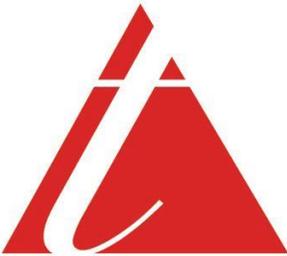


Memorandum



To: Jenny Bailey, Senior Planner
From: Bill Schultheiss, P.E. (WA. P.E. #46108)
Date: June 20, 2017
Re: East Lake Sammamish Trail, Segment 2B Review

King County has asked Toole Design Group (TDG) to evaluate the design of East Lake Sammamish Trail, segment 2B (“ELST”) - a proposed shared use path. TDG was asked to evaluate the minimum trail width necessary to safely accommodate the estimated volume of trail users and to meet applicable safety standards and guidelines, including the 2012 American Association of State Highway and Transportation Officials Guide for the Development of Bicycle Facilities (“AASHTO”). Specifically, TDG was asked to evaluate the following questions considering the trail is estimated to have peak daily volumes between 5,000 to 7,000 people, with 600 users during peak hours once the trail system is complete:

- 1) Would a reduction of the paved portion of the ELST from 12 feet to 10 feet be consistent with AASHTO and other applicable safety standards and guidelines?

Answer. No, the guide recommends wider pathways in locations with more than 300 users in the peak hour and pedestrians exceeding 30% of the traffic, and recommends using the FHWA Shared Use Path Level of Service Calculator to determine the appropriate width for anticipated user volumes and mixes.

- 2) Would a reduction of the paved portion of the ELST from 12 feet to 8 feet be consistent with AASHTO and other applicable safety standards and guidelines?

Answer. No, the guide recommends wider pathways in locations with more than 300 users in the peak hour and pedestrians exceeding 30% of the traffic. The use of 8-foot paths are restricted to rare circumstances where path volumes are low or there is a physical constraint restricting a wider path.

- 3) Would a reduction of the 2-foot shoulder and 1-foot clear zone to 1-foot total clearance be consistent with AASHTO and other applicable safety standards and guidelines?

Answer. No, the guide recommends the use of 3- to 5-foot shoulders. 1-foot shoulders are limited to constrained locations where there is a smooth, continuous barrier, railing, or fence. The shoulder will provide additional space for pedestrians to walk or run during peak periods of use to minimize conflicts on the paved surface of the trail.

- 4) Could the width of the ELST be narrowed consistent with AASHTO and other applicable safety standards and guidelines if the design included yellow centerline striping?

Answer. No, the guide recommends the use of centerlines to separate opposing directions of trail users to minimize conflicts on higher volume trails. The use of the centerline as a strategy to narrow the trail below recommended widths will not mitigate conflicts associated with a trail that is constructed too narrow to handle the capacity.

The following discussion provides additional support for the answers to the questions.

Background

As a key segment of the King County regional shared use path network (similar to the Burke Gilman Trail and I-90 Trail) it can reasonably be anticipated the trail will often be very busy and serve a wide range of users, including bicyclists, walkers, joggers, skaters and persons using wheelchairs. TDG performed a demand analysis for the system (see separate demand analyses memorandum) that conservatively estimates the following user demand once the trail opens:

- 600 -700 people per hour will use the trail during peak hours on weekends
- Bicyclists are anticipated to be approximately 50% -60% of the users of the trail
- Pedestrians (walkers and runners) are anticipated to be approximately 40-50% of the users of the trail

King County is interested in constructing a trail to a width that meets current design standards and best practices, anticipates growing use, and can handle projected future demands while providing a safe operating environment for trail users of all ages and abilities. The trail construction is funded with a combination of Local, State, and Federal funding.

This memorandum addresses the inquiries listed above and includes discussion of relevant guidance for determining trail width based on:

- Federal Highway Administration Guidance including the Shared Use Path Level of Service Calculator
- 2012 AASHTO Guide for the Development of Bicycle Facilities (with reference to 1999 guidance)
- 2015 WSDOT Design Guide (including authority of these documents);

This memorandum concludes with recommendations for the width of the East Lake Sammamish Trail. **This memorandum does not include a review of traffic control or intersection design.**

The word "Trail" within this memorandum is shorthand for the official named trail. It is in operation a shared use path as defined by AASHTO, thus the terms Trail, Path, and Shared Use Path are intended to be interchangeable within this memorandum speaking to a smoothly paved, shared use path open to access by all non-motorized travelers that meets the requirements of a Shared Use Path as defined in Chapter 5 of the 2012 AASHTO Bicycle Guide.

2016 FHWA Achieving Multimodal Networks Guide¹

Authority: The FHWA Achieving Multimodal Networks Guide was developed to promote a higher level of quality and care for the design of bicycle and pedestrian networks. Shared use paths attract a diverse set of users (walking and running pedestrians, disabled pedestrians and bicyclists, recreational and transportation bicyclists). Diverse users who operate at different speeds, have different physical and operating widths (I.e. figure 3.1 of AASHTO Bike Guide) and have different expectations. Improperly designed paths can create conflicts between these users.

Engineering Judgment: In 2016, FHWA issued this guidebook to explain the application of engineering judgment to apply the design flexibility inherent in AASHTO Guidance to mitigate potential conflicts, and to promote the design and construction of high quality shared use paths. Key issues identified as contributing factors in conflicts which reduce user safety included: high volumes of users, a wide variety of user types, speed differential, passing maneuvers, sharp curves, vertical objects near path edges (such as fences and walls), surface defects, and insufficient path width.

The following principles and best practices were identified in this FHWA guidance to mitigate these issues:

- **Path Width:** The path width should be designed to accommodate the peak volume of users (which is typically a mid-day weekend). The path width should be based on anticipated user types, speeds, and volumes to create a safe operating environment. The use of 8-foot wide paths should only be considered where volumes are low and the path is predominantly used by one type of user (e.g. pedestrians). An 11-foot minimum path width is recommended to allow safe passing with wider path widths used where volumes are higher. The FHWA Shared Use Path Level of Service Calculator² is recommended to evaluate an appropriate path width. Where path volumes and user diversity is high (e.g.- pedestrians exceed 30% of the user mix), consideration should be given to separating user types with pavement markings and/or separate surfaces – most commonly separating pedestrians from bicyclists if the property/facility is sufficiently large to accommodate two paths. Soft surface shoulders should also be considered on higher volume trails to allow use for pedestrians to walk or run.
- **Path Geometry:** paths should not be designed with sharp turns or designs that can lead to encroaching path conflicts.
- **Maintenance:** The path should be built to ensure the path can be maintained by typical service vehicles without damaging the path and a maintenance plan should ensure the path is usable and safe throughout the year.
- **Predictability and Coherence:** The design should result in predictable behaviors of path users throughout the corridor and clearly identify the proper path of travel if users are separated.
- **Future Volumes:** Paths that are part of a larger path network will experience substantially higher use than those not connected to the network. It should be anticipated that path volumes will increase over time as additional as new connections are made, population growth occurs, and people become more aware of the path system.

¹ https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_networks/

² <https://www.fhwa.dot.gov/publications/research/safety/pedbike/05138/>

- Accessibility: Due to the fact that nearly all shared use paths are used by pedestrians, they fall under the accessibility requirements of the Americans with Disabilities Act (ADA).
- Use: Increasing use of paths should be expected over time as bicycling networks become increasingly connected resulting in increased walking and bicycling. The design of a path should follow best practices and industry standards and consider future growth patterns.
- Traffic Control: Intersection controls which are inappropriately applied to path users will diminish safety and should not be applied. The least restrictive control should be used following MUTCD and AASHTO Bicycle Guide recommendations.

The design of bicycle facilities must consider the operating needs of bicyclists and the safety needs of other users in shared use path environments. A review of bicyclist crashes within the United States over the past 40 years has found consistent patterns. Studies which review hospital records consistently find bicyclist crashes, which result in injury, are underreported. The actual number of crashes are estimated to be 20 percent to approximately 50 percent higher than the total crashes officially reported. Studies also find between 70 and 90 percent of all crashes are the result of falls, collisions with fixed objects, and collisions with other bicyclists.

COMMON USERS IN CONFLICT AND TYPICAL CRASH TYPES

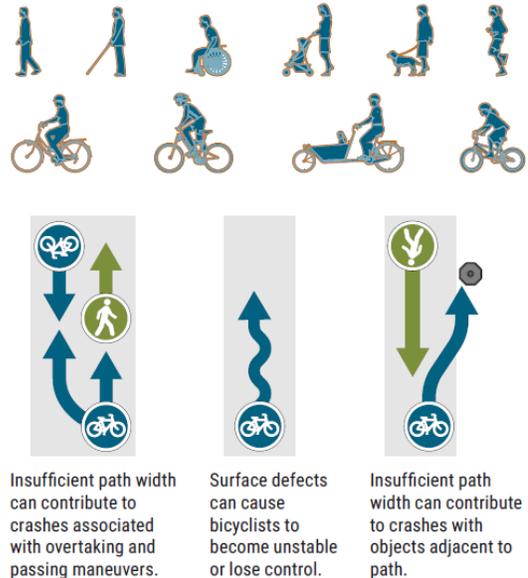


Figure 1 – Common Conflicts

Source: FHWA Achieving Multimodal Networks Guide

AASHTO Guide for the Development of Bicycle Facilities (AASHTO Bike Guide)

Authority: The AASHTO Bike Guide provides guidance on how to design on- and off-road bicycle facilities (Note: AASHTO publishes guidance for all modes using street rights-of-way). The guidance, based on research and the experience of practitioners around the country, represents ‘best practice’ with regard to safety and other design considerations. As such, transportation agencies should invest a high level of effort to follow AASHTO guidance whenever possible, whether they be facilities for motorists or other modes such as bicyclists or pedestrians. The following discussion is based on the 2012 AASHTO Bicycle Guide which updated the 1999 Guide. A brief discussion of the 1999 Guide recommendations relevant to the questions posed at the beginning of this memorandum is also included with each section for context.

Engineering Judgment: The AASHTO guidance was written to encourage the use of engineering judgment during the design of shared use paths. The guide provides extensive discussion of best practices and engineering fundamentals to allow the practitioner to develop a design that will result in a safe, comfortable, and convenient shared use path. For uniquely constrained situations, the guide provides context to apply engineering judgment to consider the use of minimum dimensions, below which there is risk of increased crash risk or crash severity. However, as noted by the FHWA Multimodal Conflicts guide, the engineering

judgment should err on the side of going beyond the minimum criteria to develop a safe facility unless unique constraints require less.

Shared Use Path Width: Path width should be determined based on three main characteristics:

1. anticipated daily and peak hourly volume of path users
2. type and percentage of path users
3. context for the path operation

For example, a path that is used by higher-speed bicyclists which also is a popular route for people walking may experience conflicts due to their differences in speeds. Providing sufficient width paths to accommodate passing movements or separating pedestrians and bicyclists is necessary to reduce conflicts as volume increases. This principle has been in place since the original 1974 AASHTO Bike Guide which recommended a minimum path width of 10.5 feet to provide three lanes of travel with a desirable width of 12.5 feet exclusive of 2-foot shoulders. The 1974 guide and subsequent guides, further elaborated that consideration should be given to designing the path to allow side by side operation of bicyclists and to allow for large vehicles to maintain the path without causing damage to the path surface. Insufficiently wide paths will contribute to crashes associated with overtaking and passing maneuvers, as well as, in some cases, crashes with objects adjacent to the path.

The 2012 AASHTO Guide recommends a minimum path width of 10 feet for a two-directional path. Wider pathways (typically 11 to 14 feet) are recommended where high volumes (greater than 300 users per hour) and/or a high percentage of pedestrians (greater than 30%) are expected (AASHTO Bike Guide 2012, p. 5-3). These numbers would constitute “substantial” demand for all path users or pedestrians³.

The AASHTO Guide recommends the use of the FHWA Shared Use Path Level of Service Calculator to determine an appropriate path width based on the anticipated users. Eleven feet (11 feet) is considered the minimum path width for higher volume paths to provide sufficient passing space for a bicyclist to pass another bicyclist without unsafely encroaching into the space of an on-coming bicyclists.

The use of 8-foot minimum width paths is allowed for short distances in constrained circumstances where bicyclist volumes were anticipated to be low during peak periods with occasional pedestrian use. The 2012 AASHTO Guide specifies where the path is narrowed to 8 feet, it should be for a very short distance where physical structures cannot be moved (such as a bridge pier) or to avoid a critical environmental feature (such as a wetland)⁴.

Clearance, Shoulders and Fences: Path clearances are an important element in path design and are important to reduce user conflicts and risk of collision with fixed objects. Vertical objects close to the path edge risk endangering users and reduce the effective, usable width of the path. Along the path, vertical objects should be set back at least two feet from the edge of the path. Path shoulders may also reduce conflicts by providing space for users who step off the path to rest, create additional space for able bodied people to walk or run, allow users to pass one another, or offer a viewing area at scenic vistas. The guide recommends shoulder

³ The 1999 AASHTO Bike Guide recommends a 10 foot minimum path width with widening to 14 feet where it will have “substantial use by bicycles, joggers, skaters and pedestrians, use by large maintenance vehicles, and/or steep grades.” What constituted substantial use was clarified in the 2012 Guide.

⁴ The 1999 AASHTO Bike Guide stated the use of 8-foot paths should be in “rare instances” where bicycle use was low, pedestrian use was not expected, frequent passing opportunities would be provided, and the trail would not be damaged by maintenance vehicles.

widths between 3 and 5 feet. Additionally, where the distance between the edge of the path pavement and the top of a slope (1V:3H or steeper with a drop of 6' or greater) is less than 5 feet, physical barriers or rails are recommended. It is not desirable to place the pathway in a narrow corridor between two fences for long distances, as this creates personal security issues, prevents users who need help from being seen, prevents path users from leaving the path in an emergency, and impedes emergency response. This is particularly important in corridors with heavy vegetation or retaining walls⁵.

Pavement Markings: Pavement markings can enhance the safety of the trail by separating opposing direction traffic, but are not a substitute for providing adequate trail width.

FHWA Shared Use Path Level of Service Calculator

The AASHTO Bike Guide recommends the FHWA Shared Use Path Level of Service Calculator (SUP LOS) be used to assist in the determination of an appropriate path width based on the predicted number and types of path users. SUP LOS scores range from A to F, with A being the most desirable score and F being the least desirable. The LOS goal should be a high C or low B to ensure a high quality, safe environment with space for additional users.

The Table below shows a LOS score for a range of theoretical trail user volumes corresponding to a range of trail widths. As a paved trail reaches a width of 16 feet, it is generally advisable to separate bicyclists from pedestrians to reduce conflicts. In 2017, the ELST is anticipated on weekdays to have peak hourly volumes of approximately 100 users. During weekends this would expand up to 600 users in peak hours. During peak weekend hours it should be anticipated the proposed soft shoulders of the path will be used by some pedestrians which will expand the effective width of the 12-foot paved trail to 16 feet. Based on the LOS assessment⁶, the ELST should provide an acceptable LOS for the majority of the week at a 12-foot paved surface width. During peak weekend periods, the users will have reduced freedom of movement and a degraded LOS once hourly volumes exceed 400 users per hour. An 8-foot or 10-foot paved surface would perform very poorly even during average use, creating a congested and unpleasant experience for trail users.

Path Hourly Volume	8' Path LOS Grade	10' Path LOS Grade	11' Path LOS Grade	12' Path LOS Grade	14' Path LOS Grade	16' Path LOS Grade
100	D	C	B	B	B	A
150	D	C	C	B	B	B
200	E	D	C	C	B	B
250	E	E	C	C	C	B
300	F	E	D	C	C	C
400	F	F	D	D	D	C
500	F	F	E	E	E	D
600	F	F	F	F	F	E

Table 1. Shared Use Path LOS for Various Hourly Path Volumes (Two-Way Trail)

⁵ The 1999 AASHTO Bike Guide recommends 3-foot shoulders as desirable with 2 feet as the minimum.

⁶ Based on FHWA SUP LOS for bicyclists assuming 55% adult bicyclists, 5% child bicyclists, 30% pedestrians, 10% runners

WSDOT Design Manual

Authority: The WSDOT Design Manual, like the AASHTO Bike Guide, provides guidance on how to design on- and off-road bicycle facilities. It also provides guidance for other modes, including pedestrian facilities. It builds on the AASHTO guidance, providing ‘best practice’ with regard to safety and other design considerations, and allowing for flexibility in “rare” situations.

Path Widths: The appropriate paved width for a shared-use path is dependent on the context, volume, and mix of users. The desirable paved width of a shared-use path, excluding the shoulders on either side, is 12 feet. The minimum paved width, excluding the shoulders on either side, is 10 feet. A paved width of more than 12 feet, excluding the shoulders on either side, may be appropriate when substantial use by both pedestrians and bicyclists is expected or maintenance vehicles are anticipated (p. 1515-4). Substantial use is not defined, but given the fact the guide references the AASHTO Bike Guide, it should be considered to be equivalent to 300 users in the peak hour with a minimum of 30% of users being pedestrians.

Clearance, Shoulders and Fences: Shared-use path shoulders are typically unpaved and 2 feet wide on either side (p. 1515-4). Where there are steep slide slopes along an existing trail with a vertical drop of 2 feet 6 inches or more, a minimum 5-foot separation from the edge of the pavement to the embankment edge is needed. If this cannot be accomplished, a pedestrian rail is needed (page 1515-5; Exhibit 1515-5, Example 4). The manual also includes detailed information on slopes (e.g. 3H:1V) and when railings, shrubs and other barriers are needed if the separation between the edge of pavement and top of slope is less than 5 feet.

Flexibility: The WSDOT Design Manual also provides some flexibility with regard to design specifications. It allows for reduced trail width when the following “rare” conditions prevail:

- Bicycle traffic is expected to be low, even on peak days or during peak hours
- Pedestrian use of the facility is not expected to be more than occasional.
- Horizontal and vertical alignments provide frequent, well-designed passing and resting opportunities.
- The shared-use path will not be regularly subjected to maintenance vehicle loading conditions that would cause pavement edge damage.
- The shared-use path is for a short distance such as a spur connection to a neighborhood.

Recommendation for the Width of the East Lake Sammamish Trail

In response to the questions provided to TDG the East Lake Sammamish Trail Segment 2B was evaluated for the feasibility of reducing the trail from 12 feet to 10 feet for longer segments and reducing to 8 feet for short distances. Based on the AASHTO and WSDOT guidelines presented above with regard to trail, shoulder and clearance widths, TDG recommends that the East Lake Sammamish Trail should be constructed as designed, with 12 feet of pavement, a two-foot shoulder on either side, plus an additional foot for clearance to vertical objects (total of 18 feet). Given the anticipated weekend peak period trail volume, any compromises on these design specifications will compromise safety and therefore should be rare occurrences.

Design considerations moving forward include:

- Continuity of design, including trail width, is critical for trail safety and should be consistent throughout the corridor, providing a predictable experience for trail users.
- Providing adequate shoulder and clearance widths is especially important in this corridor given the steep slopes and the need to provide access for emergency and maintenance vehicles. A narrower trail corridor may result in additional fences on both side of the trail for longer distances, which can prevent users who need help from being seen and from leaving the path in an emergency; and it may impede emergency response. Additionally, adequate shoulder and clearance widths are critical for pedestrian traffic. Throughout public comment and engagement, adjacent property owners who have to cross the trail have expressed concerns about the potential for conflict with trail users. The 3-foot area provides a landing space off the paved trail where people crossing the trail can stop and look for cross traffic and open gates, if applicable. Walkers and runners have consistently asked for space that enables them to move along the corridor or step off the paved trail, away from higher-speed bicyclists.
- Both the AASHTO and WSDOT guides offer some flexibility with regard to trail and clearance widths in “rare” circumstances. However, the East Lake Sammamish Trail does not meet the definition of “rare”. Trail use will be high, not low; pedestrian use is expected to be more than occasional; and the path will be regularly subjected to maintenance vehicle loading conditions that could cause pavement edge damage.
- Anticipated volumes on the East Lake Sammamish Trail are similar to some sections of the Sammamish River and Burke-Gilman Trails which are being widened to twelve feet with two- to five-foot shoulders. Some sections of the Burke-Gilman Trail are actually being widened further to separate pedestrians from bicyclists where high volumes of pedestrians are routine to improve comfort and safety of all trail users adjacent to the University of Washington Campus.

The East Lake Sammamish Trail, as part of the regional King County Trail regional trail system, will experience high volumes that can be expected to grow over time. A trail width of at least 12 feet is needed to meet both AASHTO and WSDOT guidelines, as well as King County standards and guidelines for regional trails.⁷ Anything less than 12 feet will compromise safety and the ability to meet projected demand and would not be a defensible use of “good engineering judgement” given the safety issues it would create.

⁷ King County trail guidelines recommend a trail width of at least 12 feet where volumes are anticipated to be greater than 2,000 users a day on peak days (as in the context of estimated user volumes on the ELST)