings tend to be multistory with off-street parking. Sidewalks are usually present, and bicycle lanes may exist. The range of uses encompasses health services, light industrial (and sometimes heavy industrial) uses, quick-stop shops, gas stations, restaurants, and schools and libraries. Typically, suburban areas rely heavily on passenger vehicles, but some transit may be present.
Urban 	High density, consisting principally of multistory and low- to medium-rise structures for residential and commercial use. Areas usually exist for light and sometimes heavy industrial use. Many structures accommodate mixed uses: commercial, residential, and parking. Streets have minimal on-street parking. Wide sidewalks and plazas accommodate more intense pedestrian traffic, while bicycle lanes and transit corridors are frequently present.
Urban Core 	Highest level of density with its mixed residential and commercial uses accommodated in high-rise structures. While there may be some on-street parking, it is usually very limited and time restricted. Most parking is in multilevel structures attached or integrated with other structures. The area is accessible to automobiles, commercial delivery vehicles, and public transit. Sidewalks and pedestrian plazas are present along with multilevel pedestrian bridges connecting commercial and parking structures. Bicycle facilities and transit corridors are typically common.

Source: Transportation Research Board. 2018. *NCHRP Research Report: An Expanded Functional Classification System for Highways and Streets*. HTTPS://DOI.ORG/10.17226/24775. Reproduced with permission from the National Academy of Sciences, pages 10–16 (*33*).

Figure 7. Roadway context illustrations and descriptions.

Roadway Segment Input Variables for Speed Limit Setting Groups

Several variables are needed for use in the SLS-Procedure. The needed variables vary by the SLSG. The speed data variables are provided in Table 11. The table also indicates when the variable is needed based on the SLSG, for example, the 85th percentile speed is not needed for the Full-Access SLSG. Table 12 summarizes the variables and indicates when the variable is needed based on the SLSG. Table 13 shows the variables needed when crash data are available.

Table 11. Input variables for speed data.

Speed Data Variable	Limited-Access	Undeveloped	Developed	Full-Access
50th percentile speed (mph)	✓	✓	✓	✓
85th percentile speed (mph)	✓	✓	✓	-
Maximum speed limit (mph)	✓	✓	✓	✓

Note: ✓ = variables used in SLSG, - = variables not used in SLSG.

Table 12. Roadway segment input variables.

Roadway Segment Variable	Limited-Access	Undeveloped	Developed	Full-Access
AADT (two-way total), annual average daily traffic (veh/d)	✓	✓	-	-
Adverse alignment present (yes or no)	✓	✓	✓	✓
Angle parking present (no, yes for at least 40 percent of the segment, or yes for less than 40 percent of the segment)	-	-	✓	✓
Bicyclist activity (high or not high)	-	-	✓	✓
Design speed (mph), used with grade to identify mountainous terrain	✓	-	-	-
Directional design-hour truck volume (trk/hr)	✓	-	-	-
Grade (%), used with design speed to identify mountainous terrain	✓	-	-	-
Inside (left) SW (ft)	✓	-	-	-
Lane width (ft)	-	✓	-	-
Median type, developed or Full-Access (undivided, TWLTL, or divided)	-	-	✓	✓
Median type, undeveloped (undivided or divided)	-	✓	-	-
Number of access points (total of both directions)	-	✓	✓	✓
Number of interchanges	✓	-	-	-
Number of lanes (two-way total)	✓	✓	✓	✓
Number of traffic signals	-	-	✓	✓
On-street parking activity (high or not high)	-	-	✓	✓
Outside (right) SW (ft)	✓	-	-	-
Parallel parking permitted (yes or no)	-	-	✓	-
Pedestrian activity (high, some, or negligible)	-	-	✓	✓
Segment length (mi)	✓	✓	✓	✓
SW (ft)	-	✓	-	-
Sidewalk buffer (present or not present)	-	-	✓	✓
Sidewalk presence/width (none, narrow, adequate, or wide)	-	-	✓	✓

Note: ✓ = variables used in SLSG, - = variables not used in SLSG.

Table 13. Input variables when crash data are available.

Crash Data Variable	Limited-Access	Undeveloped	Developed	Full-Access
Number of years of crash data	✓	✓	✓	✓
Average AADT (two-way total) for crash data period (veh/d)	✓	✓	✓	✓
All (KABCO) crashes for crash data period	✓	✓	✓	✓
Fatal and injury (KABC) crashes for crash data period	✓	✓	✓	✓
Average KABCO crash rate (crashes/100 MVM) and average KABC crash rate (crashes/100 MVM)? If not provided, the KABCO and KABC crash rates from HSIS is used	✓	✓	✓	✓
Is the segment a one-way street?	-	-	✓	✓
Number of lanes (pulled from the Site Characteristics section)	✓	✓	✓	✓
Median type (pulled from the Site Characteristics section)	-	✓	✓	✓

Note: ✓ = variables used in SLSG, - = variables not used in SLSG.

Speed Data Input Variables for Speed Limit Setting Groups

Speed Data Variable: 50th Percentile Speed (All SLSGs)

The user provides the 50th percentile speed.

Speed Data Variable: 85th Percentile Speed (All SLSGs)

The user provides the 85th percentile speed.

Speed Data Variable: Maximum Speed Limit (All SLSGs)

The user enters the maximum speed limit for the roadway segment in mph.

Roadway Segment Data Input Variables for Speed Limit Setting Groups

Roadway Segment Variable: AADT (Limited-Access, Undeveloped SLSGs)

The user provides the AADT (two-way total) on the Limited-Access or Undeveloped segment.

Roadway Segment Variable: Adverse Alignment Presence (All SLSGs)

The user answers the question "Is an adverse alignment present?" as either yes or no. If yes, the SLS-Tool provides a warning to consider location-specific advisory speed warnings. This variable does not contribute to the calculation of the suggested speed limit.

Roadway Segment Variable: Angle Parking Present (Developed and Full-Access SLSGs)

Because the on-street parking characteristics may vary within a segment, the user provides the on-street parking characteristics that are predominant within the segment. The user indicates if angle parking is present (no, yes for at least 40 percent of the segment, or yes for less than 40 percent of the segment).

Roadway Segment Variable: Bicyclist Activity (Developed and Full-Access SLSGs)

The user indicates if the bicyclist activity is high or not high and whether there is a separated bike line present. Suggested examples of high bicyclist activity are:

- Residential development with four or more housing units per acre interspersed with multi-family dwellings.
- Bicycle treatments including marked bike lanes, bike boxes, etc.
- Multiple transit stops within the segment.

Roadway Segment Variable: Design Speed (Limited-Access SLSG)

The user selects either ≥ 60 mph or ≤ 55 mph for the design speed of the freeway segment. This value along with the grade is used to identify mountainous terrain.

Roadway Segment Variable: Directional Design-Hour Truck Volume (Limited-Access SLSG)

The user enters the directional design-hour truck volume for the freeway segment in the units of trucks per hour.

Roadway Segment Variable: Grade (Limited-Access SLSG)

The user enters the grade for the freeway segment.

Roadway Segment Variable: ISW (Limited-Access SLSG)

The user enters the inside (left) SW for the freeway segment.

Roadway Segment Variable: Lane Width (Undeveloped SLSG)

The user enters the typical LW (ft) for the segment. Examination of the LW crash modification factor (CMF) for undeveloped facilities in the *Highway Safety Manual* (HSM) (*43*) shows that a 12-ft lane width is assigned a CMF of 1.00 (see Table 10.8, Table 11.11, and Table 11.16 in the HSM). The CMF value computes as 1.05 for 11-ft lane width and 1.30 for 10-ft lane width for two-lane roadways. For multilane undivided roadways, these values are 1.04 and 1.23 for 11-ft and 10-ft roadways, respectively. Stapleton et al. (*34*) found that rural two-lane roadway lane widths greater than 12 ft had fewer fatal and injury crashes (KABC) crashes. The guidance for lane width is synthesized as follows:

- If the LW is less than 10 ft, the posted speed limit should be set at the lower of the closest increment to the 50th percentile (C50) or rounded down to the closest increment to the 85th percentile (RD85).
- If the LW is less than 11 ft, the posted speed limit should be set at the higher of the closest increment to the 50th percentile (C50) or rounded down to the closest increment to the 85th percentile (RD85).
- If the LW is equal to or greater than 11 ft, the posted speed limit should be set at the closest increment to the 85th percentile.

Roadway Segment Variable: Median Type (Undeveloped, Developed, and Full-Access SLSGs)

With respect to Developed and Full-Access SLSGs, the safety analyses conducted as part of NCHRP Project 17-76, published as *Web-Only Document 291* (*2*) (Appendix D on Austin, Texas, and Appendix E on Washtenaw County/Greater Ann Arbor, Michigan) found fewer crashes for a raised (divided) median compared to no median. A review of the literature found studies that documented reduction in crashes when a TWLTL was added to a four-lane undivided roadway (*35, 36*).

The research team suggested that the presence of a divided (raised or depressed) median or a TWLTL on a road with four or more lanes be considered the baseline condition, and for undivided four-lane roads to be associated with suggested posted speed limits that reflect the rounding down of the 85th percentile speed.

Because the type of median may vary within a section, the user is asked for the type of median treatment that is predominant within the section.

How median type is used for the Undeveloped SLSG is discussed in the "Number of Lanes/ Median Type Combination" section that follows.

Roadway Segment Variable: Number of Access Points (Undeveloped, Developed, and Full-Access SLSGs)

The user provides the number of non-single-family residential driveways and unsignalized intersections within the segment, and the SLS-Tool calculates the access density (access point per mile). The variable is called *access density* to avoid the question of whether driveways per mile should include unsignalized intersections, which it should.

For the Developed and Full-Access SLSGs, the findings from the NCHRP Project 17-76 research supports the breakpoints used in USLIMITS2 (*37*). All types of non-single-family home driveways, such as multifamily residential, commercial, etc., along with unsignalized intersections, should be counted. The guidance for access points is provided in Table 7 for the Developed SLSG and Table 9 for the Full-Access SLSG, and can be synthesized as follows:

- If the number of access points is less than 40 per mile on Developed or Full-Access streets, the suggested posted speed limit should be the 5-mph increment closest to the 85th percentile speed.
- If the number of access points is greater than 40 per mile or less than or equal to 60 per mile, then the suggested posted speed limit should use RD85.
- If the number of access points is more than 60 per mile, then the suggested posted speed limit should be the 5-mph increment closest to the 50th percentile speed.

Previous studies for undeveloped facilities have shown that roadway safety decreases as the number of access points increases (*34, 38*). Access density for undeveloped conditions should also include any signalized intersection within the corridor. Table 6 provides guidance for access points.

Roadway Segment Variable: Number of Interchanges (Limited-Access SLSG)

The user enters the number of interchanges within the segment. This information is used with the segment length and AADT (two-way total) in veh/d. The program computes interchange spacing as length per interchange and calls for lower suggested speed limits for the specified levels of interchange spacing if the AADT equals or exceeds 180,000 veh/d.

Roadway Segment Variable: Number of Lanes (All SLSGs)

The user enters the number of lanes for both directions of travel.

Roadway Segment Variable: Number of Traffic Signals (Developed and Full-Access SLSGs)

The user provides the number of signals within the segment and the program calculates the number of signals/segment length. Previous research used breakpoints at three and four signals per mile and these values were supported by the findings from the analyses conducted in this research [see *NCHRP Web-Only Document 291* (*2*)]. A revised breakpoint was needed for use in the Full-Access SLSG, and the value of eight signals per mile was selected based on feedback from the research project panel.

Roadway Segment Variable: On-Street Parking Activity (Developed and Full-Access SLSGs)

Because the on-street parking characteristics may vary within a segment, the user provides the on-street parking characteristics that are predominant within the segment. The user indicates if on-street parking activity is high or not high. A high level of on-street parking can be characterized as having parking on both sides of the road with parking time limits.

Roadway Segment Variable: Outside (Right) SW (Limited-Access SLSG)

For Limited-Access facilities, the *Green Book* (*42*) (Chapter 8) calls for outside SWs of at least 12 ft if the truck volume exceeds 250 trk/hr, and at least 10 ft otherwise. Examination of the outside SW CMF for Limited-Access facilities in the HSM (*43*) shows that the outside SW can be reduced slightly without a significant increase in crash frequency. The CMF value computes as 1.21 for an outside SW of 7 ft and 1.14 for an outside SW of 8 ft. In other words, when the outside SW (rounded down to the nearest foot) is less than 8 ft, crash frequency is expected to increase by about 21 percent. Therefore, based on safety considerations, the research team suggested setting the posted speed limit based on the rounded-down 85th percentile if the outside SW is less than 8 ft, or the closest 85th percentile otherwise.

Roadway Segment Variable: Parallel Parking Permitted (Developed SLSGs)

Because the on-street parking characteristics may vary within a segment, the user provides the on-street parking characteristics that are predominant within the segment. The user indicates if parallel parking is permitted (yes or no). Permitted parallel parking on a street within the Developed SLSG results in using RD85.

Roadway Segment Variable: Pedestrian Activity (Developed and Full-Access SLSGs)

The user indicates if the pedestrian activity is high, some, or negligible. Suggested examples of high pedestrian activity are:

- Residential development with four or more housing units per acre interspersed with multi-family dwellings.
- Hotels located within one half mile of other attractions such as retail stores, recreation areas, or senior centers.
- Paved sidewalks, marked crosswalks, and pedestrian signals.
- Multiple transit stops within the segment.

Roadway Segment Variable: Segment Length (All SLSGs)

The user enters the length of the segment in miles.

Roadway Segment Variable: SW (Undeveloped SLSG)

The user enters the typical SW for the segment in feet. Studies have consistently found that wider paved shoulders on undeveloped roadways result in fewer crashes (*39, 40*). Examination of the SW CMF for undeveloped facilities in the HSM (*43*) shows that a 6-ft SW is assigned a CMF of 1.00 (see Table 10.9, Table 11.12, and Table 11.16 in the HSM). The CMF value computes as 1.15 for 4-ft and 1.30 for 2-ft lane widths for two-lane roadways. For multilane undivided roadways, these values are 1.15 and 1.30 for 4-ft and 2-ft SWs, respectively. For multilane divided roadways, an 8-ft right SW is assigned a CMF of 1.00 (see Table 11-17 in the HSM). Table 6 provides the guidance for SW within the SLS-Tool.

Roadway Segment Variable: Sidewalk Buffer (Developed and Full-Access SLSGs)

The user indicates if a sidewalk separation (or buffer) is present or not present. A sidewalk separation (or buffer) reflects the space between the road (the face of the curb when a curb and gutter are present, or the edge of the travel lane when a shoulder is present) and the sidewalk. A buffer could include a nature strip, a bike lane, or on-street parking.

Because the type of sidewalk buffer may vary within a section, the user provides the type of sidewalk buffer treatment that is predominant within the section.

Roadway Segment Variable: Sidewalk Presence/Width (Developed and Full-Access SLSGs)

The *FHWA University Level Course on Bicycle and Pedestrian Transportation* (*41*) (page 13-1) states that "sidewalks require a minimum width of 5.0 feet if set back from the curb or 6.0 feet if at the curb face. Any width less than this does not meet the minimum requirements for people with disabilities."

Because the sidewalk characteristics may vary within a segment, the user provides the sidewalk characteristics that are predominant within the segment. The user indicates the predominant width of the sidewalk within the following four categories for the segment:

- **None:** no sidewalk is present on either side of the street.
- **Narrow:** a narrow sidewalk is present (the sidewalk is less than 5 ft if set back from the curb or 6 ft if at the curb face).
- **Adequate:** An adequate sidewalk is present (the sidewalk is between 8 ft and 5 ft if set back from the curb, or between 8 ft and 6 ft if at the curb face).
- **Wide:** A wide sidewalk is present (the sidewalk is 8 ft or greater).

Combination of Roadway Segment Variables

Roadway Segment Combination of Variables: Grade and Design Speed (Limited-Access SLSG)

Consideration for mountainous terrain based on *Green Book* guidance for maximum grade and design speed of Limited-Access facilities (*42*) (Table 8-1) generated the following guidance:

- If the design speed is 60 mph or greater and the maximum grade exceeds 4 percent, set the posted speed limit as the higher of the closest 50th percentile or the rounded-down 85th percentile.
- If the design speed is 55 mph or less and the maximum grade exceeds 5 percent, set the posted speed limit as the higher of the closest 50th percentile or the rounded-down 85th percentile.
- In all other cases, set the posted speed limit as the closest 85th percentile.

The first two conditions are based on the breakpoints between maximum grades for rolling and mountainous terrain specified by the *Green Book*.

Roadway Segment Combination of Variables: ISW, Number of Lanes, and Hourly Truck Volume (Limited-Access SLSG)

For Limited-Access facilities, the *Green Book* (*42*) (Chapter 8) calls for the following minimum ISW:

- Directional design-hour truck volume ≤ 250 trk/hr and number of lanes (two-way total) < 6 then ISW ≥ 4 ft.
- Directional design-hour truck volume ≤ 250 trk/hr and number of lanes ≥ 6 then ISW ≥ 10 ft.
- Directional design-hour truck volume > 250 trk/hr then ISW ≥ 12 ft.

Examination of the ISW CMF for Limited-Access facilities in the HSM (*43*) shows that the ISW has a minor effect on crash frequency. The CMF value computes as 1.07 for the ISW of 2 ft. Therefore, the research team suggested setting the posted speed limit based on the *Green Book* criteria. If the criteria are met, the posted speed limit is based on the closest 85th percentile. If the criteria are not met, set the posted speed limit based on the rounded-down 85th percentile.

Roadway Segment Combination of Variables: Number of Lanes, Median Type, AADT Combination (Undeveloped SLSG)

With respect to the Undeveloped SLSG, a review of the HSM showed that the crash prediction for undivided four-lane roadways is greater than that for divided four-lane roadways. Four-lane undivided roads with AADT value (two-way total) of 2,000 has about 35 percent more crashes as four-lane divided roads with the same AADT value. The percentage is smaller for roads with AADT values less than 2,000 and larger for AADT values greater than 2,000. Therefore, the research team suggested the rounded-down 85th percentile speed be used when the road has four lanes, is undivided, and has an AADT value of 2,000 or more. Other cases, such as two-lane roads or AADT values less than 2,000, would use the closest 85th percentile speed.

The guidance for the number of lanes/median type combination is synthesized as follows:

- If the undeveloped roadway has an AADT value more than 2,000 is four or more lanes, and is undivided, the posted speed limit should be set using the rounded-down 85th percentile speed (RD85).
- For other cases, such as when the roadway is divided, the closest 85th percentile speed is used. Roads with raised, depressed, or grass medians would be considered divided.

Roadway Segment Variable: Sidewalk Presences/Width, Sidewalk Buffer, and Pedestrian Activity (Developed and Full-Access SLSGs)

When there is a reasonable expectation of pedestrians on or very near a roadway, selection of a lower operating speed can be justified. Sidewalk conditions (width and buffer) and the level of pedestrian activity are used in combination to select the speed percentile; those values are provided in Table 8 for the Developed SLSG and Table 10 for the Full-Access SLSG.

Crash Data Input Variables for Speed Limit Setting Groups

Table 13 shows the variables needed when crash data are available.

Table 14. Average KABCO rate per 100 MVM for Limited-Access SLSG.

AADT Category—Minimum	AADT Category—Maximum	Urban Limited-Access Facilities (Inter_spac > 1 mi)	Rural Limited-Access Facilities (Inter_spac > 1 mi)
0	24,999	92.83	49.20
25,000	49,999	79.80	51.23
50,000	74,999	76.96	44.16
75,000	99,999	88.34	44.16
100,000	149,999	91.16	44.16
150,000	199,999	91.60	44.16
200,000	No Limit	104.51	44.16

Note: Crash rates and injury rates were calculated using the latest 3 years of data that were available: California (2009–2011), Minnesota (2010–2012), North Carolina (2011–2013), Ohio (2010–2012), and Washington State (2010–2012).

Source: Adapted from *User Guide for USLIMITS2* (*44*), Table 1.

Crash Variables

The following variables are needed to be able to conduct an analysis of the crash data:

- Length of the study period in years and months (least 3 years of crash data is recommended; if less than 1 year of data is input, the program suggests that additional data be collected and the process repeated).
- Total number of all crashes (KABCO) in the segment.
- Total number of fatal and injury crashes (KABC) in the segment.
- AADT (two-way total) for the study period.
- Average rate of all (KABCO) crashes and average rate of fatal and injury (KABC) crashes [100 million vehicle miles (MVM)] for similar road segments in their jurisdiction. To determine the average crash/injury rate for similar segments, users should select a group of segments that have the same or similar geometry (i.e., the number of lanes, median type, etc.) and similar traffic volumes and area type.
- For Developed and Full-Access SLSGs, the user also indicates if the road is a one-way street.

Average Crash Rate

The length of study, number of crashes, and AADT are used to calculate the segment crash rate for all (KABCO) crashes and for fatal and injury (KABC) crashes per 100 MVM. If the user does not provide average rates, default values from the HSIS are used (*44*). Table 14 and Table 15 provide the values for the Limited-Access SLSG, Table 16 and Table 17 provide the values for the Undeveloped SLSG, and Table 18 and Table 19 provide the values for the Developed and Full-Access SLSGs.

Table 15. Average KABC crash rate per 100 MVM for Limited-Access SLSG.

AADT Category—Minimum	AADT Category—Maximum	Urban Limited-Access Facilities (Inter_spac > 1 mi)	Rural Limited-Access Facilities (Inter_spac > 1 mi)
0	24,999	24.74	13.39
25,000	49,999	21.24	12.92
50,000	74,999	21.37	14.41
75,000	99,999	25.15	14.41
100,000	149,999	27.69	14.41
150,000	199,999	29.25	14.41
200,000	No Limit	30.75	14.41

Note: Crash rates and injury rates were calculated using the latest 3 years of data that were available: California (2009–2011), Minnesota (2010–2012), North Carolina (2011–2013), Ohio (2010–2012), and Washington State (2010–2012).

Source: Adapted from *User Guide for USLIMITS2* (*44*), Table 1.

Table 16. Average KABCO rate per 100 MVM for Undeveloped SLSG.

AADT Category—Minimum	AADT Category—Maximum	Two-Lane Roads	Multilane Divided	Multilane Undivided
0	1,249	206.56	102.55	153.35
1,250	2,499	166.00	102.55	153.35
2,500	3,749	147.23	102.55	153.35
3,750	4,999	133.96	102.55	153.35
5,000	6,249	128.57	76.77	145.63
6,250	7,499	121.91	76.77	145.63
7,500	8,749	125.70	76.77	145.63
8,750	9,999	123.35	76.77	145.63
10,000	14,999	98.16	73.90	124.54
15,000	19,999	98.16	70.83	124.54
20,000	24,999	98.16	70.59	124.54
25,000	No limit	98.16	65.56	124.54

Note: Crash rates and injury rates were calculated using the latest 3 years of data that were available: California (2009–2011), Minnesota (2010–2012), North Carolina (2011–2013), Ohio (2010–2012), and Washington State (2010–2012).

Source: Adapted from *User Guide for USLIMITS2* (*44*), Table 1.

Table 17. Average KABC crash rate per 100 MVM for Undeveloped SLSG.

AADT Category—Minimum	AADT Category—Maximum	Two-Lane Roads	Multilane Divided	Multilane Undivided
0	1,249	65.21	28.93	50.00
1,250	2,499	54.01	28.93	50.00
2,500	3,749	47.73	28.93	50.00
3,750	4,999	43.89	28.93	50.00
5,000	6,249	43.29	22.14	42.08
6,250	7,499	41.46	22.14	42.08
7,500	8,749	44.14	22.14	42.08
8,750	9,999	43.46	22.14	42.08
10,000	14,999	35.60	20.77	41.14
15,000	19,999	35.60	20.79	41.14
20,000	24,999	35.60	23.11	41.14
25,000	No limit	35.60	21.28	41.14

Note: Crash rates and injury rates were calculated using the latest 3 years of data that were available: California (2009–2011), Minnesota (2010–2012), North Carolina (2011–2013), Ohio (2010–2012), and Washington State (2010–2012).

Source: Adapted from *User Guide for USLIMITS2* (*44*), Table 1.

Table 18. Average KABCO crash rate per 100 MVM for Developed and Full-Access SLSGs.

AADT Category—Minimum	AADT Category—Maximum	Two-Lane Roads	Multilane Divided	Multilane Undivided	One-Way Streets
0	2,499	263.17	226.43	452.14	245.12
2,500	4,999	209.14	226.43	452.14	245.12
5,000	7,499	205.37	226.43	452.14	139.27
7,500	9,999	229.55	226.43	452.14	139.27
10,000	14,999	246.62	202.46	452.26	72.18
15,000	19,999	253.25	202.46	452.26	58.31
20,000	24,999	225.17	228.69	431.09	57.36
25,000	29,999	225.17	228.69	431.09	63.87
30,000	39,999	225.17	228.37	431.25	54.63
40,000	49,999	225.17	205.73	431.25	54.63
50,000	No limit	225.17	158.17	431.25	54.63

Note: Crash rates and injury rates were calculated using the latest 3 years of data that were available: California (2009–2011), Minnesota (2010–2012), North Carolina (2011–2013), Ohio (2010–2012), and Washington State (2010–2012).

Source: Adapted from *User Guide for USLIMITS2* (*44*), Table 1.

Table 19. Average KABC crash rate per 100 MVM for Developed and Full-Access SLSGs.

AADT Category—Minimum	AADT Category—Maximum	Two-Lane Roads	Multilane Divided	Multilane Undivided	One-Way Streets
0	2,499	67.32	72.02	131.02	60.21
2,500	4,999	64.31	72.02	131.02	60.21
5,000	7,499	63.75	72.02	131.02	37.29
7,500	9,999	70.26	72.02	131.02	37.29
10,000	14,999	73.14	66.16	131.98	22.79
15,000	19,999	78.14	66.16	131.98	18.19
20,000	24,999	71.82	75.37	129.00	17.72
25,000	29,999	71.82	75.37	129.00	20.07
30,000	39,999	71.82	74.01	131.10	15.03
40,000	49,999	71.82	70.84	131.10	15.03
50,000	No limit	71.82	56.32	131.10	15.03

Note: Crash rates and injury rates were calculated using the latest 3 years of data that were available: California (2009–2011), Minnesota (2010–2012), North Carolina (2011–2013), Ohio (2010–2012), and Washington State (2010–2012).

Source: Adapted from *User Guide for USLIMITS2* (*44*), Table 1.

Critical Crash Rate

The critical crash rate is calculated from:

$$R_c = R_a + K\sqrt{\frac{R_a}{M}} + \frac{1}{2M}$$

Where:

R_c = Critical crash rate for a given road type.
R_a = Average crash rate for a given road type, provided by the user or obtained from Tables 14 through 19.
K = Constant associated with the confidence level (1.645 for 95 percent confidence).
M = Exposure (100 MVM).

Crash Rate Scenarios

When crash data are available, the program compares the crash rate—both all (KABCO) and fatal and injury (KABC)—for the segment to the critical crash rate and average crash rate, and uses the worst-case scenario. The crash rate is put into one of three categories:

- **High:** Segment crash_rate > critical crash rate.
- **Medium:** Segment crash_rate > 1.3 average crash rate.
- **Low:** neither of the above is true.

SECTION 6

Speed Limit Setting Tool

Overview of SLS-Tool Requirements

The SLS-Tool is designed to help practitioners assess and establish consistent speed limits for segments of streets and highways. The tool combines customary engineering studies with context-sensitive considerations to identify appropriate speed limits. The engineering studies typically include evaluating criteria such as 85th percentile speed, traffic volume, number of access points, bicyclist activity, pedestrian activity, crash history, and others. The SLS-Tool is designed to produce an unbiased and objective suggested speed limit value based on the 50th and 85th percentile speed, roadway characteristics, and safety.

The SLS-Tool is an Excel®-based spreadsheet program that provides an objective suggested speed limit that traffic engineers can use to communicate with the public or government officials to explain the methodology behind setting speed limits. The tool provides the rationale for setting the speed limit based on key site characteristics, including the statutory speed limit, the distribution of traffic speed, site characteristics, and crash data.

Two versions of the SLS-Tool are available:

- N17-76 SLS-Tool (macro).
- N17-76 SLS-Tool (no macro).

The N17-76 SLS-Tool (macro) uses macro code to display the required data input cells for the specified roadway context and type. This worksheet contains a single analysis worksheet that is used for all SLSGs. The macro code displays only the required data entry rows for the roadway context and type specified by the user. The macro code also includes control buttons that allow the user to clear the data from the Analysis worksheet or populate the data entry cells with a set of default values. When the user opens the tool, Excel® may display a security message indicating that macro code has been disabled. The user must click the “Enable Content” button that appears in a yellow ribbon on the top of the screen. It may also be necessary to check the macro security settings as follows:

1. Select “File” in the upper ribbon.
2. Select “Options.”
3. Select “Trust Center.”
4. Click the “Trust Center Settings” button.
5. Select “Macro Settings.”
6. If the option of “Disable all macros without notification” is selected, select a different option and click the “OK” button.

The other version of the SLS-Tool—N17-76 SLS-Tool (no macro)—does not use macro code. This version is available for users who are not able to use macro codes on their computers. The no-macro version contains one analysis worksheet for each SLSG (Limited-Access, Developed, Undeveloped, and Full-Access), and the user must select the appropriate worksheet for each analyzed segment. This version does not provide control buttons to clear data or populate the data entry cells with default values.

Data Entry

The main data entry area is located in columns A–F of the worksheet. The data entry area is organized with boxes for the following data categories:

- **Site Description Data:** Enter basic roadway characteristics such as the roadway context and type, indicate whether crash data are available for the analysis, and enter optional information such as the user's name, analysis date, and roadway segment location.
- **Analysis Results:** The SLS-Tool provides the roadway group (Limited-Access, Developed, Undeveloped, or Full-Access) based on the specified roadway context and type, and displays the suggested speed limit.
- **Speed Data:** Enter the maximum (statutory) speed limit and the needed speed distribution values. The 50th percentile speed is needed for all roadway groups, and the 85th percentile speed is needed for all roadway groups except Full-Access.
- **Site Characteristics:** Enter data to specify the segment length, AADT (two-way total), number of lanes, and other attributes describing the segment's design and traffic control characteristics.
- **Crash Data:** If crash data are available, enter data to specify the time period, traffic volume, and crash counts.

Most of the cells in the SLS-Tool are locked to prevent the user from altering equations and obtaining inaccurate results. Data entry cells are unlocked, and many of the cells have drop-down menus that contain the valid entry options for the cell. For example, the roadway context cell is limited to the categories listed in Figure 7 (Rural, Rural Town, Suburban, Urban, and Urban Core).

The data entry cells are color coded to help the user understand the type of data needed. The following colors are used:

- **Aqua:** basic input cell.
- **Denim:** basic input cell with drop-down menu.
- **Orange:** optional input cell (not needed for calculations). These cells include the user's name, analysis date, roadway name and description, current speed limit, and notes. The user may enter this information for documentation purposes if desired.
- **Green:** optional input cell. These cells contain values that are used for calculations but should be left blank if values are not available. Specifically, the user may enter average crash rates for segments like the one being analyzed, but the SLS-Tool can also estimate average crash rates if the user lacks data to provide average crash rates.
- **Rose:** intermediate calculations.
- **Purple:** final analysis results (specifically, the suggested speed limit).
- **Yellow:** calibration coefficient or policy value. The user should change these cells only based on actual data (e.g., crash rates for specified roadway types) or documented policies (e.g., statutory minimum and maximum speed limits).

Select values used in the analysis calculations are in the "Support Tables" worksheet. That worksheet includes the assumed values for minimum segment lengths by speed limits, upper and lower speed limits by roadway group, SLSGs by roadway type and roadway context, and HSIS crash rates.

Intermediate calculation cells are located to the right of the data entry area. Users will not need to use these cells.

A legend is provided on the top portion of the main data entry area to summarize the color-coding patterns. A button labeled "Clear all data" is also provided to allow the user to clear input data and restart the analysis with a blank worksheet. When this button is clicked, a message box appears and asks, "Clear all input data?" Click yes to clear the data or no to cancel the operation. After clicking yes, a second message box appears and asks, "Enter default values into data entry cells?" Click yes to populate the data entry cells with default values or no to leave the cells blank.

Advisory, Calculated, or Warning Messages

The SLS-Tool checks for several conditions and issues messages as needed. Table 20 lists the conditions along with the advisory, calculated, or warning messages. These messages are color coded to indicate the message types as follows:

- **Advisory message:** blue font, used to call attention to issues that are not errors but could be improved.
- **Calculated message:** purple font, used to describe calculation results.
- **Warning message:** red font, used to call attention to erroneous input data.

Table 20. SLS-Tool advisory, calculated, or warning messages.

Condition	Message
Missing required data	Enter values for all variables marked with O. (An O will appear to the right of empty input cells.)
Missing roadway context or roadway type	Specify roadway context and roadway type in cells B5 and B6.
Completed calculations	This value is determined by <*x*>. (The quantity *x* is specified as the maximum speed limit, speed data, site characteristics, and/or crash data, depending on which variables governed the setting of the speed limit.)
Completed calculations but with maximum speed limit out of range (too high)	The calculated value exceeds the upper value for this speed limit setting group; therefore, the suggested speed limit reflects the assumed upper value.
Completed calculations but with maximum speed limit out of range (too low)	The calculated value is below the lower value for this speed limit setting group; therefore, the suggested speed limit reflects the assumed lower value.
Maximum speed limit out of range (too high)	The assumed upper value for this speed limit setting group is <max> mph.
Maximum speed limit out of range (too low)	The assumed lower value for this speed limit setting group is <min> mph.
50th percentile speed is greater than 85th percentile speed	The 85th percentile must be greater than the 50th percentile.
85th percentile speed is only 1 mph greater than 50th percentile speed (suggesting a very tight speed distribution)	The 85th percentile is only 1 mph greater than 50th percentile. Interpret results with caution.
Segment length < Minimum_Segment_Length	For a suggested speed limit of *x* mph, minimum segment length = *y* mi.
Adverse alignment present	Consider location-specific advisory speed warnings.
Less than 1 year of crash data	Calculations based on 1 year of crash data or less and should be interpreted with caution.
Less than 3 years of crash data	Consider collecting at least 3 years of crash data.
Average crash rates are greater than computed critical crash rates	Critical rates should be higher than average rates.
The entered number of KABC crashes is greater than the entered number of KABCO crashes	The number of KABC crashes must be less than or equal to the number of KABCO crashes.
Crash rates are calculated from input data	Observed/average KABCO/KABC crash rate = *x* crashes/100 MVM. (For average crash rates, the message will also specify "from User" if the user provided the rate or "from HSIS" if the user did not provide the rate.)
Input data value justifies lowering the speed limit below the closest 85th percentile value	Rounded-down 85th, closest 50th, or rounded-down 50th percentile value.

Table 21. Upper and lower speed limit checks by Speed Limit Setting Group.

SLSG	Upper Speed Limit Check[a]	Lower Speed Limit Check
Limited-Access	Depends on the state. The SLS-Tool has 85 mph as the upper limit because it is the highest currently allowed in the United States.	50
Undeveloped	Depends on the state. The SLS-Tool has 70mph.	25
Developed	55	25
Full-Access	30	15

[a]Use the maximum speed provided by the user if the user-provided speed is lower than the value in this table.

Several messages refer to the upper and lower speed limit values for the relevant roadway group. Table 21 provides these upper and lower values. The values can be altered in the yellow table in the "Calibration Tables" worksheet if needed. For example, if the segment of interest is an undeveloped facility in a jurisdiction that has a maximum speed limit of 75 mph for these types of facilities, then the user can enter 75 mph into the appropriate cell in the yellow table.

How to Handle Situations When Data Are Not Available for One of the Variables

Some of the variables are fundamental quantities that must be provided for all analysis cases. These variables include roadway context and roadway type. For all other variables, default values can be used if actual data are not available. Table 22 shows these values for speed- and geometric-related variables, and Table 23 shows values for crash-related variables.

Table 22. Input data default values for speed and geometric-related variables.

Variable	Roadway Group	Default Value
50th percentile speed	All	Maximum speed limit – 5 mph
85th percentile speed	Limited-Access, Developed, or Undeveloped	Maximum speed limit – 2 mph
AADT (two-way total)	Developed	30,000 veh/d
AADT (two-way total)	Full-Access	10,000 veh/d
AADT (two-way total)	Limited-Access (roadway context = rural)	25,000 veh/d
AADT (two-way total)	Limited-Access (roadway context = urban)	60,000 veh/d
AADT (two-way total)	Undeveloped	15,000 veh/d
Angle parking present	Developed or Full-Access	No
Bicyclist activity	Developed or Full-Access	Not high
Design speed	Limited-Access	≥ 60 mph
Directional design-hour truck volume	Limited-Access	200 trucks/hr
Grade	Limited-Access	0%
ISW	Limited-Access	6 ft
Lane width	Undeveloped	12 ft
Maximum speed limit	All	See Table 21
Median type	Developed or Full-Access	Divided
Median type	Undeveloped	Divided
Number of access points	Developed	40 access points
Number of access points	Full-Access	60 access points
Number of access points	Undeveloped	15 access points
Number of interchanges	Limited-Access	7 (1 interchange/mi × 7 mi)
Number of lanes	Developed, Undeveloped, or Full-Access	4 lanes
Number of lanes	Limited-Access	6 lanes

Table 22. (Continued)

Variable	Roadway Group	Default Value
Number of traffic signals	Developed	3 signals
Number of traffic signals	Full-Access	8 signals
On-street parking activity	Developed or Full-Access	Not high
Outside SW	Limited-Access	10 ft
Parallel parking permitted?	Developed	No
Pedestrian activity	Developed or Full-Access	Negligible
Segment length	Developed or Full-Access	1 mi
Segment length	Limited-Access or Undeveloped	7 mi
SW	Undeveloped	10 ft
Sidewalk buffer	Developed or Full-Access	Present
Sidewalk presence/width	Developed or Full-Access	Adequate

Table 23. Input data default values for crash-related variables.

Variable	Roadway Group	Default Value
Crash data availability	All	Yes
Number of years of crash data	All	3 years
Is the segment a one-way street?	Developed or Full-Access	No
Average AADT (two-way total) for crash data period	All	Same as AADT for site characteristics data
All (KABCO) crashes for crash data period	All	Number needed to yield a crash rate equal to 1/3 that of the HSIS-based average rate
Fatal and injury (KABC) crashes for crash data period	All	Number needed to yield a crash rate equal to 1/3 that of the HSIS-based average rate

The default values are chosen to reflect ideal conditions. That is, a site with conditions equal to the default values will have its speed limit set based on the closest 85th percentile speed. The user must enter any data values that deviate from ideal conditions, which may result in setting the speed limit based on a lower speed.

SECTION 7

SLS-Tool Case Study Examples

Example 1: Limited-Access

Example 1 is a freeway in a large city. Crash data are not available. The following information is available for the site:

- Segment length = 6.5 mi.
- AADT (two-way total) = 130,000 veh/d.
- Directional design-hour volume = 200 trucks/hr.
- Number of lanes (total in both directions) = 6.
- Number of interchanges = 5.
- Design speed ≥ 60 mph.
- Grade = 2 percent.
- Outside SW = 10 ft.
- ISW = 2 ft.
- Maximum speed limit = 70 mph.
- Current posted speed limit = 65 mph.
- 85th percentile = 71 mph.
- 50th percentile = 67 mph.
- No adverse alignment present.

With these input variables, the suggested speed limit is computed as 70 mph. The speed limit criterion is identified as the rounded-down 85th percentile because of the narrow 2-ft ISW. Figure 8 shows the calculations.

Example 2: Undeveloped

Example 2 is for a rural, two-lane highway with the following characteristics:

- Segment length = 7.2 mi.
- AADT (two-way total) = 2250 veh/d.
- Number of lanes = 2.
- Median type = none.
- Number of access points (non-residential driveways and unsignalized intersections) = 14.
- Lane width = 12 ft.
- SW = 4 ft.
- Current posted speed limit = 65 mph.
- 85th percentile = 72 mph.
- 50th percentile = 68 mph.
- Adverse alignment is present.

NCHRP 17-76 Speed Limit Setting Tool

Input Cells	Description	Output Cells

Site Description Data

Input	Description
Urban	Roadway context
Freeway	Roadway type
Yes	Are crash data available?
User	Analyst
3/18/2020	Date
Example	Roadway name
Example 1	Description
65	Current speed limit (mph)
	Notes

Clear all data | Enter default data | Test macros

Color-Coding Legend

- Aqua = basic input cell
- Denim = basic input cell with drop-down menu
- Orange = optional input cell (not needed for calculations)
- Green = optional input cell (use if data for agency & region are available, leave blank otherwise)
- Rose = intermediate calculations
- Purple = final analysis results

Note: The "Test macros" button provides a message to verify proper macro operation.

Analysis Results — Advisory, Calculated, or Warning Messages

Speed limit setting group	Limited access	
Suggested speed limit (mph)	70	This value is determined by speed data & site characteristics.

Speed Data — Advisory, Calculated, or Warning Messages

Input	Description	Message
70	Maximum speed limit (mph)	
71	85th-percentile speed (mph)	
67	50th-percentile speed (mph)	

Site Characteristics — Advisory, Calculated, or Warning Messages

Input	Description	Message
6.5	Segment length (mi)	
130,000	AADT (two-way total) (veh/d)	
6	Number of lanes (two-way total)	
200	Directional design-hour truck volume (trk/hr)	
5	Number of interchanges	1.3 miles between interchanges
≥ 60 mph	Design speed (mph)	
2	Grade (%)	
10	Outside shoulder width (ft)	
2	Inside shoulder width (ft)	Rounded-Down 85th
No	Adverse alignment present?	

Crash Data — Advisory, Calculated, or Warning Messages

Input	Description	Output	Message
3	Number of years of crash data		
25,000	Average AADT for crash data period (veh/d)		
16	All (KABCO) crashes for crash data period		Observed KABCO crash rate = 8.99 crashes / 100 MVMT
4	Fatal & injury (KABC) crashes for crash data period		Observed KABC crash rate = 2.25 crashes / 100 MVMT
	Average KABCO crash rate (crashes / 100 MVMT)		HSIS average KABCO crash rate = 79.8 crashes / 100 MVMT
	Average KABC crash rate (crashes / 100 MVMT)		HSIS average KABC crash rate = 21.24 crashes / 100 MVMT
	1.3 x average KABCO crash rate (crashes / 100 MVMT)	103.7	
	1.3 x average KABC crash rate (crashes / 100 MVMT)	27.6	
	Critical KABCO crash rate (crashes / 100 MVMT)	91.1	
	Critical KABC crash rate (crashes / 100 MVMT)	27.2	

Figure 8. Spreadsheet analysis of Example 1: Limited-Access Segment.

Crash data are available and include the following:

- Number of years of crash data = 5 years.
- Average AADT (two-way total) for crash data period = 2200 veh/d.
- Number of all (KABCO) crashes for crash data period = 30 crashes.
- Number of fatal and injury (KABC) crashes for crash data period = 20 crashes.

With these input variables, the suggested speed limit is computed as 70 mph. The speed limit criterion is identified as the rounded-down 85th percentile because of the narrow 4-ft SW. Figure 9 shows the calculations.

Example 3: Developed

Example 3 is for a principal arterial in a suburban area with the following characteristics:

- Current posted speed limit = 40 mph.
- Maximum speed limit = 50 mph.
- 85th percentile = 43 mph.
- 50th percentile = 38 mph.
- Segment length = 2 mi.

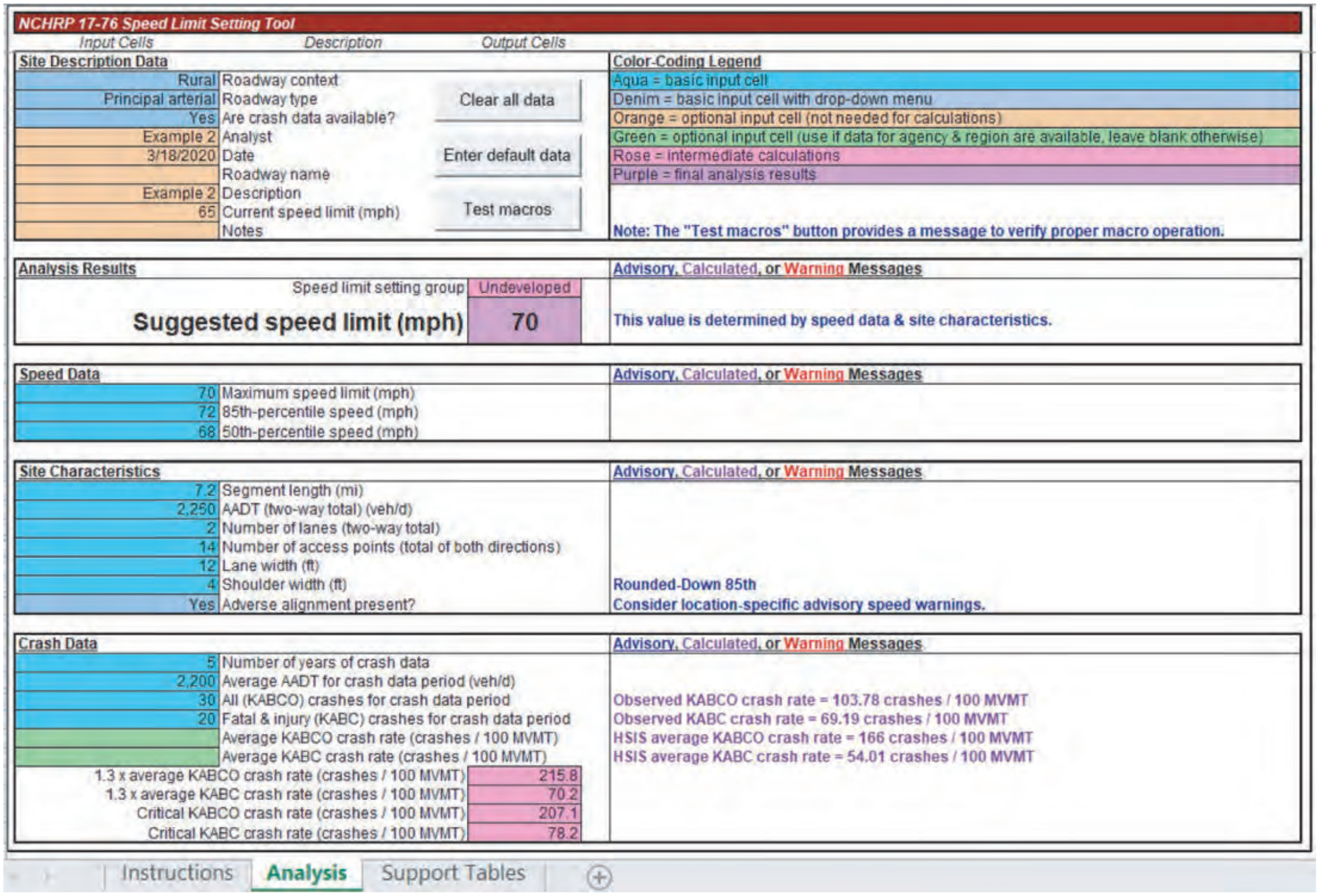


Figure 9. Spreadsheet analysis of Example 2: Undeveloped Segment.

- Number of lanes = 4.
- Median type = TWLTL.
- Number of traffic signals = 3.
- Number of access points (non-residential driveways and unsignalized intersections) = 15.
- Bicyclist activity = not high.
- Sidewalk presence/width = none.
- Sidewalk buffer = not applicable since sidewalk is not present.
- Pedestrian activity = some.
- On-street parking activity = not high.
- Parallel parking permitted = yes.
- Angle parking present = no.
- Adverse alignment present = no.

Crash data are available and include the following:

- Number of years of crash data = 2 years.
- Average AADT (two-way total) for crash data period = 20,000 veh/d.
- The segment has two-way traffic.
- Number of all (KABCO) crashes for crash data period = 25 crashes.
- Number of fatal and injury (KABC) crashes for crash data period = 10 crashes.

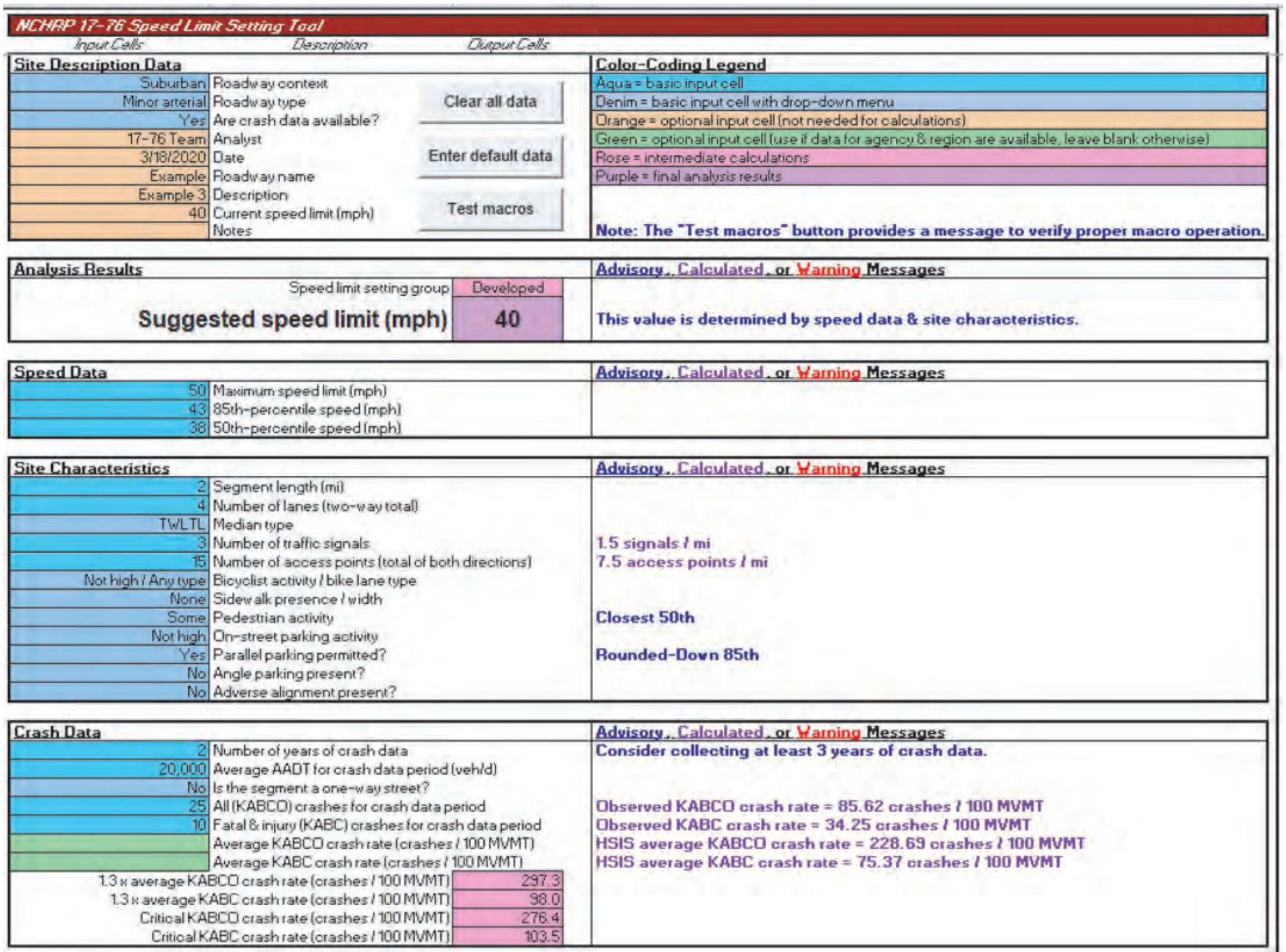


Figure 10. Spreadsheet analysis of Example 3: Developed Segment.

With these input variables, the suggested speed limit is computed as 40 mph. Figure 10 shows the calculations. The speed limit criterion is identified as the closest 50th percentile because no sidewalks are present. If sidewalks of adequate width were added, sidewalks with narrow width and a buffer were added, or pedestrian activity was negligible, the speed limit criterion would be the rounded-down 85th percentile. Because the years of crash data is less than desired (only 2 years rather than 3 years), the SLS-Tool provides an advisory message of "Consider collecting at least 3 years of crash data."

Example 4: Full-Access

Example 4 is for a collector street in the urban core of a city. The following characteristics are available:

- Current posted speed limit = 30 mph.
- Maximum speed limit = 30 mph.
- 50th percentile = 32 mph.

- Segment length = 1 mi.
- Number of lanes = 2.
- Median type = undivided.
- Number of traffic signals = 3.
- Number of access points, total of both directions (non-residential driveways and unsignalized intersections) = 10.
- Bicyclist activity = not high.
- Sidewalk presence/width = wide.
- Sidewalk buffer = present.
- Pedestrian activity = high.
- On-street parking activity = high.
- Angle parking present = no.
- Adverse alignment present = no.

Crash data are available and include the following:

- Number of years of crash data = 5 years.
- Average AADT (two-way total) for crash data period = 10,000 veh/d.
- The segment has two-way traffic.
- Number of all (KABCO) crashes for crash data period = 50 crashes.
- Number of fatal and injury (KABC) crashes for crash data period = 25 crashes.

With these input variables, the suggested speed limit is computed as 30 mph. The speed limit criterion is identified as the rounded-down 50th percentile because of the high number of KABC crashes on the segment. The observed KABC crash rate of 114.16 crashes/100 MVM exceeds the critical KABC crash rate of 105.5 crashes/100 MVM. The high level on-street parking activity also results in the suggested speed limit being the rounded-down 50th percentile value. Figure 11 shows the calculations.

NCHRP 17-76 Speed Limit Setting Tool

Input Cells	*Description*	*Output Cells*

Site Description Data			Color-Coding Legend
Urban core	Roadway context		Aqua = basic input cell
Collector	Roadway type	Clear all data	Denim = basic input cell with drop-down menu
yes	Are crash data available?		Orange = optional input cell (not needed for calculations)
User	Analyst		Green = optional input cell (use if data for agency & region are available, leave blank otherwise)
3/18/2020	Date	Enter default data	Rose = intermediate calculations
Example	Roadway name		Purple = final analysis results
Example 4	Description		
30	Current speed limit (mph)	Test macros	
	Notes		Note: The "Test macros" button provides a message to verify proper macro operation.

Analysis Results		Advisory, Calculated, or Warning Messages
Speed limit setting group	Full access	
Suggested speed limit (mph)	**30**	This value is determined by speed data, site characteristics, & crash data.

Speed Data		Advisory, Calculated, or Warning Messages
30	Maximum speed limit (mph)	
33	50th-percentile speed (mph)	

Site Characteristics		Advisory, Calculated, or Warning Messages
1.2	Segment length (mi)	
2	Number of lanes (two-way total)	
Undivided	Median type	
3	Number of traffic signals	2.5 signals / mi
10	Number of access points (total of both directions)	8.33 access points / mi
Not high / Any type	Bicyclist activity / bike lane type	
Wide	Sidewalk presence / width	
Present	Sidewalk buffer	
High	Pedestrian activity	
High	On-street parking activity	Rounded-Down 50th
No	Angle parking present?	
No	Adverse alignment present?	

Crash Data		Advisory, Calculated, or Warning Messages
5	Number of years of crash data	
10,000	Average AADT for crash data period (veh/d)	
No	Is the segment a one-way street?	
50	All (KABCO) crashes for crash data period	Observed KABCO crash rate = 228.31 crashes / 100 MVMT
25	Fatal & injury (KABC) crashes for crash data period	Observed KABC crash rate = 114.16 crashes / 100 MVMT
	Average KABCO crash rate (crashes / 100 MVMT)	HSIS average KABCO crash rate = 246.62 crashes / 100 MVMT
	Average KABC crash rate (crashes / 100 MVMT)	HSIS average KABC crash rate = 73.14 crashes / 100 MVMT
1.3 x average KABCO crash rate (crashes / 100 MVMT)	320.6	
1.3 x average KABC crash rate (crashes / 100 MVMT)	95.1	
Critical KABCO crash rate (crashes / 100 MVMT)	304.1	
Critical KABC crash rate (crashes / 100 MVMT)	105.5	Rounded-Down 50th

Figure 11. Spreadsheet analysis of Example 4: Full-Access Segment.

SECTION 8

Other Considerations When Setting Posted Speed Limits

Why 85th or 50th Percentile Speed?

Currently, the predominant method for setting speed limits is with the use of the 85th percentile speed. It was viewed as being representative of a safe speed that would minimize crashes, and the 1964 Solomon study (*45*) is frequently quoted as being the source to justify the use of the 85th percentile speed. The use of the 85th percentile speed has been supported because it:

- Represents a safe speed that minimizes crashes.
- Promotes uniform traffic flow along a corridor.
- Is a fair way to set the speed limit based on the driving behavior of most of the drivers (i.e., 85 percent).
- Represents reasonable and prudent drivers since the fastest 15 percent of drivers are excluded.
- Is enforceable in that it is fair to ticket the small percentage (15 percent) of drivers that exceed the posted speed limit.

Criticisms of the 85th percentile speed method have included the following:

- Setting the posted speed limit based on existing driver behavior may create unsafe road conditions because drivers may not see or be aware of all the conditions present within the corridor.
- Setting the posted speed limit on existing driver behavior rather than the roadway context may not adequately consider vulnerable roadway users such as pedestrians and bicyclists.
- Drivers are not always reasonable and prudent, or they only consider what is reasonable and prudent for themselves and not for all users of the system.
- Using measured operating speeds could cause operating speeds to increase over time (i.e., speed creep). Drivers frequently select speeds a certain increment above the posted speed limit, anticipating that they will not receive a ticket if they are not above that assumed enforcement speed tolerance. If this occurs, the resulting operating speed would be above the posted speed limit. Using the 85th percentile speed approach in this situation would result in recommending a posted speed limit that is higher than the existing posted speed limit. Posting that higher speed limit would set up the cycle that the next spot speed study may again find a higher operating speed because of drivers using the assumed speed enforcement tolerance to select their speed.
- Most of the early research justifying the use of the 85th percentile speed was conducted on rural roads; therefore, it may not be appropriate for urban roads.

The NCHRP Project 17-76 research team focused Phase II on collecting data for suburban and urban roads to investigate the relationships among crashes, roadway characteristics, and posted speed limit to fill the known research gap for city streets. The team found that crashes were lowest when the operating speed was within 5 mph of the average operating speed (see Appendix D of *NCHRP Web-Only Document 291*). Therefore, the research team recommended that the 50th percentile speed also be a consideration within the SLS-Procedure.

For the SLS-Procedure, the research team suggested the consideration of measured operating speed as the starting point for selecting a posted speed limit, but that the measured operating speed be adjusted based on roadway conditions and the crash experience on the segment.

Identifying the Segment Limits

Roadway segments are defined based on roadway characteristics and roadway context and type. In general, segments should be homogeneous; that is, the key variables listed in Table 22 should be reasonably uniform throughout the length of the segment. Whenever a significant change in a variable occurs, a new segment should be defined. In particular, a new segment should be defined if the number of lanes, roadway context, or roadway type changes. New segments may also be defined at logical break points based on traffic operations, such as at a major intersection with high turning volumes or a large freeway system interchange. Consider the following rules of thumb in defining break points between segments:

- Roadway context: any change.
- Roadway type: any change.
- AADT or directional design-hour volume: a change of 10 percent or more.
- Number of lanes: any change.
- Median type: any change.
- LW: change of 1 ft or more (length-weighted average for the overall segment).
- Outside or ISW: change of 2 ft or more (length-weighted average for the overall segment).
- Number of interchanges, traffic signals, or access points: the number per mile changes by 50 percent or more.
- Pedestrian or bicyclist activity: any change.
- Sidewalk presence/width: any change.
- Sidewalk buffer presence: any change.
- On-street parking activity, parallel parking presence, or angle parking presence: any change.

Some of these rules of thumb are based on the principles described for the segmentation process in Section 18.5.2 of the HSM but with somewhat higher tolerances permitted for segmentation in speed limit calculation than for safety prediction model application.

Table 24 provides minimum segment lengths based on the speed limit. If segments are defined with shorter lengths than the minimums, the roadway may have too many speed limit changes

Table 24. Minimum segment length for a particular speed limit.

Speed Limit (mph)	Minimum Length (miles)
20	0.30
25	0.30
30	0.30
35	0.35
40	0.40
45	0.45
50	0.50
55	0.55
60	1.20
65	3.00
70	6.20
75	6.20
80	6.20
85	6.20

Source: FHWA, USLIMITS 2, Table 2, page 34 (*44*).

along its length, and record keeping for the roadway will be more complex. If the roadway has a large number of short segments, it may be necessary to combine adjacent segments that are reasonably similar or apply speed limits from adjacent segments to the segment of interest, if appropriate. However, at locations where a significant change in roadway context occurs, it may be desirable to include short sections where the speed limit transitions from a high value to a low value. For example, if a rural principal arterial approaches a rural town, several short segments may be used to reduce speeds to a value consistent with rural town traffic.

Roadway segments may have individual concerns, such as a sharp horizontal curve, that require lower speeds. These concerns should be addressed with treatments that consider the specific location, such as posting an advisory speed, rather than by lowering the regulatory speed limit for the entire segment.

Gathering Operating Speed

In a general sense, the term *operating speed* relates to the speed at which drivers operate their vehicles along a section of roadway. Typically, for speed limit setting purposes, operating speeds are collected for a representative sample of free-flowing vehicles traveling along a road segment. Free-flowing vehicles are those that are unimpeded by other vehicles or TCDs. Speed data are typically collected at a specific location (or *spot*) to represent the operating speed along an entire homogeneous segment. The speed data should be collected outside the influence area of a traffic control signal, which is generally considered to be approximately 0.5 miles. If the signal spacing is less than 1 mile, the speed study should be at approximately the middle of the segment. Attention should also be given to collect data away from other potential traffic interruptions, including stops signs, driveways, and bus stops. Further, data should only be collected during dry conditions and during off-peak daytime periods.

Various types of equipment may be used to collect spot speed data, including equipment placed on the road surface (e.g., road tubes, piezoelectric sensors, tape switches, etc.) or hand-held from the roadside (e.g., radar or LIDAR). While each of these devices is appropriate for purposes of setting speed limits, it is important to understand how the data are collected such that only free-flowing vehicles are used in the speed study. For road tubes and other on-road equipment, speeds are collected for all vehicles traveling over the roadway during the duration of the study. These data must be filtered to only include free-flowing vehicles that are unimpeded by other vehicles. Similarly, when using radar or LIDAR, the data collection technician must ensure that free-flowing vehicles are selected at random.

Gathering Crash Data

Crash data should be collected from a query of crash records for the jurisdiction of interest. At least 3 years of crash data should be used, but the SLS-Tool can accommodate crash counts for times as short as 1 year. Two crash counts need to be computed for the segment: all crashes (KABCO), and fatal and injury crashes (KABC).

The SLS-Tool compares the crash counts to the computed average and critical crash rates for similar segments. The user may enter average crash rates (computed from similar segments in the state or region) or leave the average crash rate input cells blank. If the cells are left blank, the SLS-Tool computes average crash rates based on HSIS data.

In addition to setting speed limits, the crash data query can also be used to identify sites that could benefit from implementing engineering or enforcement treatments to manage speed.

Design Speed

The relationship between design speed and posted speed was addressed in a 2015 memorandum from FHWA (*46*). The memo started with quoting Joseph S. Toole's foreword to the 2009 FHWA's *Speed Concepts: Informational Guide* (*47*): "designers of highways use a designated design speed to establish design features; operators set speed limits deemed safe for the particular type of road; but drivers select their speed based on their individual perception of safety. Quite frequently, these speed measures are not compatible and their values relative to each other can vary." The 2009 guide (*47*) introduced the concept of "inferred design speed" and defined that term as "the maximum speed for which all critical design-speed-related criteria are met at a particular location." Stated in another manner, a given set of roadway characteristics can be used to infer the design speed met by that roadway section.

The results of a 2003 NCHRP project examining the relationship between design speed, posted speed, and operating speed concluded that "while a relationship between operating speed and posted speed limit can be defined, a relationship of design speed to either operating speed or posted speed cannot be defined with the same level of confidence" (*6*). The research also found that design speed appears to have minimal impact on operating speeds unless a tight horizontal radius or a vertical curve with a low K-value is present. Large variance in operating speed was found for a given inferred design speed on rural two-lane highways. The research also concluded that when posted speed exceeds design speed, liability concerns may arise even though drivers can safely exceed the design speed.

The FHWA memo (*46*) stated that the selection of a posted speed is an operational decision for which the owner and operator of the facility is responsible and that inferred design speeds less than the posted speed limit do not necessarily present an unsafe operating condition. The memo recommended that "if a state legislature or highway agency establishes a speed limit greater than a roadway's inferred design speed, FHWA recommends that a safety analysis be performed to determine the need for appropriate warning or informational signs such as advisory speeds on curves or other mitigation measures prior to posting the speed limit" (*46*).

Relationships Among Safety, Speed, and Roadway Characteristics, Including Posted Speed Limit

The relationships among safety, speed, and roadway characteristics, including posted speed limit, are complex. The association among these variables can vary widely. Table 25 provides a brief and simple overview of the relationship for different variables with operating speed and crash frequencies by rural and urban facility. A short synthesis on key variables follows. Additional details about these relationships are available in the *NCHRP Web-Only Document 291*, especially in Appendices A and B (*2*).

Traffic Variables

For a motor vehicle crash to occur or to measure how fast a driver is moving, a vehicle must be present. The quantity of traffic and the characteristics of that traffic have an obvious relationship with both speed and safety. Traffic variables include:

- **AADT:** Traffic flow measure AADT is considered the most determinant variable for the occurrence of crashes. Many safety performance functions consider only traffic flow and segment length in the model development. The relationship between traffic volume and crashes

Table 25. Effect of variables on operating speeds and crash frequencies.

Category	Variables	Rural Operating Speed	Rural Crash Frequency	Urban Operating Speed	Urban Crash Frequency
Traffic	AADT	⇩⇧	⇧	⇧	⇧
	Operating speed	—	⇩⇧	—	⇧
	Congestion	—	—	—	⇧
	Percent truck	⇧	⇧	⇧	⇩
TCD	Posted speed limit	⇧	⇩⇧	⇧	⇩⇧
	Signalized intersection	—	—	—	⇧
	Passing lane/zones	—	⇩	—	—
Roadway Geometry	Horizontal alignment	⇩	⇧	⇩	⇩⇧
	Vertical alignment	⇩	⇧	⇩	⇧
	Presence of median	⇧	⇩⇧	⇧	⇩⇧
	Median width	⇧	⇩⇧	⇧	⇩⇧
	Number of lanes	⇧	⇧	⇧	⇧
	LW	⇧	⇩	⇧	⇩
	SW	⇧	⇩	⇧	⇩
	Bike lanes	—	—	⇧	⇩
	Intersection angle	—	—	—	⇧
	Intersection lighting	—	—	—	⇩
Surroundings	Access density (driveways and intersections)	⇩	⇧	⇩	⇧
	School	—	—	⇩	⇩
	Parking	—	—	⇩	⇧
	Liquor store	—	—	—	⇧
	Sidewalk presence	—	—	—	⇩
	Development (surrounding land and use)	⇩	⇧	⇩	—
Other variables	One-way or two-way	—	—	⇩	—

Note: ⇧ = increase with increase of the attribute, ⇩ = decrease with increase of the attribute, ⇩⇧ = mixed effect, — = relationship not identified or unknown.

can be affected by whether the section is undivided or divided. The effect of this variable on crash frequencies differs based on the facility type. Usually, roadways with higher AADT values are associated with higher operating speeds on both urban and rural roadways. However, Jessen et al. (*15*) found lower operating speeds to be associated with higher AADT roadways. The researchers commented that motorists may view increases in traffic volume as a motivation to slow down.

- **Operating speed:** The operating speed measures are evaluated to assess the consistency of the adopted design values along the designed road alignment. Operating speeds reflect the speed behavior of drivers who are affected by roadway geometry, surroundings, traffic, and other variables. A study using 179 roadway sections in Israel explored the relationship between operating speeds (obtained from global positioning system devices) and crashes on rural two-lane roadways with 50-mph posted speed limit (*48*). The main finding of the study was that in both day and night hours, the number of injury crashes increased with an increase in the segment mean speed, while controlling for traffic exposure and road infrastructure conditions. Wang et al. (*49*) reviewed several previous studies to identify factors, especially traffic and road geometry factors, related to crashes. The authors concluded that some studies found increased speed reduces safety, and other studies found the opposite.
- **Other traffic variables:** Other traffic variables include congestion and the percentage of trucks. Several studies showed that congestion increases risk of traffic crashes. The percentage of trucks has a mixed effect on operating speeds.

TCD Variables

The type of TCDs present can influence operating speeds and crashes. For example, when traffic signals are timed to optimize progression along a corridor, drivers tend to operate at that speed to avoid having to stop at the next signal. Most signs and markings, however, do not have such a major impact on speeds with the exception of the posted speed limit sign. TCD variables include:

- **Posted speed limit:** Prior studies showed that posted speed limit has a significant effect on operating speed on urban streets. For rural high-speed highways, posted speed limits are typically established with consideration of several factors, including the roadway design speed. Several studies showed that vehicular operating speeds are impacted by the posted speed limit, with vehicular speeds tending to increase as the posted speed limit increases. However, the magnitude of the increase in operating speed is typically only a fraction of the amount of the actual speed limit increase. The research literature generally suggests that the resulting change in operating speeds would likely lead to an increase in the overall crash rate and would also shift the severity distribution toward crashes of greater severity.
- **Other TCD variables:** Other important TCD variables include the presence of intersections and passing lanes. For urban roadways, the presence of an intersection is associated with higher crash frequencies and lower operating speeds. Passing lanes are effective in crash reduction on rural roadways. However, passing lanes are associated with higher intersection-related crash frequencies on rural roadways.

Roadway Geometry Variables

The design of the roadway can influence either operating speed or crashes in select cases. Roadway geometry variables include:

- **Horizontal alignment:** Horizontal curves have been identified as the geometric variable that is the most influential on driver speed behavior and crash risk. The measures used in the studies varied and included the degree of curve, length of curve, deflection angle, and/or superelevation rate. Horizontal alignment is also associated with negatively affecting safety as shown in the HSM (*43*). Prior research has shown that crash frequency increases with the length and/or degree of horizontal curvature (*43*, *50*) although there is a value where the influence is no long present.
- **Vertical alignment:** Studies showed that roadways with vertical alignment experience lower operating speeds once the vertical alignment exceeds a certain value. Prior research has showed that steeper vertical alignments could induce higher crash potentials (*13*). Total crash rates typically increase with the degree of vertical alignments, mainly in the presence of hidden horizontal curves, intersections, or driveways. Safety risks associated with higher speed limits increased on segments with steeper vertical curves.
- **Median:** Median barriers are associated with severe crash rate reduction but have also been found to be associated with more property-damage-only crashes. A Michigan study found that the presence of a TWLTL was associated with a significant increase in total and injury crashes but was also associated with a significant decrease in fatal crashes (*50*).
- **SW:** Wider shoulder widths are associated with higher operating speeds. The HSM suggests that the width of the paved shoulder along non-freeways has a similar effect on crashes as travel lane widths, and that wider widths are associated with fewer crashes (*43*). The increased recovery and vehicle storage space and increased separation from roadside hazards are associated with fewer crashes.

- **Other roadway geometry variables:** Other roadway geometry variables that may have an effect on speed or crashes include the LW, number of lanes, presence of bike lane, intersection angle, and intersection lighting.

Variables Associated with Roadway Surroundings

The characteristics of the road's surroundings, including the neighboring land use, affect both operating speed and crashes. Variables associated with roadway surroundings include:

- **Access density (driveways and intersections):** Prior studies have demonstrated that as the density of access points (or the number of intersections and/or driveways per mile of highway) increases, the frequency of traffic crashes also increases. This occurs partially due to driving errors caused by intersections and/or driveways that may result in rear-end and/or sideswipe type crashes. Specifically, *NCHRP Report 420* concluded that an increase in crashes occurs due to the higher number of access points (*51*). Roadways with high access densities usually experience lower operating speeds.
- **Other variables associated with surroundings:** Other variables associated with surroundings include the presence of schools, presence of liquor stores, presence of sidewalks, and development.

SECTION 9

Related Reference Materials

This section introduces other reference materials that can be used when considering how to address speed within a segment. The materials are listed by date order with the most recent publications first.

Speed Management Safety Website

- Source: https://safety.fhwa.dot.gov/speedmgt/.
- Date: last modified April 2019.
- Publisher: Federal Highway Administration.
- Description: This website provides links to several publications and tools along with ongoing research.

Speed Management ePrimer for Rural Transition Zones and Town Centers

- Source: https://safety.fhwa.dot.gov/speedmgt/ref_mats/rural_transition_speed_zones.cfm.
- Date: January 2018.
- Publisher: Federal Highway Administration.
- Description: The *Speed Management ePrimer for Rural Transition Zones and Town Centers* reviews speeding-related safety issues facing rural communities and discusses the basic elements required for data collection, information processing, and countermeasure selection by rural transportation professionals and community decision makers. The ePrimer is presented in six distinct modules developed to allow the reader to move between each to find the desired information, without a cover-to-cover reading.

Traffic Calming ePrimer

- Source: https://safety.fhwa.dot.gov/speedmgt/traffic_calm.cfm.
- Date: February 15, 2017.
- Publisher: Federal Highway Administration.
- Description: The ePrimer presents a review of traffic calming practice in eight modules. The ePrimer presents:
  - A definition of traffic calming, its purpose, and its relationship to other transportation initiatives (like complete streets and context-sensitive solutions).
  - Illustrations and photographs of 22 different types of traffic calming measures.
  - Considerations for their appropriate application, including effects and design and installation specifics.

- Research on the effects of traffic calming measures on mobility and safety for passenger vehicles; emergency response, public transit, and waste collection vehicles; and pedestrians and bicyclists.
- Examples and case studies of both comprehensive traffic calming programs and neighborhood-specific traffic calming plans.
- Case studies that cover effective processes used to plan and define a local traffic calming program or project and assessments of the effects of individual and series of traffic calming measures.

Highway Safety Manual

- Source: available for purchasing from http://www.highwaysafetymanual.org/Pages/default.aspx.
- Date: 2010, with supplement for freeways published in 2014.
- Publisher: AASHTO.
- Description: The HSM is the premier guidance document for incorporating quantitative safety analysis in the highway transportation project planning and development processes.

Speed Management Program Plan

- Source: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812028-speedmgtprogram.pdf.
- Date: April 2012.
- Publisher: National Highway Traffic Safety Administration, FHWA, and Federal Motor Carrier Safety Administration.
- Description: The most recent version of the *Speed Management Program Plan* was published in 2014 and is an update of the original version published in 2005. The document contains strategies based on research related to managing speed through setting and enforcing speed limits and guidance on reducing speeding-related crashes. The document includes specific goals, objectives, and action items for speed management. The report also includes priority areas that transportation professionals are encouraged to focus on. However, over the past 5 years, the topic has evolved to the extent that specific content for each of these elements needs to be updated. A recent FHWA study is developing an updated version.

Methods and Practices for Setting Speed Limits: An Informational Report

- Source: https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12004/.
- Date: April 2012.
- Publisher: FHWA (FHWA-SA-12-004) and Institute of Transportation Engineers.
- Description: The report describes primary practices and methods to set speed limits and includes an engineering approach, expert systems, optimization, and injury minimization. Guidance for setting speed limits is provided, and case studies are included. The guidance also discusses speed zones including advisory, school zones, work zones, variable speed limits, and transition zones. This includes guidance for when speed transitions are needed and the setting of transition zone speeds.

Speed Concepts: Informational Guide

- Source: https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa10001/fhwasa10001.pdf
- Date: December 2009.
- Publisher: FHWA (FHWA-SA-10-001).

- Description: The guide discusses speed concepts and includes:
  - Definitions of speed terms (e.g., 85th percentile speed and design speed).
  - Summary of research on the effects of speed.
  - Characteristics of speed such as speed distributions and speed profiles.
  - Processes to document speeds.
  - Agency roles in addressing speed including establishing speed limits and advisory speeds and enforcing speed limits.
  - Speed management technique and countermeasures.

NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 23: A Guide for Reducing Speeding-Related Crashes

- Source: http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Reducing_Speeding Related_Crashes_160862.aspx.
- Date: 2009.
- Publisher: Transportation Research Board.
- Description: The guide summarizes the collection and evaluation of speed and crash data. The guide covers strategies to set reasonable and prudent speed limits that account for roadway design, traffic, and environment. The guide also covers increasing drivers' awareness of the risks of driving at unsafe speeds.

MUTCD for Streets and Highways

- Source: https://mutcd.fhwa.dot.gov/.
- Date: last modified December 2009.
- Publisher: FHWA.
- Description: The MUTCD is the national standard for signing on all highways. Sections 2B.13–16 address regulatory speed limits, Section 2C addresses advisory speed signs, Section 7B addresses school zone speed limit signs, and Section 6C addresses work zone speed limits.

USLIMITS2

- Source: https://safety.fhwa.dot.gov/uslimits.
- *User Guide for USLIMITS2*: https://safety.fhwa.dot.gov/uslimits/documents/appendix-l-user-guide.pdf.
- Date: March 2008 for initial development, December 2017 for updated user guide.
- Publisher: U.S. Department of Transportation, FHWA.
- Description: USLIMITS2 is a web-based tool that was designed to assist practitioners in setting consistent and safe speed limits. It is used to set speed limits for specific segments of roads and can be used on all types of roads (local roads to freeways).

Speed Enforcement Program Guidelines

- Source: https://www.safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa09028/resources/Speed Enforcement Program Guidelines.pdf%23page=1.
- Date: March 2008.

- Publisher: U.S. Department of Transportation, National Highway Traffic Safety Administration.
- Description: The objective of the guidelines is to provide law enforcement personnel and decision-makers with tools to establish and maintain an effective speed management program. The guidelines include:
  - Identification of the problem.
  - Legislative, regulation, and policy.
  - Program management, including public outreach.
  - Enforcement countermeasures.
  - Program evaluation.

Acronyms and Abbreviations

AADT	Average annual daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average daily traffic
C50	The 5-mph increment that is closest to the 50th percentile speed
C85	The 5-mph increment that is closest to the 85th percentile speed
CMF	Crash modification factor
Expanded FCS	Expanded Functional Classification System
FHWA	Federal Highway Administration
HSIS	Highway Safety Information System
HSM	*Highway Safety Manual*
ISW	Inside shoulder width
K	Constant associated with the confidence level (1.645 for 95 percent confidence)
KABC	Fatal and injury crash severity levels
KABCO	All crash severity levels
LW	Lane width
M	Exposure (100 million vehicle miles)
mph	Miles per hour
MUTCD	*Manual on Uniform Traffic Control Devices*
MVM	Million vehicle miles
N	Number of lanes
NCHRP	National Cooperative Highway Research Program
NTSB	National Transportation Safety Board
R_a	Average crash rate for a given road type, provided by the user or obtained from HSIS tables
R_c	Critical crash rate for a given road type
RD50	The 5-mph increment obtained by rounding down the 50th percentile to the nearest 5-mph increment
RD85	The 5-mph increment obtained by rounding down the 85th percentile to the nearest 5-mph increment
SLS-Procedure	Speed Limit Setting Procedure
SLS-Tool	Speed Limit Setting Tool
SLSG	Speed Limit Setting Group
SW	Shoulder width
TCD	Traffic control device
TWLTL	Two-way left-turn lane

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Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S. DOT	United States Department of Transportation

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