GAPS & OPPORTUNITIES ANALYSIS REPORT

CITY OF GRESHAM

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PEDESTRIAN LEVEL OF SERVICE

The Pedestrian Level of Service (PLOS) Map illustrates the segment-based analysis of pedestrian comfort on roadways throughout Gresham. This analysis looks only at the roadway segment and does not analyze intersections or roadway crossings.

Pedestrian comfort and safety is measures using four factors: posted speed limit, roadway width (number of travel lanes), pedestrian buffer (on-street parking or bicycle lanes), and the presence of sidewalks. Generally, more pedestrian space on a lower speed roadway segment correlates to a higher comfort level.

An incomplete sidewalk network, higher speeds, and a greater number of lanes correlate to a lower comfort level. Bicycle lanes or on-street parking act as buffers between pedestrians and motor vehicle traffic, increasing comfort.

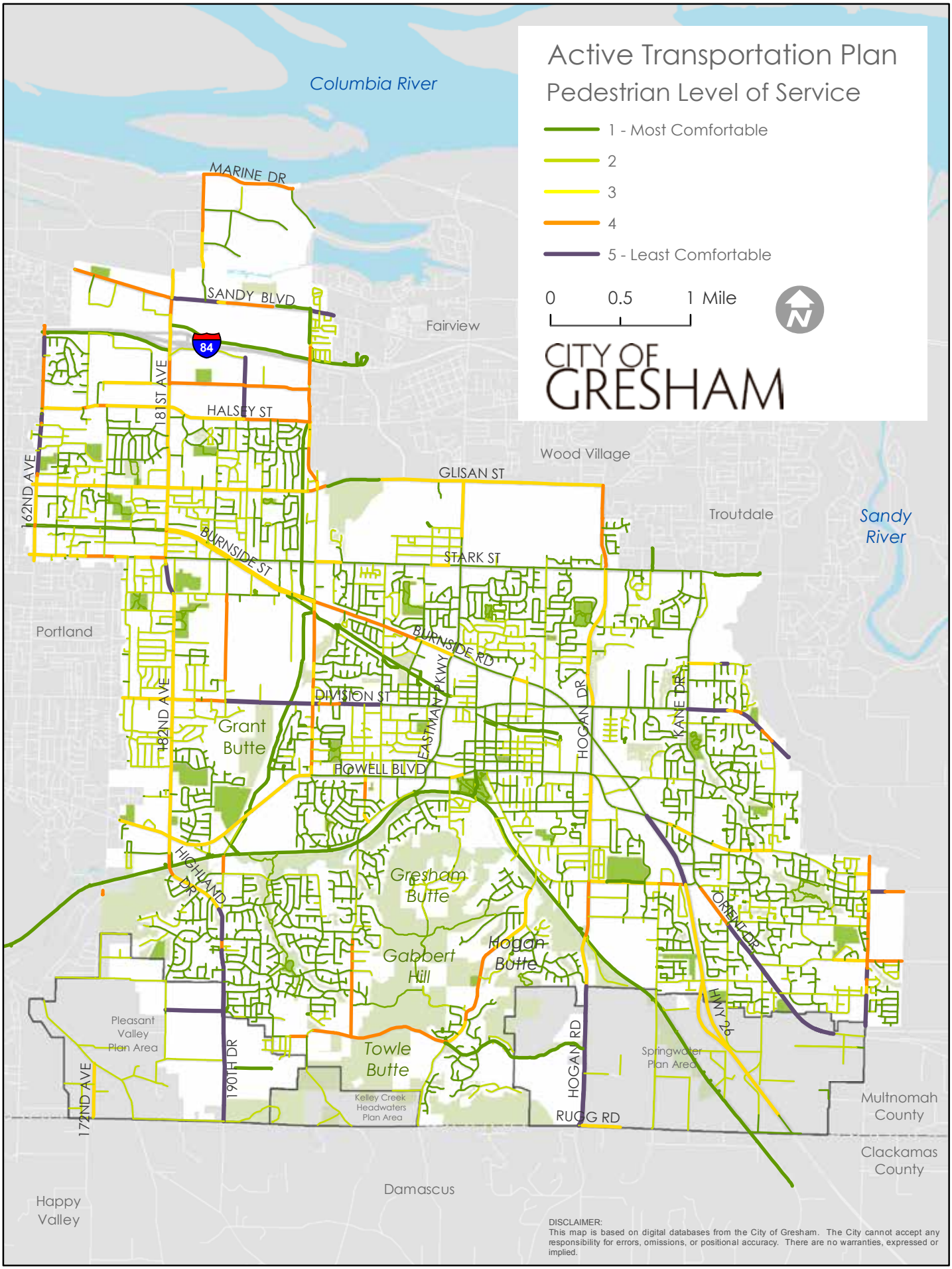
Many streets in Gresham are categorized as PLOS 1 and 2, the most comfortable environment for pedestrians. These roadways tend to be residential neighborhood streets, with low motor vehicle speeds and volumes. Pedestrian facilities that are completely separated from motor vehicle traffic, such as multi-use paths and trails, are also categorized as PLOS 1.

Arterial roadways, typically multi-lane roads with high vehicle speeds, are categorized as least comfortable for pedestrians. Roadways in Gresham that are categorized as PLOS 4 and 5 include 162nd Avenue, 190th Drive, Burnside Road, the southern portion of Hogan Road, portions of Highway 26, Orient Drive and portions of Division Street.

Overall, Gresham has 307 miles of sidewalk throughout the City. Table 1 shows the breakdown of streets in Gresham by sidewalk condition. Over half of street segments have a complete sidewalk on both sides, while 37 percent of streets do not have a complete sidewalk on either side of the street.

Table 1- Sidewalk Conditions in Gresham

Sidewalk Conditions	Percent
Complete Sidewalk on Both Sides	*53%*
Complete Sidewalk on One Side	*10%*
No Complete Sidewalk	*37%*


Active Transportation Plan
Pedestrian Level of Service
1 - Most Comfortable
2
3
4
5 - Least Comfortable
0
0.5
1 Mile
CITY OF GRESHAM
Columbia River
MARINE DR
SANDY BLVD
Fairview
84
181ST AVE
HALSEY ST
162ND AVE
Wood Village
GLISAN ST
Troutdale
Sandy River
BURNSIDE ST
STARK ST
Portland
BURNSIDE RD
EASTMAN PKWY
DIVISION ST
182ND AVE
Grant Butte
HOGAN DR
KANE DR
POWELL BLVD
HIGHLAND DR
Gresham Butte
ORIENT DR
Gabbert Hill
Hogan Butte
HWY 26
Pleasant Valley Plan Area
1901H DR
Towle Butte
HOGAN RD
Springwater Plan Area
Kelley Creek Headwaters Plan Area
172ND AVE
RUGG RD
Multnomah County
Clackamas County
Damascus
Happy Valley
DISCLAIMER:
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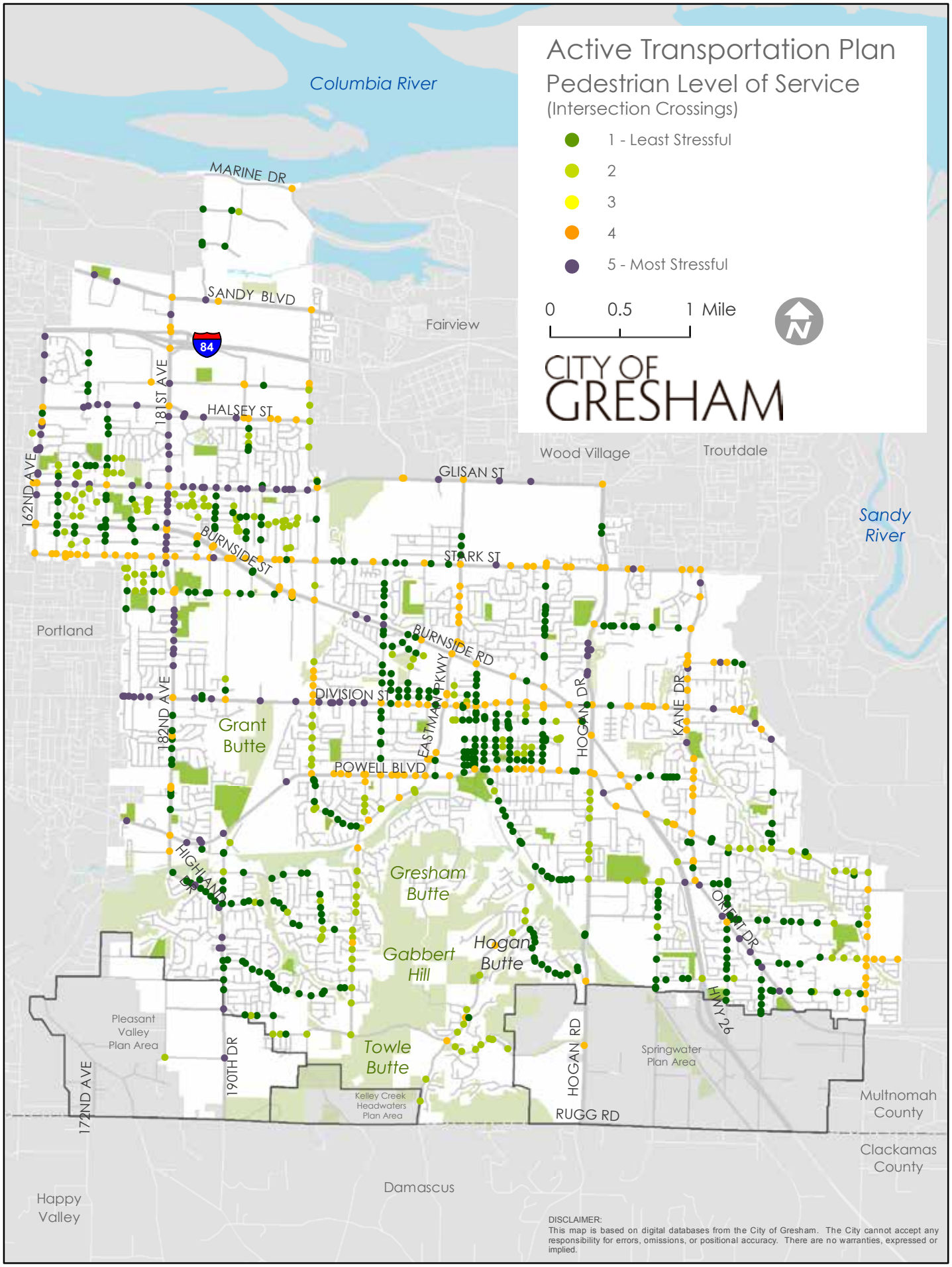
PEDESTRIAN LEVEL OF SERVICE INTERSECTION CROSSINGS

The Pedestrian Level of Service (PLOS) Intersection Crossings Map illustrates the intersection crossings analysis of pedestrian comfort on roadway crossings throughout Gresham. This analysis looks only at the quality of pedestrian crossing infrastructure and does not analyze roadway segments.

Signalized and unsignalized intersections were examined along roadways with a functional classification of 'collector' or 'arterial'. Each intersection leg was scored based on the characteristics of the crossing. Like the segment-based scoring, PLOS 1 represents the most comfortable pedestrian environment. Intersection scoring is additive - scores start at 1 or 2 depending on speed, and then increase with missing infrastructure. Stop-sign controlled or uncontrolled crossings receive additional points since pedestrians must find gaps in traffic.

PLOS 5 represents the most stressful pedestrian environment, with intersection crossings at high speed, high volume streets and inadequate infrastructure to facilitate a comfortable pedestrian crossing.

Similar to the segment-based Pedestrian Level of Service analysis, the most stressful intersections are located on busy arterial roadways, such as Glisan Street, Division Street, 162nd Avenue, 182nd Avenue, Hogan Drive and Orient Drive. The least stressful crossings are at locations with improvement pedestrian crossing treatments and at locations with lower vehicle speeds and volumes.



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BICYCLE LEVEL OF TRAFFIC STRESS WITH EXISTING INFRASTRUCTURE

The Bicycle Level of Traffic Stress (LTS) with Existing Infrastructure Map illustrates the LTS for all roadways through the City of Gresham. The analysis uses the posted speed limit, the number of travel lanes, and the presence and character of bicycle lanes, as a proxy for bicyclist comfort level. Road segments are classified into one of four levels of traffic stress based on these factors.

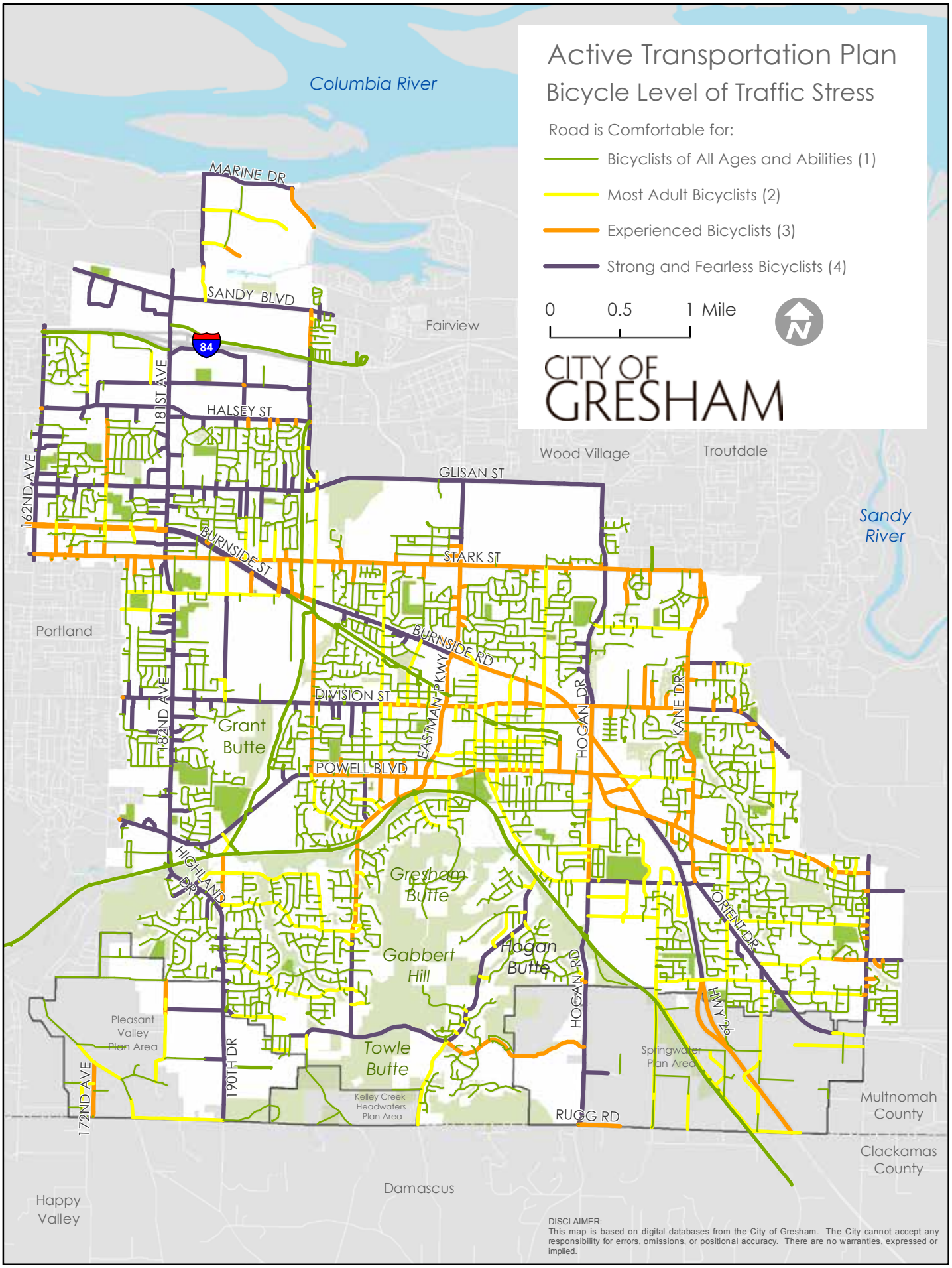
Bicycle LTS 1 represents roadways that bicyclists of all ages and abilities would feel comortable riding on, with LTS 2 represents slightly less comfortable roads, where most adults would be comfortable bicycling. Many streets in Gresham are categorized as LTS 1 and 2, the most comfortable environment for bicyclists. These roadways tend to be residential neighborhood streets, with low motor vehicle speeds and volumes. Bicycle facilities that are completely separated from motor vehicle traffic, such as multi-use paths and trails, are also categorized as LTS 1.

Arterial roadways, typically multi-lane roads with high vehicle speeds that may or may not have bicycle facilites, are categorized as least comfortable for bicylists. LTS 3 and 4 are roadways that would only be comfortable for experienced or strong and fearless bicyclists. Roadways in Gresham that are categorized as PLOS 5 include 190th Drive, the southern portion of Hogan Road, portions of Highway 26, Orient Drive and portions of Division Street.

Table 2 displays the classification of the street network by Level of Traffic Stress.

Table 2 - Street Network Level of Traffic Stress

LTS	Length (Miles)	Percent
1	*216*	*62%*
2	*41*	*12%*
3	*38*	*11%*
4	*56*	*16%*


Active Transportation Plan
Bicycle Level of Traffic Stress
Road is Comfortable for:
Bicyclists of All Ages and Abilities (1)
Most Adult Bicyclists (2)
Experienced Bicyclists (3)
Strong and Fearless Bicyclists (4)
0 0.5 1 Mile
CITY OF GRESHAM
Columbia River
MARINE DR
SANDY BLVD
84
Fairview
181ST AVE
HALSEY ST
162ND AVE
Wood Village
Troutdale
GLISAN ST
Sandy River
BURNSIDE ST
STARK ST
Portland
BURNSIDE RD
EASTMAN PKWY
DIVISION ST
182ND AVE
Grant Butte
POWELL BLVD
HOGAN DR
KANE DR
HIGHLAND DR
Gresham Butte
ORIENT DR
Gabbert Hill
Hogan Butte
HOGAN RD
HWY 26
Pleasant Valley Plan Area
190TH DR
Towle Butte
Springwater Plan Area
Kelley Creek Headwaters Plan Area
172ND AVE
RUGG RD
Multnomah County
Clackamas County
Damascus
Happy Valley
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BICYCLE NETWORK LEVEL OF TRAFFIC STRESS

The Bicycle Network Level of Traffic Stress (LTS) Map illustrates the LTS of the City's bicycle network, with both existing and future/proposed facilities. This analysis does not include all roadways, but rather the roadways that are designated as a part of the bicycle network.

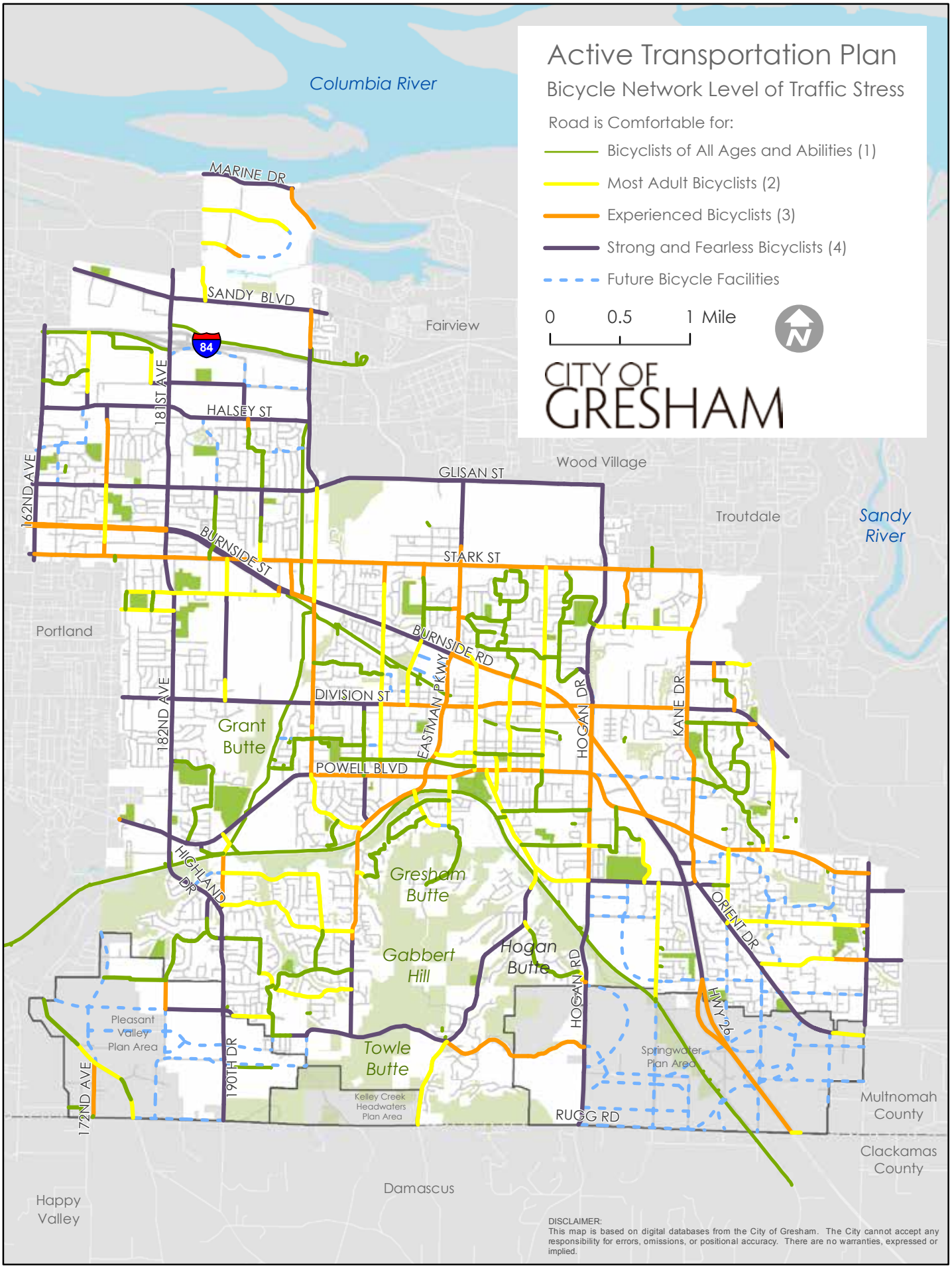
The map illustrates the locates of existing and future bicycle facilities and categorizes the factilities based on LTS. Like the previous map, facilities on arterials tend to be categorized as higher stress roadways, ranging from LTS 3 to 5. Facilities on low volume, low speed residential streets are categorized as LTS 1 or 2 and would be comfortable for more bicyclists.

The future bicycle facilties, illustrated as dashed blue lines, show where the City of Gresham has planned bicycle facilties.

Table 3 displays the classification of the bicycle network by Level of Traffic Stress.

Table 3 - Bicycle Network Level of Traffic Stress

LTS	Length (Miles)	Percent
1	*41*	*29%*
2	*25*	*18%*
3	*30*	*22%*
4	*42*	*30%*



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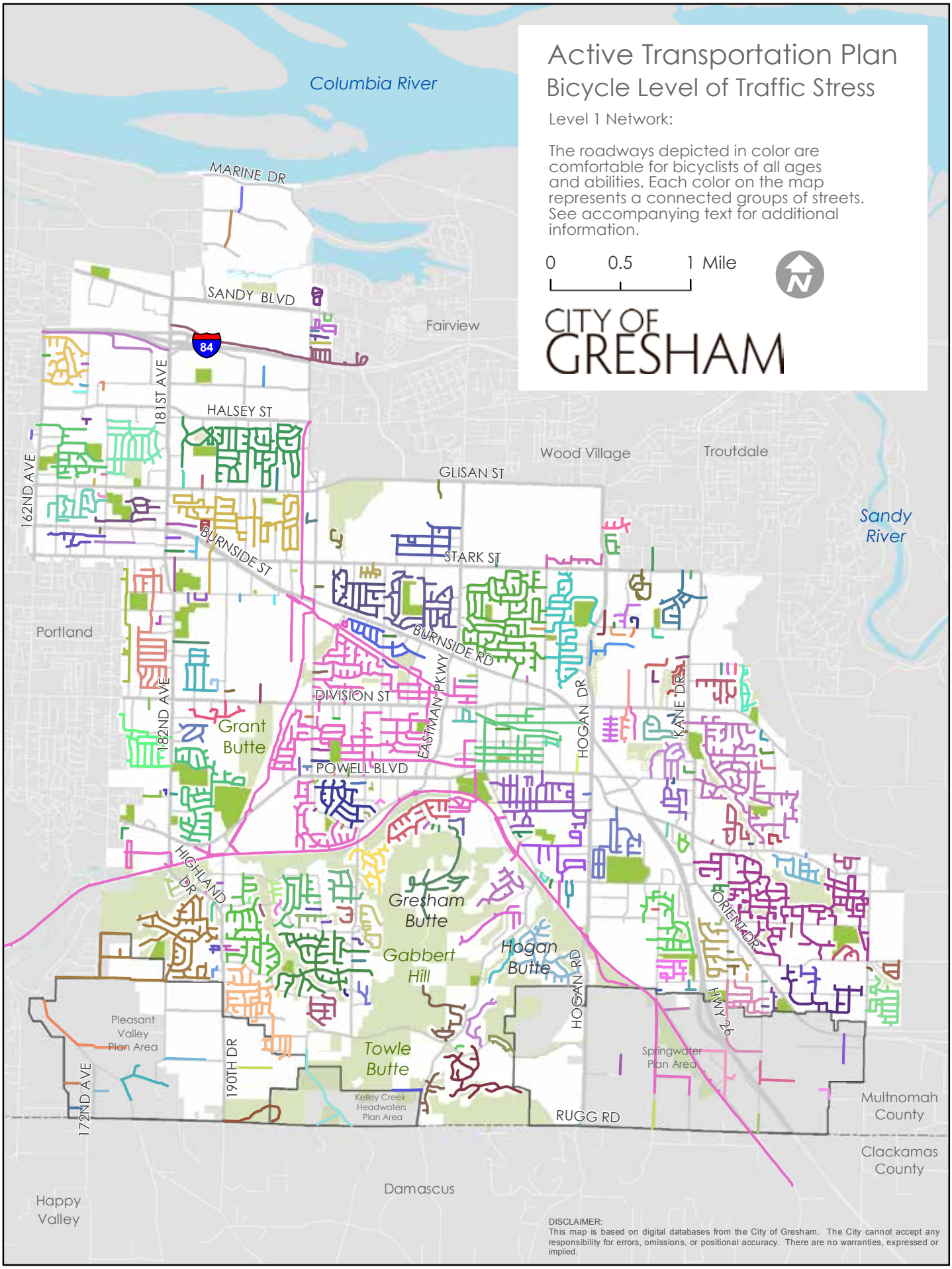
BICYCLE LEVEL OF TRAFFIC STRESS- LEVEL 1 NETWORK

The Bicycle Level of Traffic Stress- Level 1 Network Map displays the streets and trails in Gresham that have a Level of Traffic Stress of 1. These streets make up the network that is comfortable to bicyclists of all ages and abilities. Each color on the map represents a connected groups of streets.

The many colors on the map illustrate that while Gresham has many low stress bicycle facilities they are disconnected from each other.


Active Transportation Plan
Bicycle Level of Traffic Stress
Level 1 Network:
The roadways depicted in color are comfortable for bicyclists of all ages and abilities. Each color on the map represents a connected groups of streets. See accompanying text for additional information.
0 0.5 1 Mile
CITY OF GRESHAM
Columbia River
MARINE DR
SANDY BLVD
84
Fairview
181ST AVE
162ND AVE
HALSEY ST
Wood Village
Troutdale
GLISAN ST
Sandy River
BURNSIDE ST
STARK ST
Portland
BURNSIDE RD
EASTMAN PKWY
HOGAN DR
KANE DR
182ND AVE
DIVISION ST
Grant Butte
POWELL BLVD
HIGHLAND DR
Gresham Butte
Gabbert Hill
Hogan Butte
ORIENT DR
HOGAN RD
HWY 26
Pleasant Valley Plan Area
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Springwater Plan Area
172ND AVE
Kelley Creek Headwaters Plan Area
RUGG RD
Multnomah County
Clackamas County
Damascus
Happy Valley
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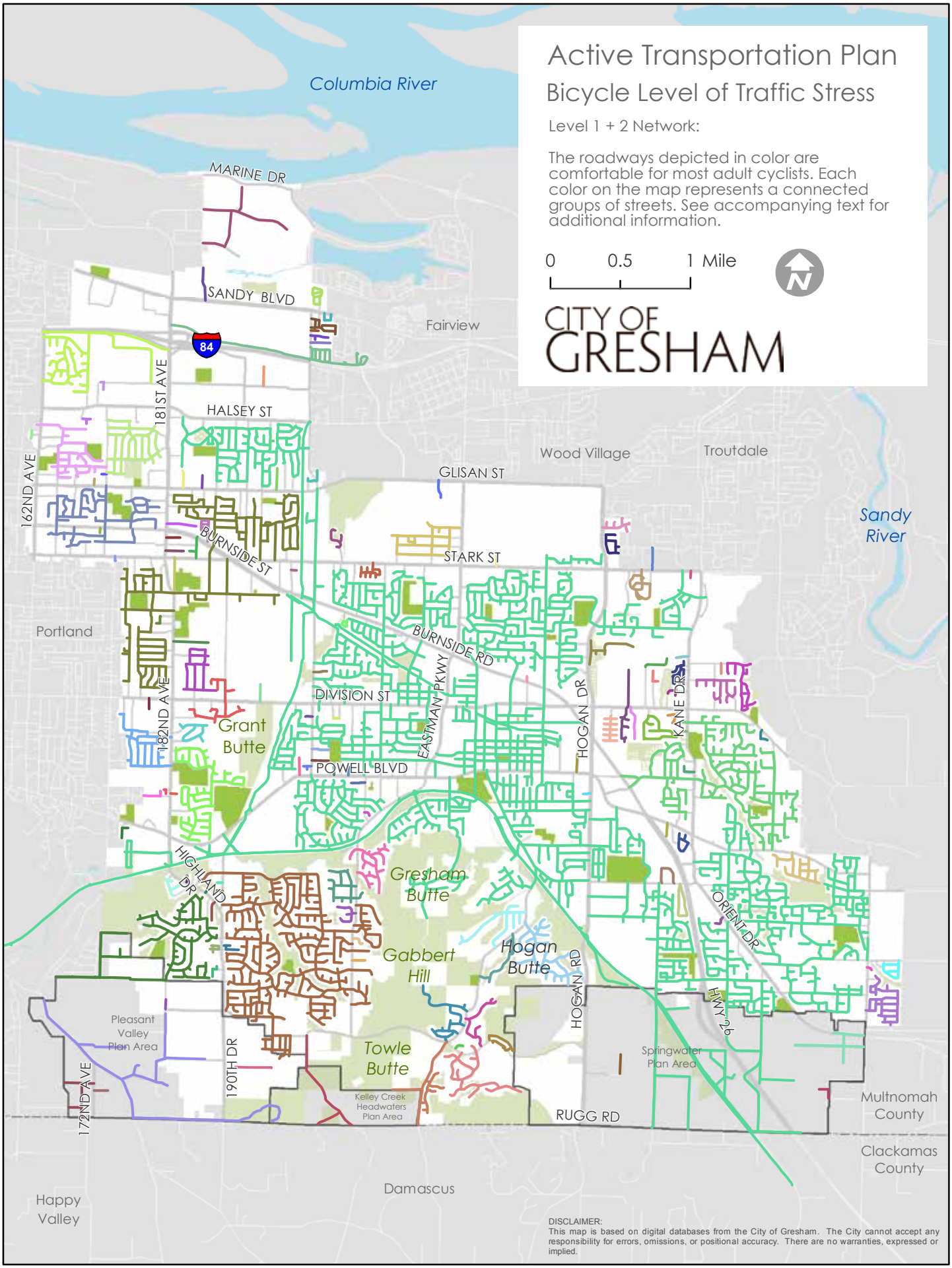
BICYCLE LEVEL OF TRAFFIC STRESS- LEVEL 1 & 2 NETWORK

The Bicycle Level of Traffic Stree- Level 1 & 2 Map is the same as the Bicycle Level of Traffic Stress- Level 1 Network Map but also includes streets with a Level of Traffic Stress of 2. These streets are comfortable for most adults to ride a bicycle on, no matter how much experience they have.

The map shows there is a connected network of LTS 1 and 2 streets that covers much of the Northwest, Hollybrook, Central City, North Central, Historic Southeast, Mt. Hood, and Kelly Creek Neighborhoods (shown in turquoise). However, there are limited connections across major arterials indicating that many trips within this area would require out-of-direction travel. The map also illustrates that neighborhoods in northwest Gresham, and particularly in Rockwood, do not have bikeways for less experienced cyclists that connect to the rest of the city.


Active Transportation Plan
Bicycle Level of Traffic Stress
Level 1 + 2 Network:
The roadways depicted in color are comfortable for most adult cyclists. Each color on the map represents a connected groups of streets. See accompanying text for additional information.
0
0.5
1 Mile
CITY OF GRESHAM
Columbia River
MARINE DR
SANDY BLVD
84
Fairview
181ST AVE
HALSEY ST
162ND AVE
Wood Village
Troutdale
GLISAN ST
Sandy River
BURNSIDE ST
STARK ST
Portland
BURNSIDE RD
EASTMAN PKWY
DIVISION ST
182ND AVE
Grant Butte
POWELL BLVD
HOGAN DR
KANE DR
HIGHLAND DR
Gresham Butte
ORIENT DR
Gabbert Hill
Hogan Butte
HOGAN RD
HWY 26
Pleasant Valley Plan Area
190TH DR
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Springwater Plan Area
172ND AVE
Kelley Creek Headwaters Plan Area
RUGG RD
Multnomah County
Clackamas County
Damascus
Happy Valley
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METHODOLOGY FOR TRAFFIC STRESS AND LEVEL OF SERVICE ANALYSIS

1. OVERVIEW

1.1 Introduction

Alta conducted a Bicycle Level of Traffic Stress Analysis (BLTS) and a Pedestrian Level of Service Analysis (PLOS) for the City of Gresham. These models provide objective, data-driven scores of roadway comfort for pedestrian and bicycle travel. The results of these models used to identify pedestrian and bicycle network gaps and potential projects and aid in system-wide prioritization.

This document summarizes the method for both PLOS and BLTS. Each analysis incorporates the recent research on factors that impact bicycle and pedestrian comfort and safety, and was tailored to the City of Gresham using the data available. Each model analyzed the full roadway network, excluding limited access highways, to provide a full picture of connectivity around the City of Gresham.

1.2 Assumptions

The following assumptions were used to carry out the analysis:

- The number of lanes for each roadway segment was calculated using the following assumptions:
    - Minor Arterials and Collectors: 2-3 lanes
    - Streets without a functional classification in the dataset (local streets): 1 lane (no marked centerline)
    - Standard/Major/Principal Arterials: 4 -5 lanes (these were also verified of corrected using aerial imagery)
- Bike lane width was assumed to be 5.5 feet or less
- Parking lane width was assumed to be 8 feet throughout the county
- Streets without specified speed limits in the data were assumed to be 25 MPH

2. BICYCLE CONDITIONS - LEVEL OF TRAFFIC STRESS ANALYSIS

2.1 Introduction to Level of Traffic Stress

The methods used for the Level of Traffic Stress Analysis were adapted from the 2012 Mineta Transportation Institute (MTI) Report 11-19: Low-Stress Bicycling and Network Connectivity. The approach outlined in the MTI report uses roadway network data, including posted speed limit, the number of travel lanes, and the presence and character of bicycle lanes, as a proxy for bicyclist comfort level. Road segments are classified into one of four levels of traffic stress based on these factors.

The lowest level of traffic stress, LTS 1, is assigned to roads that would be tolerable for most children to ride, and also to multi-use paths that are separated from motorized traffic. LTS 1 is labeled on these maps as "Bicyclists of All Ages and Abilities. LTS 2 roads are those that could be comfortably ridden by the mainstream adult population. LTS 2 is labeled as "Most Adult Bicyclists". The higher levels of traffic stress, LTS 3 and 4, correspond to types of cyclists characterized by Portland's bicycle coordinator Roger Geller in his Four Types of Cyclists report[3]. This categorization of cyclist types is accepted throughout the bicycling planning practice across the U.S. LTS 3 is the level assigned to roads that would be acceptable to current "enthused and confident" cyclists and LTS 4 is assigned to segments that are only acceptable to "strong and fearless" bicyclists, who will tolerate riding on roadways with higher motorized traffic volumes and speeds. LTS 3 is labeled as "Experienced Bicyclists" and LTS 4 is labeled as "Strong and Fearless Bicyclists" on the Gresham maps. The definitions for each level of traffic stress are shown Table 2.1.

The Level of Traffic Stress analysis completed for Gresham utilizes the MTI approach, with some alterations due to available data. The scoring methodology developed by the MTI is summarized in Tables 2.2-2.4.

After each segment in the roadway network had been assigned a Level of Traffics Stress score, unsignalized intersections were analyzed. Unsignalized crossings increase stress for cyclists along otherwise low-stress routes. The intersection level of service analysis identifies difficult crossings in the network. Crossing comfort decreases as the number of lanes and posted speed increase. While median refuges can reduce the stress of an unsignalized crossing, refuges were not included in this analysis because of insufficient data. Table 2.5 displays the scoring matrix for unsignalized intersections.

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3 Roger Geller. Four Types of Cyclists. http://www.portlandoregon.gov/transportation/article/237507

Table 2.1: Levels of Traffic Stress (LTS) Definitions

LTS 1	Presenting little traffic stress and demanding little attention from cyclists, and attractive enough for a relaxing bike ride. Suitable for almost all cyclists, including children trained to safely cross intersections. On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a slow traffic stream with no more than one lane per direction, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where cyclists ride alongside a parking lane, they have ample operating space outside the zone into which car doors are opened. Intersections are easy to approach and cross.
LTS 2	Presenting little traffic stress and therefore suitable to most adult cyclists but demanding more attention than might be expected from children. On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a well-confined traffic stream with adequate clearance from a parking lane, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where a bike lane lies between a through lane and a right-turn lane, it is configured to give cyclists unambiguous priority where cars cross the bike lane and to keep car speed in the right-turn lane comparable to bicycling speeds. Crossings are not difficult for most adults.
LTS 3	More traffic stress than LTS 2, yet markedly less than the stress of integrating with multilane traffic, and therefore welcome to many people currently riding bikes in American cities. Offering cyclists either an exclusive riding zone (lane) next to moderate-speed traffic or shared lanes on streets that are not multilane and have moderately low speed. Crossings may be longer or across higher-speed roads than allowed by LTS 2, but are still considered acceptably safe to most adult pedestrians.
LTS 4	A level of stress beyond LTS3.

Source: Mineta Transportation Institute Report 11-19

Table 2.2: Criteria for Bike Lanes Alongside a Parking Lane

	LTS ≥ 1	LTS ≥ 2	LTS ≥ 3	LTS ≥ 4
Street width (through lanes per direction)	1	(no effect)	2 or more	(no effect)
Sum of bike lane and parking lane width (includes marked buffer and paved gutter)	15 ft. or more	14 or 14.5 ft.[a]	13.5 ft. or less	(no effect)
Speed limit or prevailing speed	25 mph or less	30 mph	35 mph	40 mph or more
Bike lane blockage (typically applies in commercial areas)	rare	(no effect)	frequent	(no effect)

Note: (no effect) = factor does not trigger an increase to this level of traffic stress.

a. If speed limit < 25 mph or Class = residential, then any width is acceptable for LTS 2.

Source: Mineta Transportation Institute Report 11-19

Table 2.3: Criteria for Bike Lanes Not Alongside a Parking Lane

	LTS ≥ 1	LTS ≥ 2	LTS ≥ 3	LTS ≥ 4
Street width (through lanes per direction)	1	2, if directions are separated by a raised median	more than 2, or 2 without a separating median	(no effect)
Bike lane width (includes marked buffer and paved gutter)	6 ft. or more	5.5 ft. or less	(no effect)	(no effect)
Speed limit or prevailing speed	30 mph or less	(no effect)	35 mph	40 mph or more

Source: Mineta Transportation Institute Report 11-19

Table 2.4: Criteria for Level of Traffic Stress in Mixed Traffic

	Street Width		
Speed Limit	2-3 lanes	4-5 lanes	6+ lanes
Up to 25 mph	LTS 1[a] or 2[a]	LTS 3	LTS 4
30 mph	LTS 2[a] or 3[a]	LTS 4	LTS 4
35+ mph	LTS 4	LTS 4	LTS 4

Note: [a] Use lower value for streets without marked centerlines or classified as residential and with fewer than 3 lanes; use higher value otherwise.

Source: Mineta Transportation Institute Report 11-19

Table 2.5: Intersection Scoring Matrix for Bicycle Level of Traffic Stress
1 = Highest Comfort Level

Number of Travel Lanes	Posted Speed Limit		
	<= 30	35	>= 35
Up to 3 lanes	1	2	3
4 - 5 lanes	2	3	4
6+ lanes	4	4	4

3. PEDESTRIAN CONDITIONS – LEVEL OF SERVICE ANALYSIS

3.1 Pedestrian Level of Service Analysis Methodology

The Pedestrian Level of Service Analysis treats segments and intersections separately. A level of service was identified for each roadway segment in the study area, apart from limited access highways, while intersections were examined that were identified as marked or unmarked crosswalks in the City of Gresham data (includes all major crossing).

3.1.1 Segment Analysis
The selected segment-based Pedestrian Level of Service Analysis (PLOS) is rooted in the concept that a doubling of travel speed results in a four-fold increase in stopping time and resulting crash severity. According to one study, speed has the following impact on pedestrian fatalities[3]:

- At 20 mph the odds of pedestrian fatality are 5%
- At 30 mph the odds of pedestrian fatality are 45%
- At 40 mph the odds of pedestrian fatality are 85%

While other studies have found some variation, these approximate numbers are reported consistently across the literature.

It is imperative that dedicated travel facilities are provided to create safe travel conditions for pedestrians. ***This PLOS analysis is based primarily on safety and does not consider factors of the built environment known to make walking an attractive and preferred form of transportation.*** While built environment factors are not explicitly considered, lower posted speeds and more dedicated pedestrian space will typically correlate with places people want to walk, based on the surrounding land uses and urban form (e.g., residential neighborhoods and commercial uses in lower speed urban areas).

The segment-based Pedestrian Level of Service Analysis (PLOS) measures pedestrian safety using four factors: posted speed limit, roadway width (number of travel lanes), pedestrian buffer (on-street parking or bicycle lanes), and the presence of sidewalks. Table 3.1 outlines the scoring methodology of the PLOS analysis. The PLOS follows a five-point scale, with 1 representing the highest comfort level. Generally, more pedestrian space on a lower speed roadway segment correlates to a higher comfort level. An incomplete sidewalk network, higher speeds, and a greater number of lanes correlate to a lower comfort level. Bicycle lanes or on-street parking act as buffers between pedestrians and motor vehicle traffic, increasing comfort.

3 Killing Speed and Saving Lives, UK Dept. of Transportation, London, England. See also Limpert, Rudolph. Motor Vehicle Accident Reconstruction and Cause Analysis. Fourth Edition. Charlottesville, VA. The Michie Company, 1994, p. 663.

Table 3.1: Scoring Matrix for Pedestrian Level of Service: Roadway Segments.
1 = Highest Comfort Level

Pedestrian Space along Roadway	Speed Limit (mph)					
	<= 25 mph		30 - 35 mph		>= 40 mph	
	2 lanes	> 2 lanes	2 lanes	> 2 lanes	2 lanes	> 2 lanes
Complete sidewalk on both sides next to a buffer*	1	1	1	1	2	3
Complete sidewalk on both sides	1	1	2	3	3	4
Complete sidewalk on one side next to a buffer*	2	2	2	3	3	4
Complete sidewalk on one side	2	3	3	4	4	5
No dedicated space next to a buffer*	2	3	3	4	4	5
No dedicated space	2	3	4	5	5	5

**Bicycle lanes and/or on-street parking*

Table 3.2: Scoring Matrix for Pedestrian Level of Service: Intersections.
1 = Highest Comfort Level

Intersections: Characteristics of Ped Crossing Leg	Posted Speed Limit		
	<= 25 mph**	30 - 35 mph	>= 40 mph
Baseline (Signalized intersection)	1	1	2
More than 2 lanes	1	2	2
No Marked crosswalk	0	1	1
Crossing controlled by stop sign	0	0	1
Uncontrolled or Yield crossing	1	1	2
Total Score	Sum of applicable parameters		

3.1.2 Crossing Analysis

Intersections along major roadways were reviewed for the quality of pedestrian crossing infrastructure. The selected intersection-based Pedestrian Level of Service is rooted in evidence on pedestrian crash reduction factors related to design treatments or interventions[3].

- Installation of a pedestrian crossing reduces crashes by 25%
- Conversion of an unsignalized intersection to a roundabout reduces crashes by 27%
- Installation of a raised median and crosswalk reduces crashes by 56%
- Speed reduction by enforcement reduces crashes by 71%

Signalized and unsignalized intersections were examined along roadways with a functional classification of 'collector' or 'arterial'. Each intersection leg was scored based on the characteristics of the crossing. Like the segment-based scoring, 1 represents the highest level of service. Intersection scoring is additive - scores start at 1 or 2 depending on speed, and then increase with missing infrastructure. Stop-sign controlled or uncontrolled crossings receive additional points since pedestrians must find gaps in traffic.

3 Source: Federal Highway Administration. Desktop Reference for Crash Reduction Factors. http://safety.fhwa.dot.gov/

Made possible with funding from the centers for disease control and prevention.