MEMO

TO: Christopher Kidd, SFMTA
FROM: Brian Almdale, MUPP, Rebecca Sanders, PhD, RSP_{2B}, and Jessica Schoner, PhD
DATE: 2023-07-12
RE: Final Draft Crash Analysis – Step II
PROJECT: SFMTA Bike Plan

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Introduction

This memo summarizes the methodology and key findings for the second phase of the bicycle crash analysis being conducted as part of the San Francisco Active Communities Plan. The first phase of crash analysis (Step I) focused on investigating factors related to who, where, when, and why crashes that involved a bicyclist occurred. This phase (Step II) investigated modifiable risk factors associated with fatal and severe bicyclist crashes. This Step II analysis will help us further understand the risk factors associated with bicycle crashes, which can then be used to inform the bicycle network development phase and countermeasure selection.

Most sections of this memo analyzed the 5-year study period (2017-2021) as the base study period. This analysis also looked at crashes that occurred during the pre-pandemic period (2017-2019) and during the pandemic (2020-2021) to control for changes in travel behaviors due to the COVID-19 pandemic.

Key findings

Reported crash data that involved a bicyclist was the primary dataset in this crash analysis. Reported crash data are critical to understanding crash patterns. While reported crash data are known to have problems with underreporting[1,2], they are often the most complete data source in terms of the number and consistency of crash attributes available and the breadth and number of crashes included. As such, these data can provide the necessary detail for informing engineering treatments and help us understand who was involved in a crash. This report acknowledges the crash data used in this analysis provides us with an incomplete picture of crashes but allows us to use the most complete and readily available data that represent crash events and the people involved in crashes. Key findings from this crash analysis include the following:

- ***Crash Location:***
    - The majority of crashes overall and KSI crashes in particular occurred at intersections (79.3% and 78.4%, respectively).
    - When looking only at KSI crashes, those occurring at midblock locations tended to result in a slightly more severe outcome than those at intersections, with 10.1% of crashes resulting in a KSI and an average EPDO score of 24.23.
- ***Neighborhoods:***
    - Changes in the distribution of crashes were observed between study periods in several neighborhoods. These differences most likely reflect changes in how people traveled during the pandemic, with fewer people working downtown and potentially an increase in recreational trips.
    - Neighborhoods with large differences in percentage points between the pre-pandemic and pandemic study period for bicyclist *KSI crashes* include: Castro/Upper Market (5.8%), Tenderloin (+5.8%), Mission (-5.6%), Golden Gate Park (+4.5%), Sunset/Parkside (+3.9%), North Beach (-3.8%), Bayview Hunters Point (-3.7%), and Outer Richmond (+3.2%).
    - Differences in *overall crash* distributions were highest in the following neighborhoods: Financial District (-3.6%), SOMA (-3.3%), Mission (-2.6%), North Beach (-1%), and Nob Hill (-0.9%).
- ***High Injury Network:***
    - The majority of the crashes that occurred along the HIN occurred at intersections (84% of all crashes and KSI crashes), most often at signalized intersections (80% of all crashes; 81% of KSI crashes). Half of the KSI crashes at signalized intersections along the HIN were reported as a roadway user disregarding a red signal.
    - Nearly 46% of the motorist-bicyclist crashes along the HIN were perpendicular crashes, half of which were broadside crashes.

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[1] Stutts, J., & Hunter, W. (1998). Police reporting of pedestrians and bicyclists treated in hospital emergency rooms. Transportation Research Record: Journal of the Transportation Research Board, (1635), 88-92.

[2] San Francisco Department of Public Health-Program on Health, Equity and Sustainability. 2017. Vision Zero High Injury Network: 2017 Update – A Methodology for San Francisco, California. San Francisco, CA. Available at: https://www.sfdph.org/dph/files/EHSdocs/PHES/VisionZero/2017_Vision_Zero_Network_Update_Methodology_Final_20170725.pdf

- The pandemic study period had a higher concentration of KSI crashes having occurred along the HIN. Additional monitoring of crashes and travel behaviors is recommended to better understand if the pandemic fundamentally changed travel behaviors.

- ***Functional Classification:***
  - Across all years (including pre-pandemic and mid-pandemic years) the most severe crashes occurred on major/highways and the most crashes overall occurred on collector roadways.
  - Arterials accounted for the largest number of crashes on a per mile basis followed by collectors.
  - When looking at intersection crashes and the highest and lowest functional classification present, collector-residential and residential-residential combinations had the largest share of all crashes and KSI crashes. Future evaluation is recommended, as there may be underlying data issues related to how some streets are coded, particularly for residential streets that have the characteristics of an arterial or collector.
  - The most severe crashes occurred at intersections with generally higher functional classes; crashes at intersections of major highways and arterials were the most severe (40.0 avg. EPDO), followed by intersections of major highways and collectors (31.9 avg. EPDO).
- ***Intersection Control:***
  - Uncontrolled stops and partial stop-controlled intersections had the highest average EPDO score per crash. This is likely due to a bicyclist attempting to cross a street in which the motorist does not have a traffic control device, therefore leading to higher kinetic energy transfer at the time of the crash.
  - The majority of the KSI crashes that occurred at signalized intersections occurred in non-residential areas, with 39% in mixed land use areas and 25% in commercial land use areas compared to 19% within residential land use areas.
- ***Number of Lanes:***
  - There is a clear and positive relationship between crash densities, severity, and the number of lanes: there were 108.2 crashes per 10 miles of 5-lane roads, 89.1 crashes per 10 miles of 3-lane roads, and 86.4 crashes per 10 miles on 4-lane roads, compared with just under 10.7 crashes per 10 miles on 2-lane roadways.
  - Certain roadway configurations seem more dangerous for bicyclists than others. In particular, while bicyclist crashes on 3-lane roadways were rarer than those on other roadway configurations, crashes on these roadways were disproportionately severe.
- ***Posted Speed Limit and Observed Speed:***
  - There were differences among crash trends when comparing reported crashes by posted speed limit and observed speed. There were more crashes on low speed limit facilities (≤ 25pmh), and on average more severe crashes were on roadways with a 30 mph posted speed limit. Higher observed speeds, however, were correlated with more severe safety outcomes for bicyclists; the most severe crashes occurred on facilities with prevailing speeds of 35-39 mph. While these relationships are likely confounded with the number of people cycling on the low-speed roads versus higher-speed roadways, it is clear that traveler speed is positively correlated with severe bicyclist crashes.
  - Nearly 80% of KSI crashes occurred along 25 mph streets. Of the crashes that occurred along 25 mph streets:
    - 27.5% of KSI crashes were solo bicyclist.
    - 79% of KSI crashes occurred at an intersection (slightly more than half at signalized intersections).
    - Same and perpendicular direction of travel between the motorist and bicyclists accounted for the largest share of crashes, both with 38.8% of KIS crashes.
    - Most of the KSI crashes along a 25mph street did not occur along a bike facility of any type.

- ***Bicyclist Volume Estimates:***
    - Unsurprisingly, the data show locations with higher bicycle volumes had a higher bicycle crash frequency due to higher levels of exposure. This does not necessarily mean locations with higher volumes of bicyclists have higher crash risk.
    - Relative to the percentage of all crashes that occur on the streets with the highest bicyclist ridership, there are fewer severe crashes than for other volume categories.
        - The proportion of midblock crashes resulting in a KSI outcome are quite low for the highest volume street (8.4%) whereas the lowest volume streets have the highest proportion of KSI outcomes (21.4%).
        - Intersections with higher volume estimates had fewer crashes that resulted in a KSI, whereas intersections with a lower volume estimate have a higher proportion of crashes that resulted in a KSI. This relationship between bicyclist volumes and the average severity of crashes at intersections may suggest a safety in numbers effect.
- ***Bike Facility Type:***
    - Over the study period, only about one-third of KSI crashes occurred along streets with a bike facility. Given how ridership tends to occur disproportionately along the bike network, these numbers suggest a protective effect of the bike network in terms of KSI crashes.
    - Bike facilities were further analyzed by comparing post-installation crashes per year rate by a number of variables to help us better understand the safety effect bicycle facilities have by facility type.
    - Class III facilities accounted for the largest share of both overall crashes and KSI crashes per year (39.7% and 48.2%, respectively), followed closely by Class II facilities (39.2% and 31.7%, respectively). Class IV accounted for the third highest share of crashes (20.1%) and KSI crashes (19%) per year.
    - While Class II facilities accounted for the large share of crashes, the percentage of crashes that *resulted in a KSI outcome* was the lowest (7.8%), followed by Class IV (9.0%). This finding suggests that the Class II and Class IV facilities and the type of physical separation they provide may help reduce the severity of crashes if they occur.
    - Regardless of bike facility type, the largest share of crashes by relative direction of travel between the bicyclists and motorists was the same direction (47.9% of all crashes; 42.4% of KSI crashes).
        - Exploring the same direction crashes further, the most common movement types involved a bicyclist proceeding straight and a motorist making a right turn (9% of all crashes, n=66; 5.1% of KSI crashes, n=3) while the most common movement type for KSI crashes was bike proceeding straight and the motorists stopped (5.6% of all crashes, n=41; 13.6% of KSI crashes, n=8). Five of the eight KSI crashes were dooring crashes.
    - Crashes along any type of bike facility were concentrated at intersections (81.5% of all crashes; 82.2% of KSI crashes), with KSI crashes occurred most frequently at signalized intersections (~60%).
    - Most intersection crashes along a bike facility were perpendicular (35.5% of all crashes; 39% of KSI crashes), followed by same direction (30.3% of all crashes; 24.7% of KSI crashes). Midblock crashes largely involved both parties traveling in the same direction (65.2% of all midblock crashes and 65.4% midblock KSI crashes).
    - Nearly all bicyclist-motorist KSI crashes (18 of 20) that occurred along a Class II facility were at an intersection. Similarly, 11 of the 13 KSI crashes along a Class IV facility were at an intersection. For KSI crashes along a Class IV facility at an intersection, most KSI crashes involved both parties traveling perpendicularly (54.5%).
    - Crashes along residential streets with a Class II or Class III facility also tended to be less severe, with fewer crashes resulting in a KSI outcome compared to collector or arterial streets. This is

likely due to lower vehicle volumes and speeds resulting in lower exposure and less kinetic energy at the time of the crash due to lower vehicle speeds.
  - Class I and Class IV facilities, which provide the greatest level of physical separation, had the lowest crash rates and KSI crash rates per year and per mile along streets with four lanes. This is a particularly interesting finding, given that Class I and IV facilities are often installed along streets with higher levels of stress and crash risk.
  - Roughly 60% of bicycle crashes and 55% of KSI crashes along a bike facility of any kind occurred along the HIN. Class II and Class III facilities along the HIN had the highest rate of crashes per year, followed by Class II and Class III facilities off the HIN. KSI crashes per year were highest along the Class III facilities along the HIN, followed by Class III facilities off the HIN. These findings underscore the need for bicycle facilities along these routes, but may also indicate insufficient protection gained from Class II and Class III facilities along these routes.
  - Nearly half (47.8%) of the crashes and KSI crashes (47.1%) along any bike facility type occurred along the HIN at an intersection.
- ***One-Way Streets:***
  - Crashes on one-way streets were more severe in terms of crashes per mile, KSI crashes per mile, and EPDO values per mile than other roadways across all years.
  - Most crashes along one-way streets occurred at intersections (91% of all crashes and KSI crashes). One quarter of the KSI crashes along a one-way street were cited as *disregard red signal*, followed by *dooring* (11.8%).
- ***Street Slope:***
  - The share of all crashes is distributed mostly among slopes between 1 - 6.9. KSI crashes are concentrated on roadways with slopes of 1- 4.9, which makes some sense given that steeper slopes are more difficult to access via bicycle.
- ***Bus Stops:***
  - Across the entire network, there were 26.6 crashes per 100 intersections, but there were notably more crashes per 100 intersections (46.8) when considering intersections with bus stops. This may point a relationship between intersections with more conflicting or complex traveler movements and bicycle crashes.
- ***Land Use:***
  - Severe crashes seem to be over-represented in commercial and mixed-use contexts. These findings may reflect that the complexity of interactions among roadway users in commercial and mixed-use spaces is an important factor in bicycle safety.
- ***Equity Priority Communities:***
  - Slightly more than half of the reported bicyclist crashes (N=2,432) occurred *outside of* EPCs (55.2%) and these crashes tend to be more severe, with an average EPDO score of 23.2 and 10.3% of crashes resulting in a KSI outcome.
  - There is a clear correlation between crashes along the HIN and EPCs: nearly 81% of all crashes and 80% of KSI crashes across all EPCs occurred along the HIN.
- ***Location-Movement Crash typing:***
  - The top three location-movement crash types include:
    - Intersection – perpendicular – bike proceeding straight, motorist proceeding straight (14.9% crashes; 21.8% KSI crashes)
    - Intersection – perpendicular – bike proceeding straight, motorist making left turn (6.4% crashes, 6.1% KSI crashes)
    - Intersection – same direction – bike proceeding straight, motorist making right turn (6.2% crashes; 4.2% KSI crashes)

- ***Safer Street Priority Finder (SSPF) Crash Risk Estimation***
  - The SSPF estimated the following streets to have high crash risk:
    - **Howard St** from Van Ness Ave to 3rd St
    - **Turk St** from Laguna St to Market St
    - **Taylor St** from Market St to Bush St
    - **Sansome St** from Broad Way to the Embarcadero (not along HIN)
    - **Silver Ave** from Alemany Blvd to Madison St (not along HIN) and Princeton St to Barneveld Ave
    - **3rd St** from Mariposa St to China Basin St (not along HIN)
    - **Valencia St** from 7th St to Market St
  - Many of these higher scoring corridors are located areas of the city that generally have higher volumes of bicycle and motor vehicle volumes such as the Financial District, SOMA, Mission, Tenderloin, Western Addition, and North Beach. Many of the highest scoring corridors are also within EPCs and overlap with sections of the HIN.

Next Steps

- Toole Design and SFMTA to review this draft analysis and provide comments for Safe Streets to address. Key questions to consider in during the review:
  - Are there any findings that do not reflect your current understanding of bicyclist safety in San Francisco?
  - Are there areas of this memo for which you would like additional information? If so, what else would you like to know?
- Once this analysis is finalized, Safe Streets will deliver the following files to Toole Design and SFTMA. Toole Design will use these files to produce any necessary graphics or maps.
  - CSV file of crash data with geospatial attributes
  - Crash analysis Word Document and PDF
  - Refined and contextualized intersection and segment data. Both data include aggregated crashes.

Data Preparation

Crash data were processed and evaluated as part of the Step I crash analysis. No other cleaning to the underling crash data occurred as part of the Step II analysis. Roadway characteristics, land use, and demographic data were processed as part of the Step II analysis and joined to a master intersection and centerline dataset. The crashes were joined to the intersection and centerline data to contextualize the crash data and to aggregate the crash data to the network data to allow for a systemic safety analysis to be conducted.

As part of the data preparation effort, the intersection and centerline data were thoroughly reviewed at the start of this analysis. A number of data quality issues with both the street centerline and intersection data were identified and are detailed in Appendix A: Network Data QC.

Crash Weights

Crashes have been assigned an Equivalent Property Damage Only value (EPDO) that will be used throughout this analysis to weight crashes based on the estimated crash cost. Applying severity-based weights to crashes allows us to better understand the general crash intensity when analyzing crash frequencies in cross tabs. A higher EPDO value may suggest a particular roadway characteristic is associated with higher crash severities and/or crash frequencies. Most tables in this report present EPDO values via the total EPDO by variables as well as the average EPDO score per score (total EPDO divided by the total number of crashes) to help us understand the average severity of crashes (see Table 1).

Table 1: Crash EPDO Scoring

Crash Severity*	Location Type	Crash Cost***	Equivalent Property Damage Only
**Fatal and Severe Injury (KA)	Signalized Intersection	$1,787,000	119.93
	Non-Signalized Intersection	$2,843,000	190.81
	Roadway	$2,461,000	165.17
Evident Injury – Other Visible (B)		$159,000	10.67
Possible Injury – Complaint of Pain (C)		$90,900	6.10
Property Damage Only (O)		$14,900	1.00

** The letters in parenthesis (K, A, B, C and O) refer to the KABCO scale commonly used by law enforcement agencies in their crash reporting efforts. The KABCO scale is further documented in the Highway Safety Manual (HSM).*
*** Figures were calculated based on an average Fatality (K) / Severe Injury (A) ratio for each area type, a crash cost for a Fatality (K) of $8,112,200, and a crash cost of a Severe/Disabling Injury (A) of $437,100. These costs are used in the HSIP Analyzer.*
**** Based on Table 7-1, HSM First Edition, 2010. Adjusted to 2022 Dollars.*

Descriptive Analysis

Crash Location (Intersection vs. Midblock)

Crashes were assigned a location type as either having occurred at an intersection or a midblock location. Crashes were coded as having occurred at an intersection if the geocoded data point was within 75 ft of an intersection centroid. All other crashes were coded as midblock. We performed a sensitivity analysis to inform this threshold by comparing the spatial location of several samples of crashes and whether each crash was coded as an intersection crash. Intersection crashes were reviewed with aerial imagery to ensure the results are intuitive. CHP's current approach is to assign each crash one of the following values: intersection ≤ 20 ft, intersection rear end ≤ 150 ft, or midblock > 20 ft. Caltrans' Highway Safety Improvement Program uses 250 ft as the threshold to define intersection crashes. For the purposes of this analysis, reflecting the density of San Francisco's streets, we used a tailored option of 75 ft to help us better understand risk factors and behavioral patterns associated with crashes and crash locations. The results of this approach are summarized in Table 2. The differences between this GIS proximity-based approach and the officer-reported locations resulted in 307 (13% of crashes) previously midblock crashes being coded as intersection crashes, and 33 (~1%) previously coded intersection crashes recoded as midblock crashes.

Table 2: Crashes by intersection relation and spatial proximity, 2017-2021

Location Type (SSRC)	Intersection (CHP)	# Crashes
intersection	Intersection ≤ 20 ft	**1,599**
intersection	Midblock > 20 ft	**307**
intersection	Intersection Rear End ≤ 150 ft	**37**
	Intersection Total	**1,943**
mid-block	Midblock > 20 ft	**456**
mid-block	Intersection Rear End ≤ 150 ft	**29**
mid-block	Intersection ≤ 20 ft	**4**
	Midblock Total	**489**

Table 3 summarizes bicyclist crashes by location type for crashes that occurred between 2017 and 2021. The majority of crashes (79.3%) and KSI crashes in particular (78.4%) occurred at intersections. This distribution is expected for bicyclist crashes, as most interactions between roadway users occur at intersection locations, rather than midblock. When looking at the percentage of crashes that resulted in a KSI, midblock crashes tended to result in a slightly more severe outcome, with 10.1% of crashes resulting in a KSI and an average EPDO score of 24.2. Motorist speeds are likely higher midblock than at intersections, resulting in higher kinetic energy and limited reaction time, both of which may contribute to midblock crashes being more likely to be severe. Of the midblock KSI crashes, 31.4% were solo-bicyclist crashes, and only 2 of the 51 midblock KSI crashes were coded as a dooring crash. For motorist-bicyclist KSI crashes, 21 out of the 22 KSI crashes included both roadway users traveling in the same direction.

The most common violation type for KSI crashes at an intersection included unsafe speed (20%), red signal – driver or bicyclist responsibility (14.1%), and Unknown (11.9%). The most common violation type for midblock KSI crashes includes unsafe speed (37.3%), unsafe turn or lane change prohibited (13.7%), and unknown (9.8%). Of the unsafe speed violations for both intersection and midblock crashes, 58.9% of those crashes were solo-bicyclist or bicyclist-pedestrian crashes.

Table 3: Bicyclist crashes by location type, 2017-2021

Location Type	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg EPDO per crash*
intersection	1928	79.3%	185	78.4%	41,169	77.1%	9.6%	21.4
midblock	504	20.7%	51	21.6%	12,211	22.9%	10.1%	24.2
Total	***2432***	***100.0%***	***236***	***100.0%***	***53,380***	***100.0%***	***9.7%***	***22.0***

Table 4 summarizes bicycle crashes by location type for the pre-pandemic study period. Most crashes (77.7%) and KSI crashes (79.1%) occurred at intersections. Unlike the 5-year study period, intersection crashes tended to result in a KSI outcome more often than midblock crashes, with 9.6% of crashes resulting in a KSI, but the average severity of crashes in terms of average EPDO score was similar between location types. The top three violation types for the pre-pandemic study period were the same as the 5-year study period for KSI intersection crashes, and similar for midblock crashes, with unsafe speed (7.6%), unknown (3.2%), and unsafe turn or lane change (2.5%) being the leading contributing factors.

Table 4: Bicyclist crashes by location type, 2017-2019

Location Type	# Crashes	% Crashes	# KSI	% KSI	EPDO	% EPDO	% Crashes resulting in KSI	Avg EPDO per crash
intersection	1296	77.7%	125	79.1%	27,668	77.0%	9.6%	21.4
midblock	372	22.3%	33	20.9%	8,254	23.0%	8.9%	22.2
Total	***1668***	***100.0%***	***158***	***100.0%***	***35,923***	***100.0%***	***9.5%***	***21.5***

Table 5 Summarizes bicycle crashes by location type for the pandemic study period. Like the pre-pandemic study period, most crashes (82.7%) and KSI crashes (76.9%) occurred at intersections. However, unlike the pre-pandemic study period, midblock crashes tended to result in a KSI outcome (13.6%) more often than intersection crashes (8.9%). Regardless of location type, crashes that occurred during the pandemic study period resulted in a KSI outcome slightly more often than during the pre-pandemic study period (10.2% compared to 9.5%, respectively). The top three violation types for the pandemic study period match the top three violation types for the 5-year study period for both intersection and midblock KSI crashes.

Table 5: Bicyclist crashes by location type, 2020-2021

Location Type	# Crashes	% Crashes	# KSI	% KSI	EPDO	% EPDO	% Crashes resulting in KSI	Avg EPDO per crash
intersection	632	82.7%	60	76.9%	13,501	77.3%	9.5%	21.4
mid-block	132	17.3%	18	23.1%	3,956	22.7%	13.6%	30.0
Total	***764***	***100.0%***	***78***	***100.0%***	***17,457***	***100.0%***	***10.2%***	***22.9***

Intersection Control

Table 6 summarizes intersection bicycle crashes by intersection control from 2017-2021. Most bicycle crashes occurred at signalized intersections both overall (67.9%) and particularly for KSI crashes (71.5%). Additionally, the number of crashes and KSI crashes per intersection with a traffic signal was substantially higher than intersections with other traffic control types. When looking at the average severity of crashes by intersection control type, crashes at signalized intersections tended to be the least severe with an average EPDO score of 20.2. Uncontrolled stops and partial stop-controlled intersections had the highest average EPDO score per crash (27.1 and 25.2, respectively). Perpendicular relative direction of travel (e.g., broadside, motorist left turn into bicyclist) is the most common crash type at partial stop-controlled intersections for bicyclist-motorist crashes (43.5% of all crashes; 40% of KSI crashes). This could be due to a bicyclist attempting to enter or cross a street in which the motorist does not have a traffic control device (or vice versa), therefore leading to higher kinetic energy at the time of the crash.

The majority of the KSI crashes that occurred at signalized intersections occurred in non-residential areas, with 39% occurring in mixed land use areas and 25% in commercial land use areas compared to 19% at signalized intersections within residential land use areas. This higher share of crashes at signalized locations in non-residential land uses is likely associated with higher bicyclist and motorist exposure levels at these locations. Additionally, there tend to be more interactions between moving bicyclists and motorists at signalized intersections compared to other location types. The most frequent reported violation types for KSI crashes at signalized intersections included *disregard red signal* (19.7%), *unsafe speed* (18.9%), *unknown* (13.6%), *unsafe turn or lane change* (8.3%), *violation right-of-way left turn* (8%), and *dooring* (8%).

Nearly 25% of the KSI crashes and 11% of overall crashes at signalized intersections were solo-bicyclist crashes, most of which were cited as traveling too fast for conditions or unknown. The signalized intersections with solo-bicyclist KSI crashes generally have a max slope between 2-4% grade, which is not especially steep for the city, but may still have contributed to a bicyclist or motorist going "too fast for conditions." This slope range accounts for 39% of the street network, but 68% of solo-bike KSI crashes at signalized intersections.

Table 6: Bicycle crashes by intersection control, 2017-2021

Intersection Control	*# Int*[3]	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg. EPDO per Crash
Signalized	1,323	18.4%	1,310	67.9%	133	71.5%	26,426	64.1%	99.0	10.1	20.2
Partial Stop	2,025	27.0%	291	15.1%	27	14.5%	7,331	17.8%	14.4	1.3	25.2
All-Way Stop	2,011	26.7%	230	11.9%	16	8.6%	4,847	11.8%	11.4	0.8	21.1
Uncontrolled	1,879	27.9%	97	5.0%	10	5.4%	2,630	6.4%	5.2	0.5	27.1
Total	***7,238***	***100.0%***	***1,928***	***100.0%***	***186***	***100.0%***	***41,234***	***100.0%***	**26.6**	**2.6**	**21.4**

Table 7 and Table 8 summarize intersection bicyclist crashes by intersection control type for the pre-pandemic and pandemic study periods respectively. The distribution of crashes was comparable between study periods with most crashes and KSI crashes having occurred at signalized intersections followed by partial stop-controlled intersections.

[3] "Intersections" are shortened to "Ints" in the tables throughout this document to allow the table to fit within an 8.5x11" portrait layout.

Table 7: Bicycle crashes by intersection control, 2017-2019

Intersection Control	***# Ints***	***% Ints***	***# Crashes***	***% Crashes***	***# KSI Crashes***	***% KSI Crashes***	***EPDO***	***% EPDO***	**Crashes per 100 Ints**	**KSI Crashes per 100 Ints**	**Avg. EPDO per Crash**
Signalized	1,323	18.4%	890	68.7%	89	71.2%	17,779	64.1	67.3	6.7	20.0
Partial Stop	2,025	27.0%	194	15.0%	15	12.0%	4,338	15.7	9.6	0.7	22.4
All-Way Stop	2,011	26.7%	146	11.3%	13	10.4%	3,595	13.0	7.3	0.6	24.6
Uncontrolled	1,879	27.9%	66	5.1%	8	6.4%	2,006	7.2%	3.5	0.4	30.4
Total	***7,238***	***100.0%***	***1,296***	***100.0%***	***125***	***100.0%***	***27,718***	***100.0***	***17.9***	***1.7***	**21.4**

Table 8: Bicycle crashes by intersection control, 2020-2021

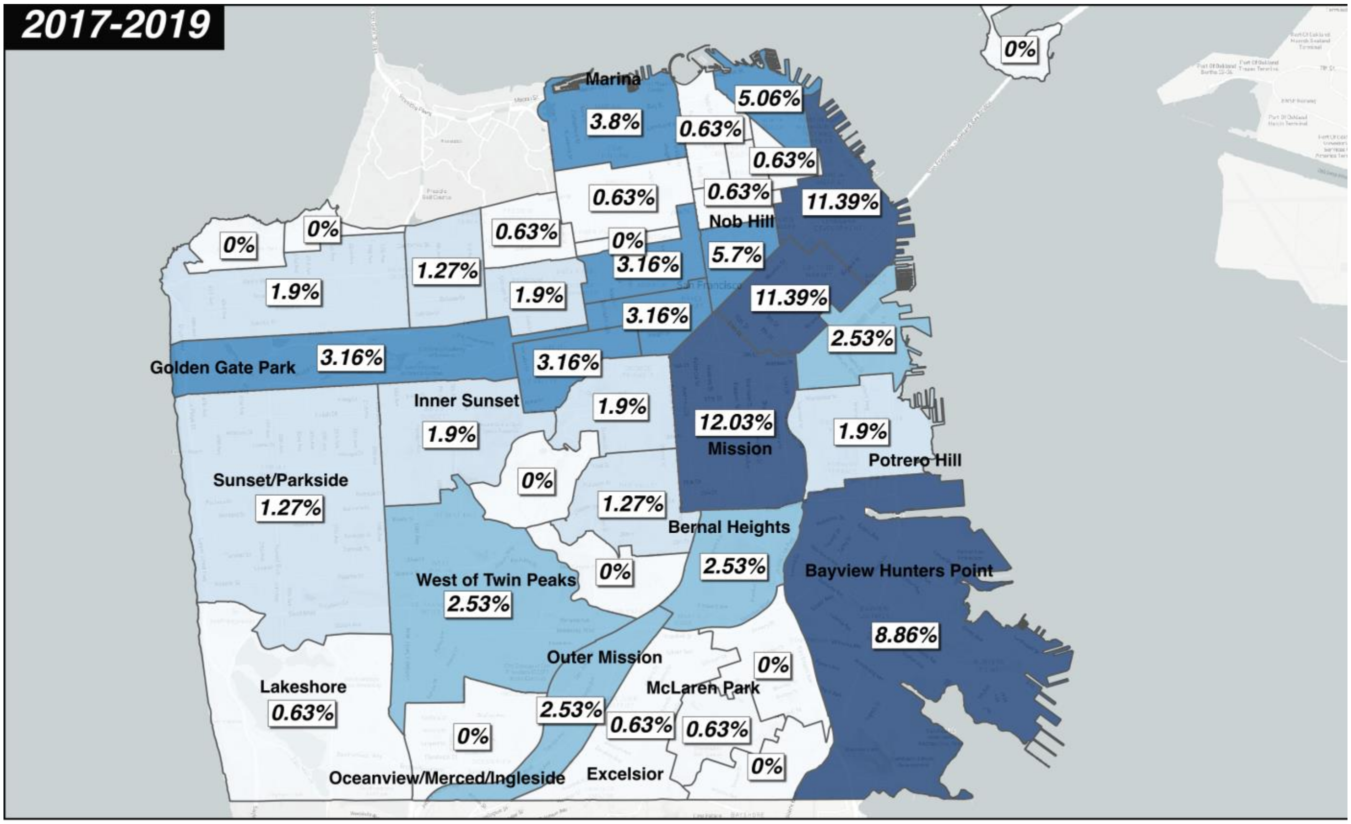
Intersection Control	***# Ints***	***% Ints***	***# Crashes***	***% Crashes***	***# KSI Crashes***	***% KSI Crashes***	***EPDO***	***% EPDO***	**Crashes per 100 Ints**	**KSI Crashes per 100 Ints**	**Avg. EPDO per Crash**
Signalized	1,323	18.4%	420	66.5%	44	72.1%	8,666	64.0%	31.7	3.3	20.6
Partial Stop	2,025	27.0%	97	15.3%	12	19.7%	2,995	22.1%	<0.1	<0.1	30.9
All-Way Stop	2,011	26.7%	84	13.3%	3	4.9%	1,258	9.3%	<0.1	<0.1	15.0
Uncontrolled	1,879	27.9%	31	4.9%	2	3.3%	626	4.6%	<0.1	<0.1	20.2
Total	***7,238***	***100.0%***	***632***	***100.0%***	***61***	***100.0%***	***13,545***	***100.0%***	***0.1***	***<0.1***	***21.4***

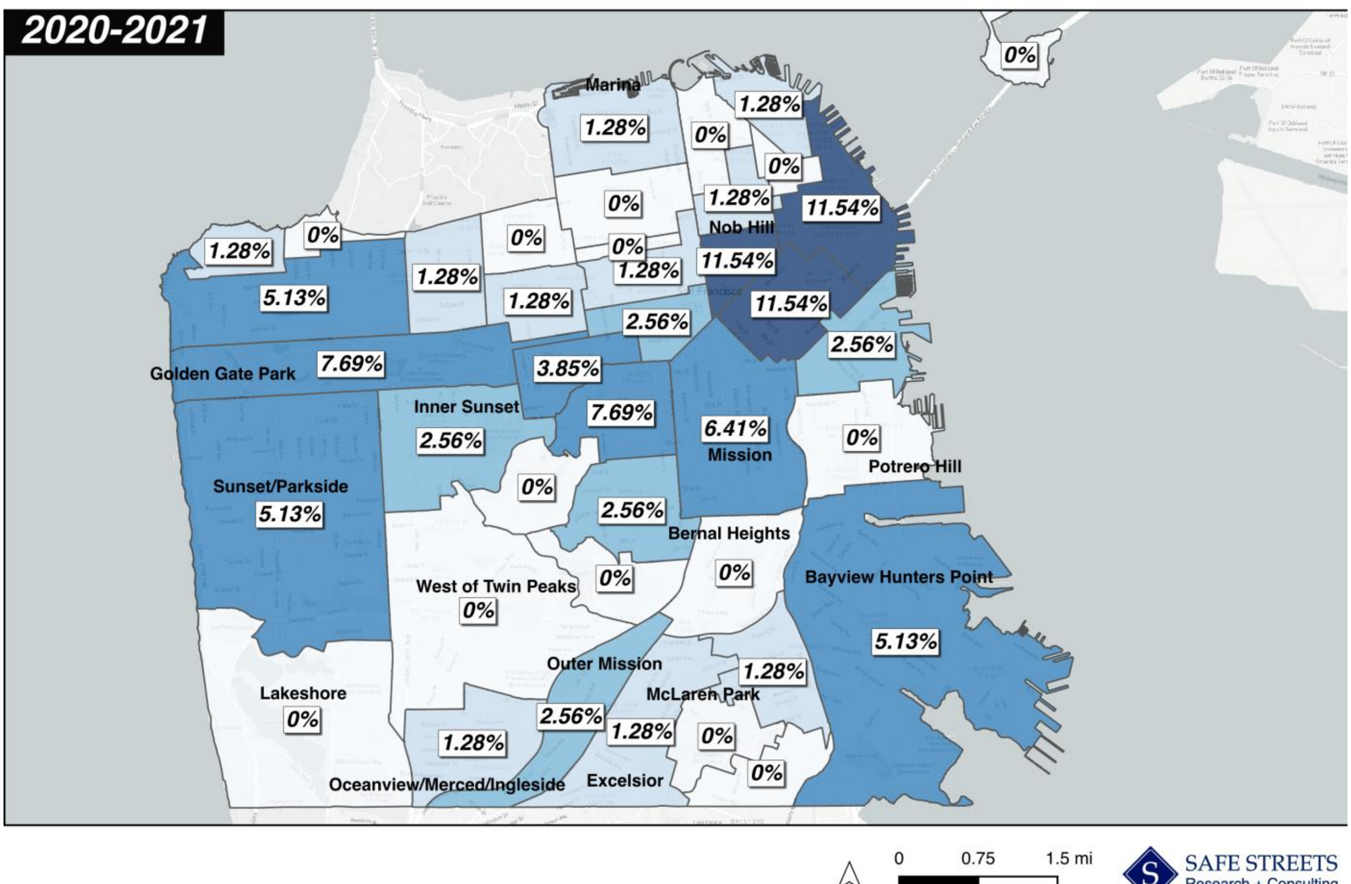
Neighborhoods

Map 1 displays the percentage of KSI crashes by neighborhood for pre-pandemic and pandemic study periods, to help us understand spatial patterns during the two study periods. For example, the Mission District accounted for approximately 12% of KSI crashes that occurred during the pre-pandemic study period, but only about 6.4% of KSI crashes in the pandemic study period. For both periods, KSI crashes were most concentrated within the Financial District and the surrounding neighborhoods, with some key differences in certain places between periods, including a noticeable reduction in the percentage crashes in the Bayview Hunters Point area and a contrasting increase near Golden Gate Park in the latter period.

These differences between the two study periods are further highlighted in Map 2, which depicts these KSI distribution changes as well as the difference between overall bicycle crash distribution. Neighborhoods with large differences in percentage points between the pre-pandemic and pandemic study period for bicyclist *KSI crashes* include: Castro/Upper Market (5.8%), Tenderloin (+5.8%), Mission (-5.6%), Golden Gate Park (+4.5%), Sunset/Parkside (+3.9%), North Beach (-3.8%), Bayview Hunters Point (-3.7%), and Outer Richmond (+3.2%). Differences in *overall crash* distributions were highest in the following neighborhoods: Financial District (-3.6%), SOMA (-3.3%), Mission (-2.6%), North Beach (-1%), and Nob Hill (-0.9%). These differences most likely reflect changes in how people traveled during the pandemic, with fewer people working downtown and potentially an increase in recreational trips. Further analysis and continued monitoring of travel behaviors and crash patterns will help the SFMTA to better understand longer-term impacts related to travel behavior changes associated with the COVID-19 pandemic and higher rates of people working from home.

Map 1: Percent of KSI bicyclist crashes by neighbor and study period





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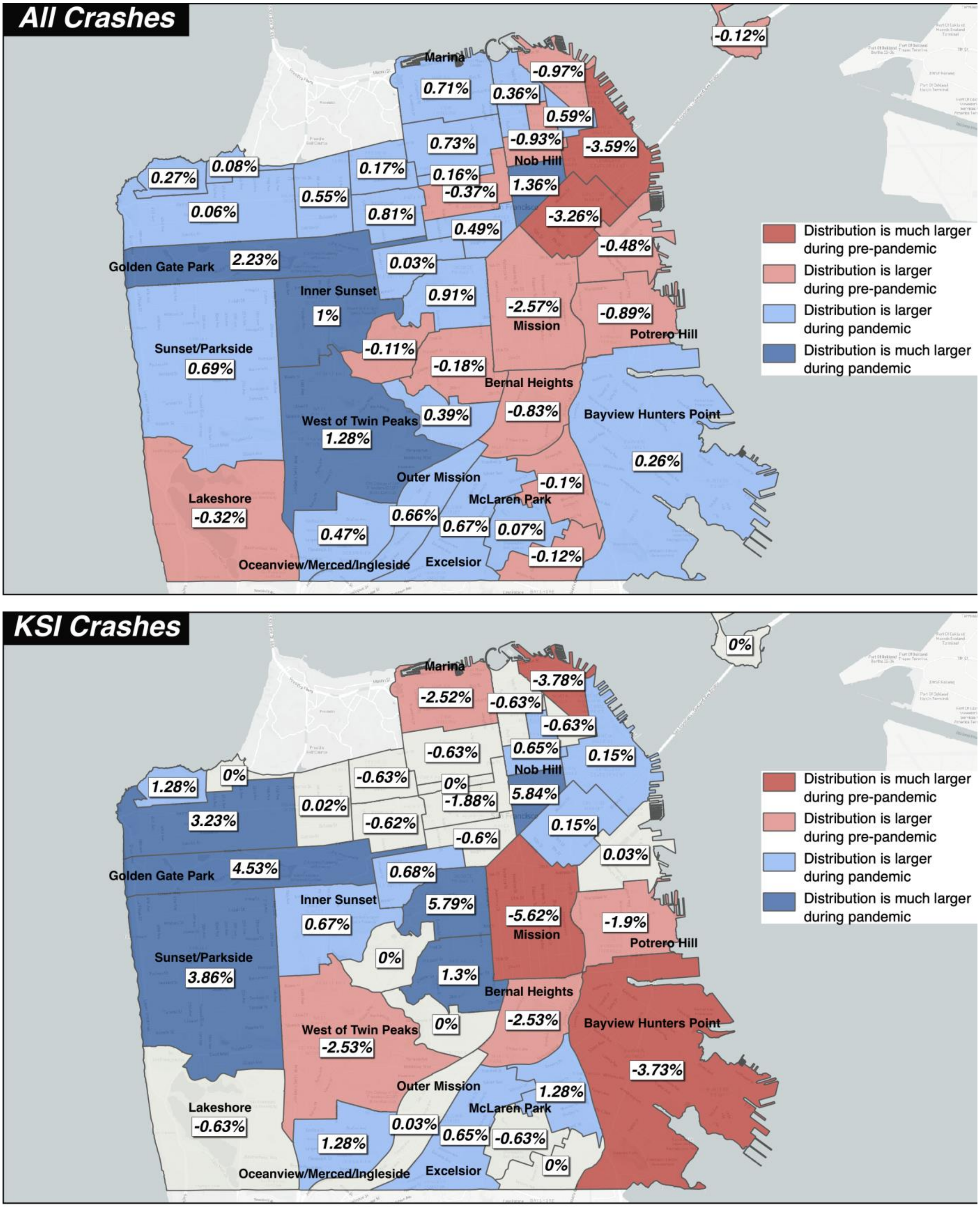
Map 2: Difference between crash and KSI crash distribution by neighborhood and study period



0 0.75 1.5 mi

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High Injury Network

Table 9 summarizes bicycle crashes along the High Injury Network (HIN) for crashes that occurred between 2017-2021. Map 3 displays bicyclist crashes and the HIN from 2017-2021. As expected, both overall crashes and KSI crashes were concentrated along the HIN, accounting for 67% and 62.3% of all crashes and KSI crashes, respectively. The majority of the crashes that occurred along the HIN involved a bicyclist and a motorist (83.1% of all crashes; 67.8% of KSI crashes), as opposed to solo-bicyclist crash (11.3% of all crashes; 28.1% of KSI crashes). Interestingly, crashes that occurred along the HIN were less severe on average, as reflected in the average EPDO scores. This finding may be related to the HIN being informed by aggregating historic crash data, which does not necessarily account for risk or exposure (exposure is coarsely handled by HIN segmentation lengths). For example, many portions of the HIN have high volumes of people riding a bike, therefore we can expect a higher concentration of crashes. Streets not along the HIN can be either lower-risk or low-stress streets with few recorded crashes, or the conditions may be so stressful that few people ride their bikes along that street. The latter of the two scenarios may factor into crashes that occurred off the HIN being slightly more severe.

Of the crashes that occurred along the HIN, the majority occurred at intersections (84% of all crashes and KSI crashes). Crashes along the HIN were most often at signalized intersections (just over 80% of all crashes and KSI crashes), followed by partial stop-controlled intersections (10.8% of all crashes and % of KSI crashes). Half of the KSI crashes at signalized intersections along the HIN were reported as the *driver or bicyclist failing to obey a red signal* (19.6%), *unsafe speed* (18.6%), and *unknown* (13.7%). Digging deeper into the *disregard red signal* violation, we see that about 70% of these violations for crashes overall and for KSI crashes are attributed to the bicyclist. These violations can indicate an unmet need for cyclists (e.g., long wait times, unresponsive traffic signals, dangerous conditions) and prompt a need to examine signalized intersections and network connectivity overall for bicyclists, as well as to consider engaging in outreach, to better understand how the system could work better for bicyclists.

Nearly 46% of the KSI crashes that involved a motorist and a bicyclist that occurred along the HIN involved perpendicular pre-crash directions of travel between the motorist and bicyclist, with nearly half of those involving both parties proceeding straight (i.e., a broadside crash). The second most common crash type included both parties traveling in the same direction with the bicyclist proceeding straight and the motorist stopped (8.6% of KSI crashes); most of those crashes were related to the bicyclists getting doored. The third most common crash type along the HIN involved both parties traveling in perpendicular directions, with the bicyclist proceeding straight and the motorist making a left turn (7.6% of KSI crashes).

Table 9: Bicycle crashes along the High Injury Network, 2017-2021

HIN	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Yes	128.8	13.1%	1,625	67.0%	147	62.3%	32,850	61.7%	126.14	117.53	20.2
No	853.8	86.9%	801	33.0%	89	37.7%	20,402	38.3%	9.38	10.74	25.5
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.69***	***24.74***	***22.0***

Table 10 and Table 11 summarize crashes along the HIN for the pre-pandemic study period and pandemic study period respectively. The patterns are similar between study periods, though the pandemic study period had a higher concentration of KSI crashes having occurred along the HIN. As discussed above, additional monitoring of these data and periodic reevaluation of the HIN will help clarify whether pandemic era crashes differed from historic crashes in a short-term way, or if pandemic era travel fundamentally shifted the HIN longer-term in San Francisco.

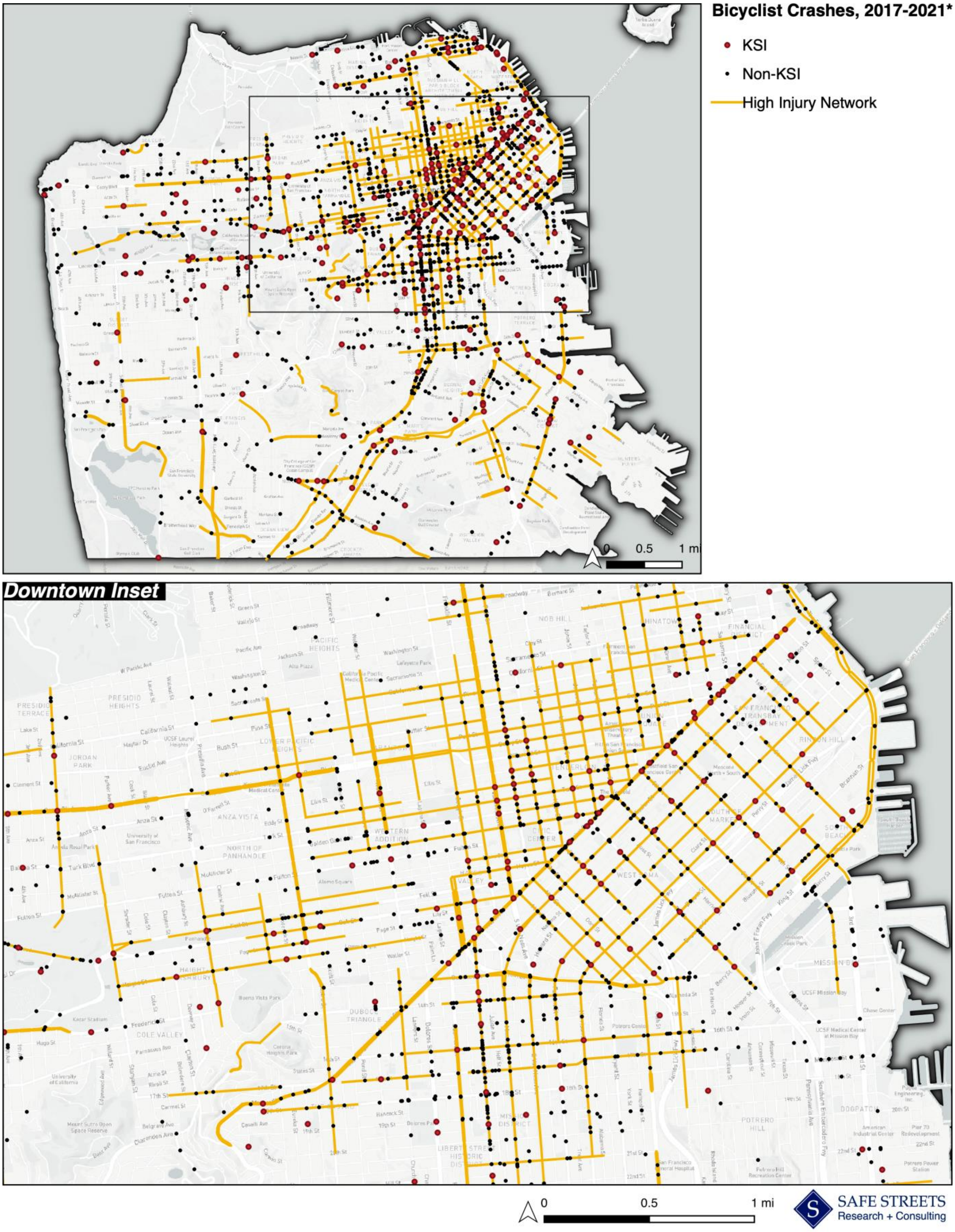
Table 10: Bicycle crashes along the High Injury Network, 2017-2019

HIN	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Yes	128.8	13.1%	1,127	67.8%	94	59.9%	21,736	60.7%	87.48	7.30	19.3
No	853.8	86.9%	536	32.2%	63	40.1%	14,047	39.3%	6.28	0.74	26.2
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.92***	***1.60***	***21.5***

Table 11: Bicycle crashes along the High Injury Network, 2020-2021

HIN	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Yes	128.8	13.1%	498	65.3%	53	67.1%	11,137	63.6%	38.66	4.11	22.4
No	853.8	86.9%	265	34.7%	26	32.9%	6,370	36.4%	3.10	0.30	24.0
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.76***	***0.80***	***22.9***

Map 3: Bicyclist crashes and High Injury Network, 2017-2021



Functional Classification

Table 12 summarizes bicyclist crashes by functional classification that occurred between 2017 and 2021, including both intersection and midblock crashes. Map 4 displays bicyclist crashes and functional classification. The highest functional classification was assigned to crashes that occurred at intersections. Most crashes occurred along collector streets (36.4% of all crashes and 33.5% of KSI crashes). When looking at the number of crashes on a per mile basis, crashes and KSI crashes are concentrated along major streets. Arterial streets had the highest concentration of crashes, with 94.6 crashes and 10.6 KSI crashes per 10 miles. Collectors had the second highest concentration of crashes per 10 miles (62.5), whereas major/highway had the second highest concentration of KSI crashes per 10 miles (9.9). Additionally, crashes were most severe on average along major/highway, although only 2.5% of crashes occurred along those streets. Crashes along arterials were the second most severe on average (22.8 avg. EPDO) and accounted for the largest share of KSI crashes, despite arterials only comprising 7.8% of the street network mileage. Table 13 and

Table 14 show crashes by functional class before and after the pandemic, and while there are some differences among total crash volumes and crash severity, the general trends (e.g., most servere crashes on major highways, most crashes on collector roadways, and highly concentrated crahses and KSI crashes on collectors and arterials) were the same during all time periods.

Table 12: Bicycle crashes by highest functional classification, 2017-2021

Functional Classification	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Collector	141.2	14.4%	883	36.4%	79	33.5%	18,555	34.8%	62.5	5.6	21.0
Residential	754.9	76.8%	760	31.3%	66	28.0%	16,465	30.9%	10.1	0.9	21.7
Arterial	76.4	7.8%	723	29.8%	81	34.3%	16,461	30.9%	94.6	10.6	22.8
Major/Highway	10.1	1.0%	60	2.5%	10	4.2%	1771	3.3%	59.3	9.9	29.5
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***22.0***

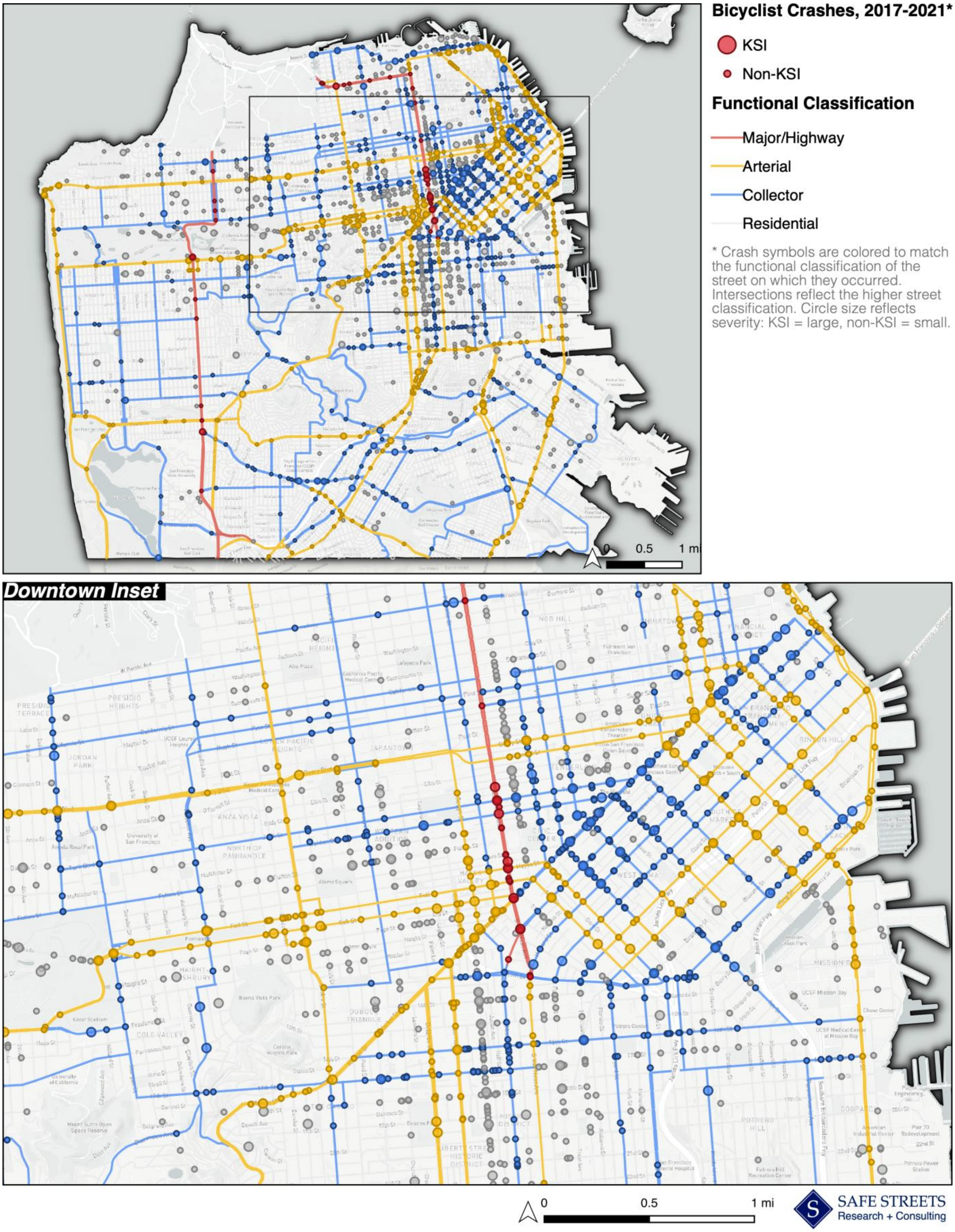
Table 13: Bicycle crashes by highest functional classification, 2017-2019

Functional Classification	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Collector	141.2	14.4%	595	35.8%	60	38.2%	13,554	37.9%	42.1	4.2	22.8
Residential	754.9	76.8%	533	32.1%	42	26.8%	10,932	30.6%	7.1	0.6	20.5
Arterial	76.4	7.8%	497	29.9%	50	31.8%	10,337	28.9%	65.1	6.5	20.8
Major/Highway	10.1	1.0%	38	2.3%	5	3.2%	960	2.7%	37.6	4.9	25.3
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***21.5***

Table 14: Bicycle crashes by highest functional classification, 2020-2021

Functional Classification	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Collector	141.2	14.4%	288	37.7%	19	24.1%	5,012	28.6%	20.4	1.3	17.4
Residential	754.9	76.8%	227	29.8%	24	30.4%	5,546	31.7%	3.0	0.3	24.4
Arterial	76.4	7.8%	226	29.6%	31	39.2%	6,136	35.0%	29.6	4.1	27.2
Major/Highway	10.1	1.0%	22	2.9%	5	6.3%	813	4.6%	21.7	4.9	37.0
Total	***982.6***	***100.0***	***763***	***100.0%***	***79***	***100.0%***	***17,50***	***100.0%***	***7.8***	***0.8***	***22.9***

Map 4: Bicyclist crashes and functional classification, 2017-2021



Functional Classification – Intersection Crashes

Table 15 summarizes reported bicycle crashes at intersections by functional classification between 2017 and 2021. Crashes are categorized by both the minimum and maximum functional classification of the streets at the intersection. The most severe crashes occurred at intersections with generally higher functional classes, as risk factors would suggest; crashes at intersections of major highways and arterials were the most severe (40.0 avg. EPDO), followed by intersections of major highways and collectors (31.9 avg. EPDO). There are relatively few intersections between major/highway roads and either arterials or collectors, but crashes that occur there are disproportionately severe.

Surprisingly, a large share of overall crashes (26.8%) and KSI crashes (24.2%) occurred at intersections of residential-residential roadways, which make up 60.5% of all intersections, but are typically designed for slower speeds and less traffic. Additionally, the largest share of overall crashes (29.5%) and the second-largest share of KSI crashes (23.1%) occurred at intersections of collector and residential roadways, even though these intersections make up only 20.5% of all intersections – indicating that crashes at these intersections are overrepresented for both metrics. Upon review of these locations, many do not appear to fit the common characteristics of residential streets. Several intersections with at least one KSI crash are located downtown along collector streets and cross with very small alley-like streets (e.g., 8th St. and Minna St., 7th St. and Natoma St., and 5th St. and Natoma St.). Additionally, several streets stand out upon review. For example, Webster St. is coded as residential, but has a buffered bike lane, two general purpose lanes in each direction, a striped centerline, and a raised median – characteristics often found along arterial roadways. As seen in Map 4, Valencia St., Polk St., Harrison St., Folsom St., and Balboa St. are also coded as residential and as having no centerline, even though they have many of the characteristics of a collector or arterial and a centerline is visible through street view imagery. These potential miscodes may help explain why the residential functional classification is associated with such a large share of KSI crashes. If the SFMTA uses street classification for safety or throughput evaluation, we recommend revisiting these classifications and characteristics in the source data.

Table 16 and Table 17 show crashes during 2017 through 2019 and 2020-2021, respectively, and they share the same crash trends as the 5-year period, with some notable differences. Average EPDO per crash was highest (52.6) during 2020-2021, and lowest before the pandemic (37.8). Also, arterial intersections had highest number of crashes per intersection during the 5-year period and before the pandemic, but major/highway intersections with collectors and arterials had the highest number of crashes during the pandemic.

Table 15: Intersection bicyclist crashes by highest and lowest functional classification, 2017-2021

Max Functional Class	*Min Functional Class*	*# Int*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg EPDO per crash
Collector	Residential	1,524	20.5%	569	29.5%	43	23.1%	37.3	2.8	19.4
Collector	Collector	185	2.9%	165	8.6%	18	9.7%	89.2	9.7	20.9
Residential	Residential	4,384	60.5%	516	26.8%	45	24.2%	11.8	1.0	21.6
Arterial	Residential	816	11.2%	350	18.2%	40	21.5%	42.9	4.9	23.2
Arterial	Collector	141	2.0%	182	9.4%	22	11.8%	129.1	15.6	22.5
Arterial	Arterial	64	1.1%	89	4.6%	8	4.3%	139.1	12.5	18.7
Major/Highway	Residential	92	1.3%	33	1.7%	5	2.7%	35.9	5.4	27.9
Major/Highway	Collector	16	0.2%	17	0.9%	3	1.6%	106.3	18.8	31.9
Major/Highway	Arterial	10	0.1%	7	0.4%	2	1.1%	70.0	20.0	40.0
Major/Highway	Major/ Highway	5	0.1%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total		***7,237***	***100.0%***	***1,928***	***100.0%***	***186***	***1.0***	***26.6***	***2.6***	***21.4***

Table 16: Intersection bicyclist crashes by highest and lowest functional classification, 2017-2019

Max Functional Class	Min Functional Class	# Ints	% Ints	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg EPODO per crash
Collector	Residential	1,524	20.5%	371	28.6%	34	27.2%	24.3	2.2	22.0
Collector	Collector	185	2.9%	109	8.4%	12	9.6%	58.9	6.5	20.5
Residential	Residential	4,384	60.5%	357	27.5%	31	24.8%	8.1	0.7	21.7
Arterial	Residential	816	11.2%	239	18.4%	23	18.4%	29.3	2.8	20.0
Arterial	Collector	141	2.0%	123	9.5%	15	12.0%	87.2	10.6	22.4
Arterial	Arterial	64	1.1%	61	4.7%	5	4.0%	95.3	7.8	17.9
Major/Highway	Residential	92	1.3%	24	1.9%	3	2.4%	26.1	3.3	22.8
Major/Highway	Collector	16	0.2%	10	0.8%	2	1.6%	62.5	12.5	37.8
Major/Highway	Arterial	10	0.1%	2	0.2%	0	0.0%	20.0	0.0	8.5
Major/Highway	Major/Highway	5	0.1%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total		***7,237***	***100.0%***	***1,296***	***100.0%***	***125***	***100.0%***	***17.9***	***1.7***	***21.4***

Table 17: Intersection bicyclist crashes by highest and lowest functional classification, 2020-2021

Max Functional Class	Min Functional Class	# Ints	% Ints	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg EPODO per crash
Collector	Residential	1,524	20.5%	198	31.3%	9	14.8%	1.3	0.6	14.5
Collector	Collector	185	2.9%	56	8.9%	6	9.8%	3.0	3.2	21.8
Residential	Residential	4,384	60.5%	159	25.2%	14	23.0%	0.4	0.3	21.3
Arterial	Residential	816	11.2%	111	17.6%	17	27.9%	1.4	2.1	30.2
Arterial	Collector	141	2.0%	59	9.3%	7	11.5%	4.2	5.0	22.6
Arterial	Arterial	64	1.1%	28	4.4%	3	4.9%	4.4	4.7	20.5
Major/Highway	Residential	92	1.3%	9	1.4%	2	3.3%	1.0	2.2	41.4
Major/Highway	Collector	16	0.2%	7	1.1%	1	1.6%	4.4	6.3	23.7
Major/Highway	Arterial	10	0.1%	5	0.8%	2	3.3%	5.0	20.0	52.6
Major/Highway	Major/Highway	5	0.1%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total		***7,237***	***100.0%***	***632***	***100.0%***	***61***	***100.0%***	***0.9***	***0.8***	***21.4***

Number of Lanes

Table 18 summarizes all reported bicycle crashes by the number of roadway lanes between 2017 and 2021. The number of lanes reflects the overall number of general purpose lanes along the street in both directions of travel. Crashes at intersections were assigned the greatest number of lanes of the intersecting roadways. The number of lanes of roadways considered for this analysis ranged between 1 and 5+. Most roads (76.4%) considered in this study are two lane roadways, and these roadways were the site of about one-third of all crashes and KSI crashes. However, there is a clear and positive relationship between crash densities, severity, and the number of lanes: there were 108.2 crashes per 10 miles of 5-lane roads, 89.1 crashes per 10 miles of 3-lane roads, and 86.4 crashes per 10 miles on 4-lane roads, compared with just under 10.7 crashes per 10 miles on 2-lane roadways. The rate of KSI crashes per 10 miles and EPDO scores further illustrate the disproportionate burden that roadways with 3, 4, or 5+ lanes create for overall network safety. Furthermore, 53% of the 3-lane roadway mileage occurs along one-way streets; as shown later in this report, one-way traffic is often a separate risk factor in safety models (i.e., irrespective of lane numbers) due to the lack of oncoming traffic. This trend is the same during pre-pandemic years and during the pandemic, as shown in Table 19 and

Table 20.

Table 18: Bicycle crashes by number of lanes, 2017-2021

# Lanes	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
1	56.0	5.7%	13	0.5%	0	0.0%	108	0.2%	2.3	0.0	1.9
2	751.0	76.4%	802	33.1%	77	32.6%	19,054	35.8%	10.7	1.0	25.4
3	36.4	3.7%	324	13.4%	22	9.3%	5,573	10.5%	89.1	6.1	153.3
4	101.1	10.3%	874	36.0%	87	36.9%	18,597	34.9%	86.4	8.6	183.9
>=5	38.2	3.9%	413	17.0%	50	21.2%	9,920	18.6%	108.2	13.1	259.8
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***54.2***

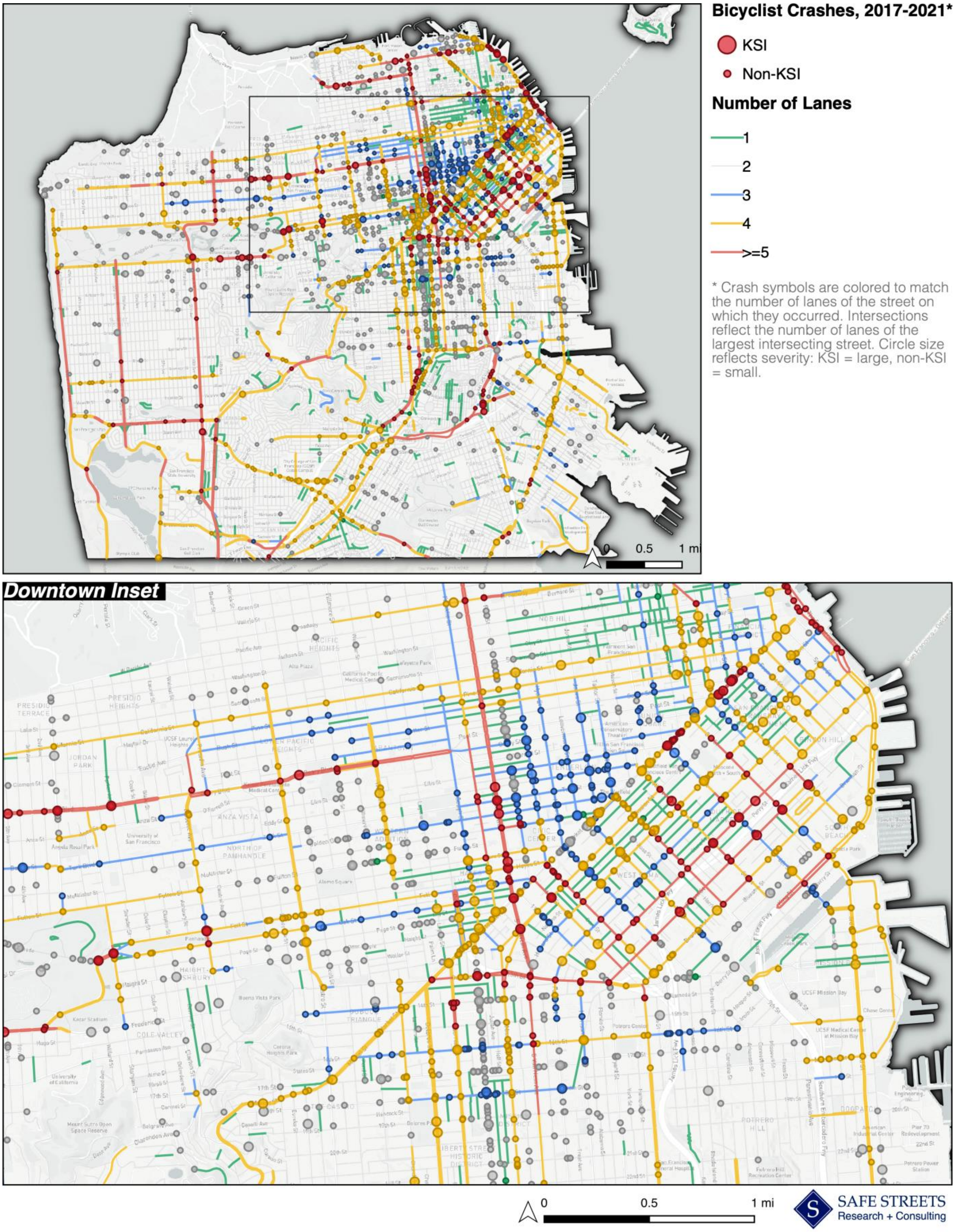
Table 19: Bicycle crashes by number of lanes, 2017-2019

# Lanes	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
1	56.0	5.7%	9	0.5%	0	0.0%	74	0.2%	1.6	0.0	1.3
2	751.0	76.4%	555	33.4%	53	33.8%	13,220	36.9%	7.4	0.7	17.6
3	36.4	3.7%	222	13.3%	16	10.2%	3,967	11.1%	61.1	4.4	109.1
4	101.1	10.3%	595	35.8%	57	36.3%	12,142	33.9%	58.8	5.6	120.1
>=5	38.2	3.9%	282	17.0%	31	19.7%	6,380	17.8%	73.9	8.1	167.1
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***36.4***

Table 20: Bicycle crashes by number of lanes, 2020-2021

# Lanes	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
1	56.0	5.7%	4	0.5%	0	0.0%	34	0.2%	0.7	0.0	0.6
2	751.0	76.4%	247	32.4%	24	30.4%	5,852	33.4%	3.3	0.3	7.8
3	36.4	3.7%	102	13.4%	6	7.6%	1,609	9.2%	28.1	1.7	44.3
4	101.1	10.3%	279	36.6%	30	38.0%	6,468	36.9%	27.6	3.0	64.0
>=5	38.2	3.9%	131	17.2%	19	24.1%	3,544	20.2%	34.3	5.0	92.8
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***17.8***

Map 5: Bicyclist crashes and number of lanes, 2017-2021



Posted Speed Limit

Table 21 summarizes the number of reported bicycle crashes categorized by the posted speed limit (i.e., not prevailing speed) between 2017 and 2021. Speed limits ranged between 25 mph (or less) to 45 miles per hour. About 3% of roadways in the network (26.7 miles) did not have speed limit data available. Most of the network (90.6%) has a posted speed limit of 25 mph, and most of the overall crashes (82%) and the KSI crashes (79%) occurred on these roadways, as shown in Map 6. Two-thirds of crashes and 60% of KSI crashes along 25 mph streets occurred along the HIN. Around 13% of crashes were on roadways with posted speeds of 30 mph, even though they make up less than 3% of the network. The 30 mph roadways also had the highest number of crashes per 10 miles (110.2), KSI crashes per 10 miles (10.9), and EPDO per 10 miles (2,357.4), indicating that a disproportionate share of severe injuries and fatalities occur on these roads. Similarly, it is notable that roadways with a speed limit of 35 mph have the second highest EPDO per 10 miles (1,268.9) and 8% of KSI crashes, despite comprising less than 3% of the network.

Most KSI crashes along 25 mph streets involved a bicyclist and a motorist (68%), followed by solo-bicyclist (27.5%) and bicyclist-pedestrian (4.5%) crashes. Nearly 80% of these KSI crashes occurred at an intersection, with 53% at a signalized intersection, 13% at a partial stop, and 8% at an all-way stop. Looking at bicyclist-motorists crashes, perpendicular and same direction crashes accounted for nearly 39% of KSI crashes each. The most frequent movement types for perpendicular KSI crashes were both parties proceeding straight (20.7%, n=25), followed by bicyclist proceeding straight and motorist making a left turn (4.1%, n=5). The most frequent movement types for same direction crashes were bike proceeding straight and motorist stopped (9.9%, n=12, 7 of the 12 were dooring related), followed by other/unknown (5.8%, n=7) and bike proceeding straight and motorists making a right turn (5%, n=6).

The majority (about two thirds) of the KSI crashes along 25mph streets did not occur along a bike facility of any type. Of the bicycle facilities along 25 mph streets, Class III facilities had the largest share of KSI crashes (54.8%), followed by Class II (36.7%) and Class IV (12.7%) facilities. Similar to the findings in the functional classification section of this analysis, intersections along 25 mph streets at collector-residential and residential-residential streets accounted for nearly 50% of KSI crashes. As stated earlier in this memo, several of these streets coded as a residential street may have the characteristics of a collector or arterial, including being major destination hubs with more motorist and bicyclist travel than we would expect on a typical residential street.

These trends do not differ between study years before the pandemic and during the pandemic, as shown in Table 22 and Table 23.

Table 21: Bicycle crashes by posted speed limit, 2017-2021

Posted Speed Limit	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	890.5	90.6%	1,983	81.7%	186	78.8%	42,915	80.6%	22.3	2.1	481.9
30	27.6	2.8%	304	12.5%	30	12.7%	6,503	12.2%	110.2	10.9	2,357.4
35	27.9	2.8%	117	4.8%	19	8.1%	3,544	6.7%	41.9	6.8	1268.9
40	6.7	0.7%	6	0.2%	1	0.4%	155	0.3%	8.9	1.5	231.2
45	3.2	0.3%	8	0.3%	0	0.0%	72	0.1%	24.7	0.0	221.9
unknown	26.7	2.7%	8	0.3%	0	0.0%	63	0.1%	3.0	0.0	23.6
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***541.9***

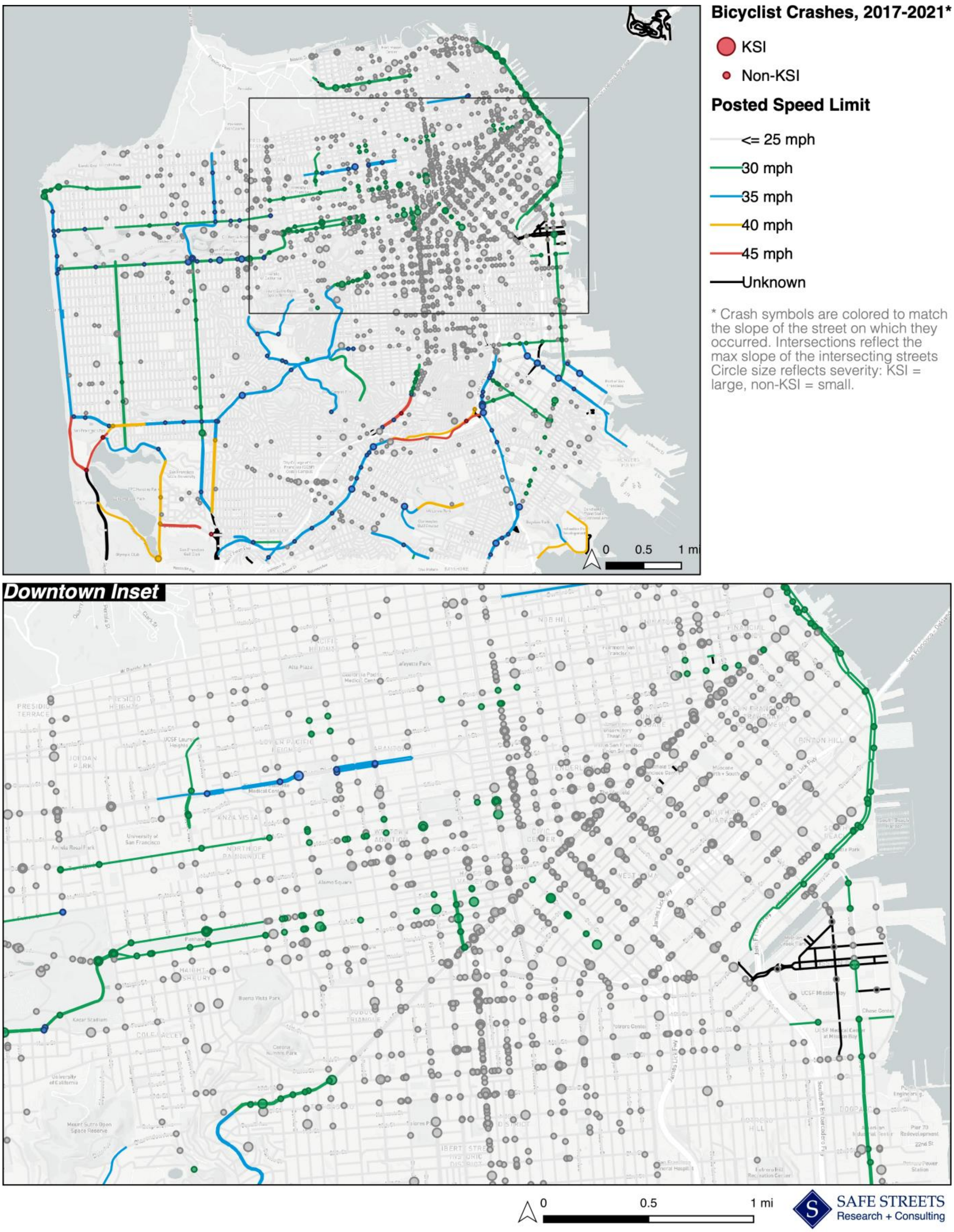
Table 22: Bicycle crashes by posted speed limit, 2017-2019

Posted Speed Limit	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	890.5	90.6%	1,378	82.9%	126	80.3%	29,415	82.2%	15.5	1.4	330.3
30	27.6	2.8%	198	11.9%	16	10.2%	3,614	10.1%	71.8	5.8	1,310.1
35	27.9	2.8%	73	4.4%	14	8.9%	2,531	7.1%	26.1	5.0	906.2
40	6.7	0.7%	4	0.2%	1	0.6%	143	0.4%	6.0	1.5	213.3
45	3.2	0.3%	5	0.3%	0	0.0%	40	0.1%	15.4	0.0	123.3
unknown	26.7	2.7%	5	0.3%	0	0.0%	40	0.1%	1.9	0.0	15.0
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***364.1***

Table 23: Bicycle crashes by posted speed limit, 2020-2021

Posted Speed Limit	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<=25	890.5	90.6%	605	79.3%	60	75.9%	13,532	77.3%	6.8	0.7	152.0
30	27.6	2.8%	106	13.9%	14	17.7%	2,893	16.5%	38.4	5.1	1,048.8
35	27.9	2.8%	44	5.8%	5	6.3%	1,014	5.8%	15.8	1.8	363.1
40	6.7	0.7%	2	0.3%	0	0.0%	12	0.1%	3.0	0.0	17.9
45	3.2	0.3%	3	0.4%	0	0.0%	33	0.2%	9.2	0.0	101.7
unknown	26.7	2.7%	3	0.4%	0	0.0%	23	0.1%	1.1	0.0	8.6
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***178.2***

Map 6: Bicyclist crashes and posted speed limit, 2017-2021



Mean Observed Speed

This analysis also looked at the relationship between mean *observed* speeds per segment. It is important to note that the nature of this analysis precludes analysis into top-end speeding that may be observed at times throughout the city. Table 24 summarizes bicycle crashes by categorized by the mean observed speed between 2017 and 2021. The mean observed speeds range from ≤ 25 mph to ≥ 45 mph, with categories separated into 5 mph bins. Intersection crashes were assigned the highest mean observed speed on the intersecting roadways. Less than 1% of roadways in the network (6.5 miles) lacked a reported speed, and only one of the crashes during the study period occurred on these roadways. Most crashes (96%) and most KSI (98%) crashes occurred on lower-speed roadways, which is likely confounded by the prevalence of lower mean speeds throughout the network, as well as the number of people cycling on the low-speed roads. Map 7 compares the posted speed limit data to the mean observed speed data, illustrating the predominance of 25 mph for both categories. The EPDO scores indicate higher crash severities for the very small percentage of the network where mean motorist speeds between 30 and 39 mph were observed, but there were only four KSI crashes on those roads, so crashes are not illustrated in this map comparison. That the KSI crashes occurred almost exclusively at lower observed speeds – contrasting with well-established injury severity research – suggests both that additional scrutiny is needed for these data and that these findings should be interpreted with caution.

While reported crash trends before the pandemic are similar to the 5-year reported trends (see Table 25), crash trends during the pandemic differ slightly (see Table 26). During the pandemic period, most crashes (95%) and KSI crashes (98%) still occurred on low-speed roadways, but crashes were slightly more distributed among higher speed roadways. Crashes on low-speed roads (≤ 25 mph) had low EPDO scores per 10 miles (176.3) when compared with roadways with 35-39 mph prevailing speeds (648.5), 25-29 mph prevailing speeds (350.6), and 45 mph or greater (220.5). There were also 30.4 crashes per 10 miles on roadways with observed speeds of 45 mph or greater, which is the highest of all categories. In keeping with the conclusion stated above, the extreme concentration of KSI crashes at lower observed speeds suggests caution with these data.

Table 24: Bicycle crashes by observed motorist speed, 2017-2021

Observed Motorist Speed	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	952.4	96.9%	2,331	96.1%	230	97.5	51,437	96.6%	24.5	2.4	540.1
25-29	10.4	1.1%	45	1.9%	2	0.8%	749	1.4%	43.1	1.9	717.4
30-34	7.7	0.8%	33	1.4%	3	1.3%	746	1.4%	43.0	3.9	971.4
35-39	3.1	0.3%	10	0.4%	1	0.4%	264	0.5%	32.1	3.2	847.5
40-44	1.2	0.1%	2	0.1%	0	0.0%	21	0.0%	16.5	0.0	173.6
45+	1.3	0.1%	4	0.2%	0	0.0%	29	0.1%	30.4	0.0	220.5
unknown	6.5	0.7%	1	0.0%	0	0.0%	6	0.0%	1.5	0.0	9.3
Total	**982.6**	**100.0%**	***2,426***	***100.0***	***236***	***100.0***	***53,252***	***100.0***	***24.7***	***2.4***	***541.9***

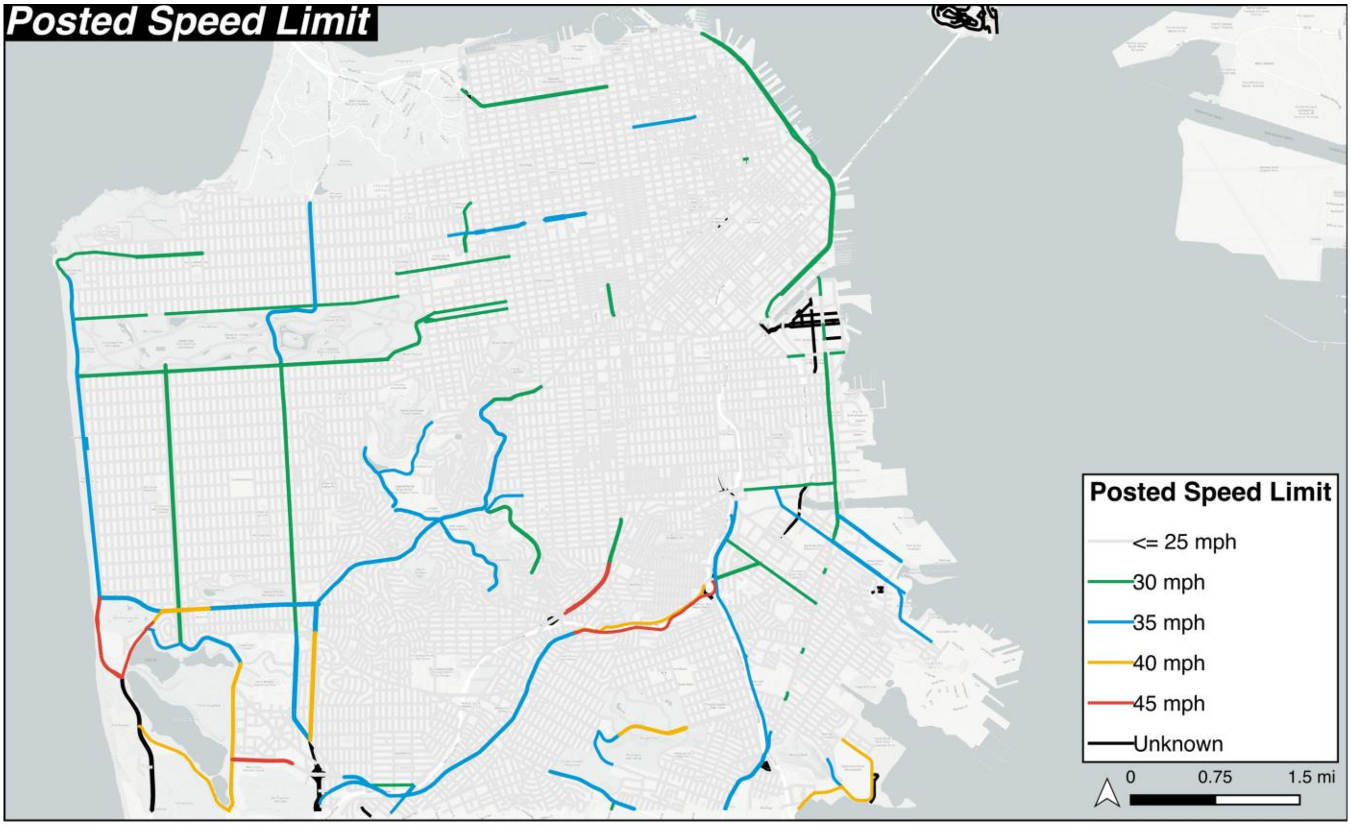
Table 25: Bicycle crashes by observed motorist speed, 2017-2019

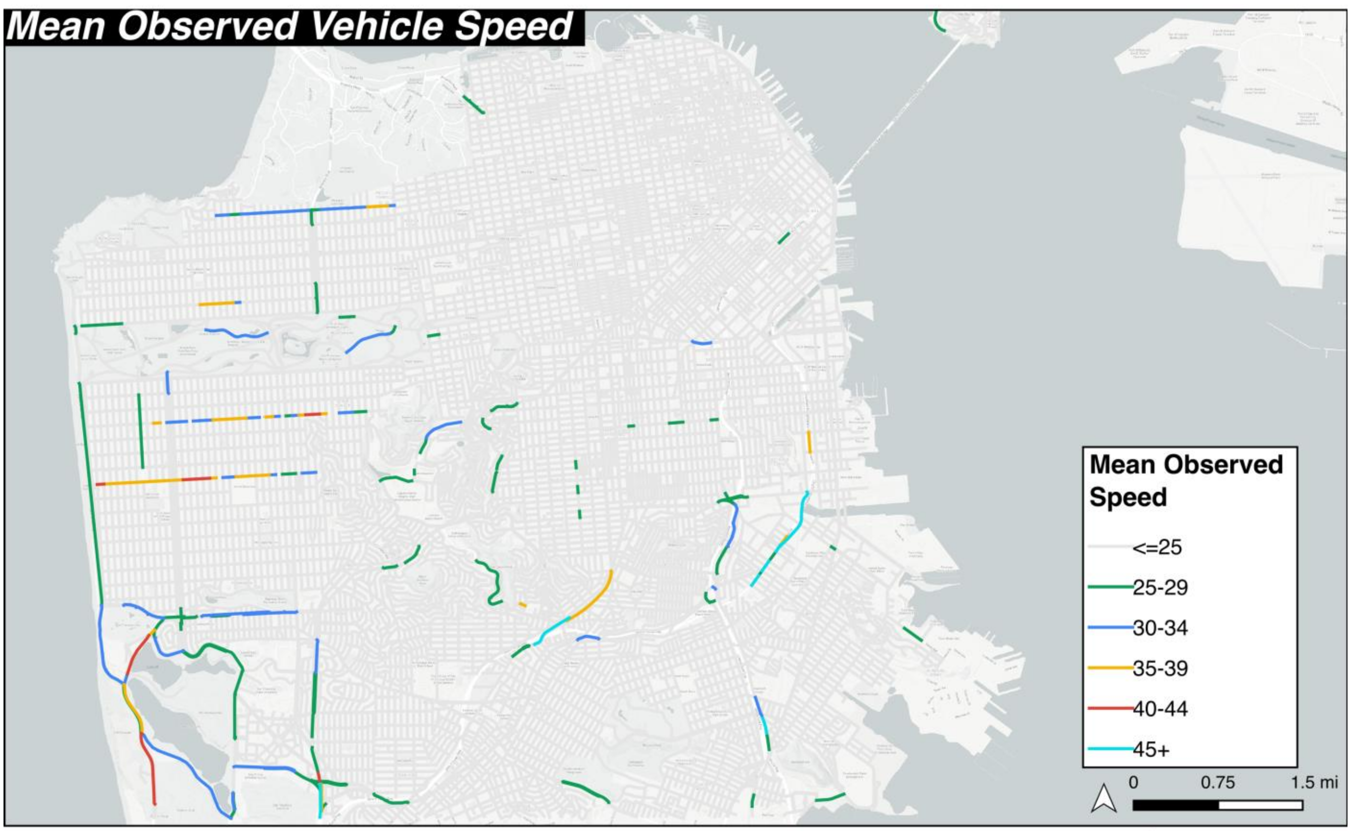
Observed Motorist Speed	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	952.4	96.9%	1,609	96.8%	153	97.5%	34,682	96.9%	16.9	1.6	364.1
25-29	10.4	1.1%	24	1.4%	1	0.6%	383	1.1%	23.0	1.0	366.9
30-34	7.7	0.8%	21	1.3%	3	1.9%	644	1.8%	27.3	3.9	838.5
35-39	3.1	0.3%	8	0.5%	0	0.0%	63	0.2%	25.7	0.0	202.2
40-44	1.2	0.1%	1	0.1%	0	0.0%	11	0.0%	8.3	0.0	90.9
45+	1.3	0.1%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0	0.0
unknown	6.5	0.7%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total	**982.6**	**100.0%**	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***364.1***

Table 26: Bicycle crashes by observed motorist speed, 2020-2021

Observed Motorist Speed	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	952.4	96.9%	722	94.6%	77	97.5%	16,792	95.9%	7.6	0.8	176.3
25-29	10.4	1.1%	21	2.8%	1	1.3%	366	2.1%	20.1	1.0	350.6
30-34	7.7	0.8%	12	1.6%	0	0.0%	101	0.6%	15.6	0.0	131.5
35-39	3.1	0.3%	2	0.3%	1	1.3%	202	1.2%	6.4	3.2	648.5
40-44	1.2	0.1%	1	0.1%	0	0.0%	11	0.1%	8.3	0.0	90.9
45+	1.3	0.1%	4	0.5%	0	0.0%	29	0.2%	30.4	0.0	220.5
unknown	6.5	0.7%	1	0.1%	0	0.0%	6	0.0%	1.5	0.0	9.3
Total	**982.6**	**100.0%**	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***178.2***

Map 7: Posted Speed Limit and Mean Observed Vehicle Speed, 2017-2021





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Bike Volume Estimates

Citywide bicycle volumes along every street in San Francisco were estimated as part of the SFMTA ACP. Those estimates have been integrated into this analysis through a serious of descriptive crosstabs. Due to data limitations that affected the bicycle volume estimation process and outputs, these estimates are used in broad categories, rather than as raw numbers. The bicycle volume estimation task categorized the low, medium, and high bins based on the following break points: 166[4]-249, 250-499, and 500+. The low category accounts for 65.8% of the network by mileage, medium accounts for 27%, and high accounts for 7.2%.

The volume estimates for both intersection and midblock locations were separately binned into quantiles for the purpose of this analysis. Quintiles divide the segment and intersection data into five bines with roughly the same number of records (or locations) (lowest being the 20th percentile and below and highest being the 80th percentile and above). Segment and intersection crashes are analyzed separately given that the categories applied to intersections will have different values than segment categories. Additionally, the bike volume estimates were not conducted separately for the pre-pandemic and pandemic study periods. As such, the volume estimates will be used to analyze the 5-year study period, rather than the two study periods separately.

Unsurprisingly, the following tables show locations with higher bicycle volumes had a higher bicycle crash frequency due to higher levels of exposure. This does not necessarily mean locations with higher volumes of bicyclists have higher crash risk. Research has found that specific locations may have a non-linear relationship between bicyclist volumes and crash frequencies, meaning crash rates declined when bicyclist volume exceeded a certain threshold[5]. Research also suggests there is a change in motorist behavior in the presence of higher volumes of bicycle and pedestrian volumes. Additionally, there are many characteristics that influence bicyclist crash risk that are not captured by the ACP bicycle volume estimates and bike facility design that have been explored in previous efforts such as SFTMA's safety performance functions (SPFs). SFDPH will be developing another SPF for bicyclists which will explore the relationship between contextual variables and bicyclist volumes as they relate to crash risk. The following sections summarize the bicycle crashes by bicycle volume estimates as a way to explore the relationship between the data. This section does not suggest causation between the estimated bicycle volume, crashes, and other variables summarized in the following crosstabs.

Mid-block Crashes

Midblock crashes are summarized using two different classifications of bicyclist volume estimates. Table 27 summarizes bicycle crashes by the low, medium, and high classifications used in the ACP bike volume estimation task. As previously mentioned, blocks with higher bicycle volume estimates had a higher frequency of crashes. These blocks also have a much higher rate of crashes per mile, KSI crashes per mile, and EPDO per mile, but those are likely related to the method in which the low, medium, and high classifications were created. Blocks with high bicyclist volume estimates account for only 7.2% of the network but account for 38.4% and 24% of KSI crashes. Moreover, relative to the percentage of all crashes that occur on the streets with the highest bicyclist ridership, there are fewer severe crashes than for other volume categories.

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[4] There are no streets with an estimated bicycle volume less than 166, which is considered a data limitation for this crash analysis.

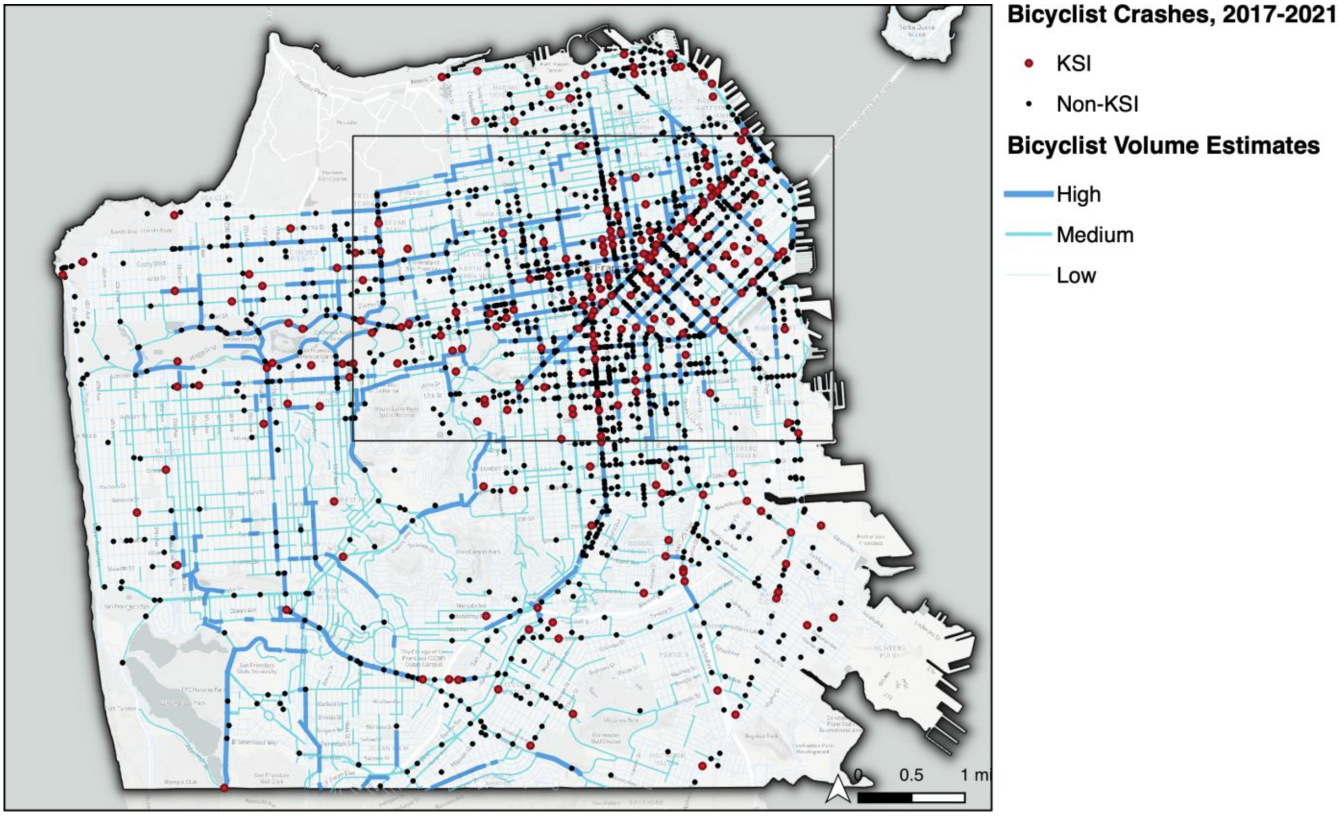
[5] Jacobsen P. L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury prevention: journal of the International Society for Child and Adolescent Injury Prevention*, *9*(3), 205–209. https://doi.org/10.1136/ip.9.3.205

Table 27: Midblock bicycle crashes by estimate bike volume, 2017-2021

Bicyclist Volume Estimates	*# Miles*	*% Miles*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	**Crashes per 10 Miles**	**KSI Crashes per 10 Miles**	**EPDO per Mile**
High	70.4	7.2%	191	38.4%	12	24.0%	3,496	29.1%	27.1	1.7	496.3
Medium	265.3	27.0%	159	31.9%	19	38.0%	4,292	35.7%	6.0	0.7	161.8
Low	646.9	65.8%	148	29.7%	19	38.0%	4,230	35.2%	2.3	0.3	65.4
Total	***982.6***	***100.0%***	**498**	**100.0%**	**50**	**100.0%**	**12,018**	**100.0%**	***5.1***	***0.5***	***122.3***

Table 28 summarizes midblock bicyclist volumes by classifying the bike volumes by quintiles. Like Table 27, streets with higher volume estimates had a higher frequency of overall crashes and KSI crashes. This aligns with our general expectations: as exposure increases, crashes are likely to increase as well. However, when we look at the proportion of midblock crashes that result in a KSI outcome, we can see there appear to be safety benefits along higher-volume streets for bicyclists. The proportion of midblock crashes resulting in a KSI outcome are quite low for the highest volume street (8.4%) whereas the lowest volume streets have the highest proportion of KSI outcomes (21.4%).

Map 8: Bicyclist crashes and estimated bicyclist volumes (low, medium, high), 2017-2021



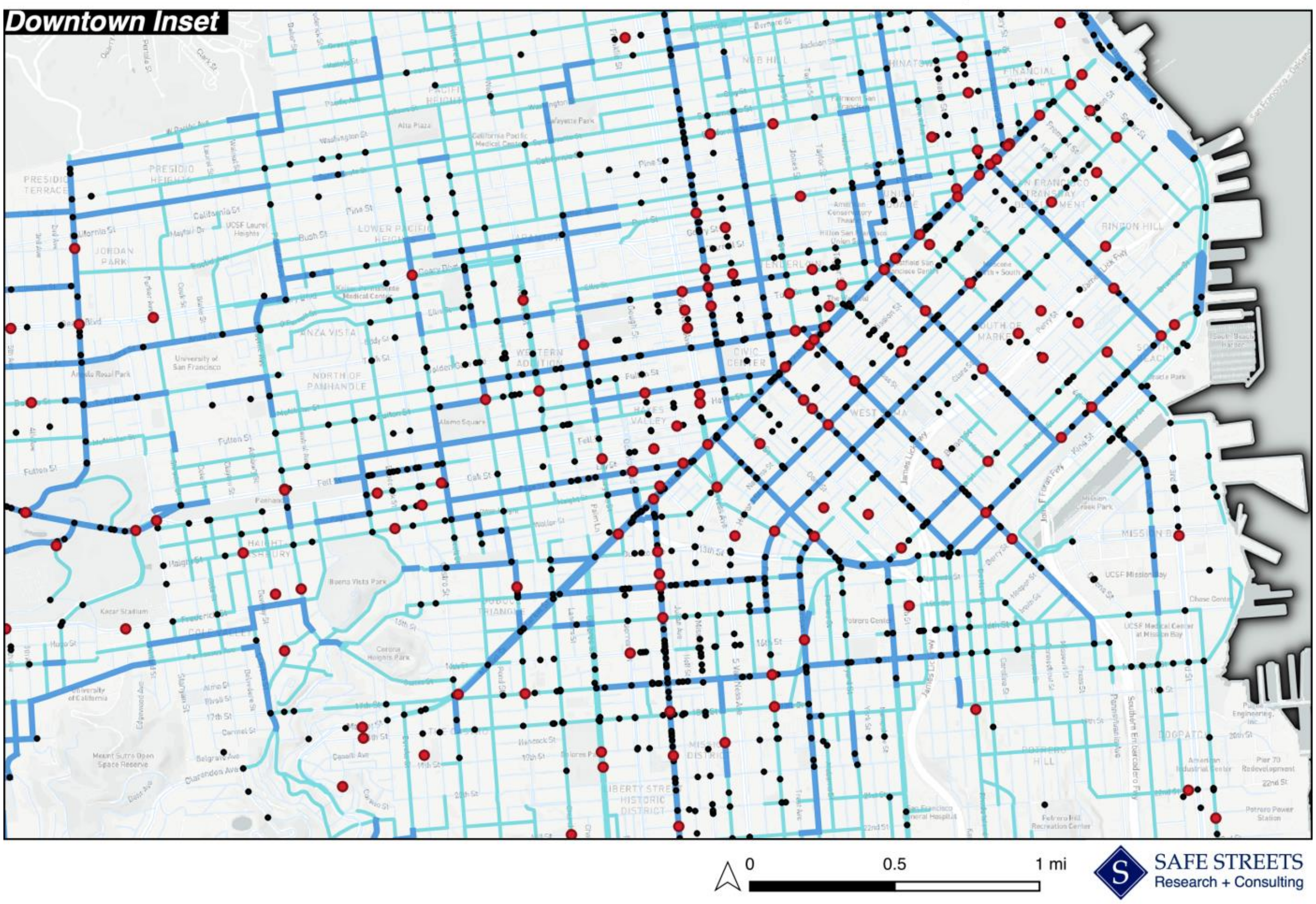


Table 28: Midblock bicycle crashes by estimate bike volume (quantiles), 2017-2021

Bicyclist Volume Estimates Quantiles	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	% Crashes resulting in KSI
5 (highest)	188.7	19.2%	287	57.6%	24	48.0%	6,179	51.4%	15.21	1.27	8.4%
4	191.9	19.5%	75	15.1%	10	20.0%	2,188	18.2%	3.91	0.52	13.3%
3	201.3	20.5%	76	15.3%	8	16.0%	1,914	15.9%	3.78	0.40	10.5%
2	194.2	19.8%	46	9.2%	5	10.0%	1,156	9.6%	2.37	0.26	10.9%
1 (lowest)	206.6	21.0%	14	2.8%	3	6.0%	581	4.8%	0.68	0.15	21.4%
Total	***982.7***	***100.0%***	***498***	***100.0%***	***50***	***100.0%***	***12,018***	***100.0%***	***5.07***	***0.51***	***10.0%***

Intersection Crashes

Intersections were categorized into quantiles like street centerlines, but the volume estimates were aggregated from all intersecting legs. The bicycle volume estimates do not differentiate directional volume estimates to allow for the volume estimates to be aggregated to intersections to reflect entering bicyclist volumes. Intersection bicyclist crashes by bicyclist volume estimates are summarized in Table 29. Like midblock crashes, bicyclist crashes were concentrated at intersections that have the highest bicyclist volume estimates (62.7% crashes; 58.1% of KSI crashes). Again, this is not a direct reflection of crash risk, but a representation of the reality that where there are higher volumes of bicyclists traveling, we can expect to observe a higher frequency of crashes. Interestingly, we do see an inverse relationship between the percentage of crashes that resulted in a KSI outcome and bicyclist volume estimates. Intersections with higher volume estimates had fewer crashes that resulted in a KSI, whereas intersections with a lower volume estimate have a higher proportion of crashes that resulted in a KSI. This relationship between bicyclist volumes and the average severity of crashes at intersections may suggest a safety in numbers effect.

Table 29: Intersection bicycle crashes by estimate bike volume (quantiles), 2017-2021

Bicyclist Volume Estimates Quantiles	# Int	% Ints	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 100 Ints	KSI Crashes per 100 Ints	% Crashes resulting in KSI
5 (highest)	1,447	20.0%	1,209	62.7%	108	58.1%	23,638	57.3%	83.6	7.5	8.9%
4	1,448	19.9%	370	19.2%	40	21.5%	8,728	21.2%	25.6	2.8	10.8%
3	1,438	19.2%	183	9.5%	17	9.1%	3,914	9.5%	12.7	1.2	9.3%
2	1,456	19.4%	113	5.9%	13	7.0%	3,119	7.6%	7.8	0.9	11.5%
1 (Lowest)	1,449	21.5%	53	2.7%	8	4.3%	1,835	4.5%	3.7	0.6	15.1%
Total	***7,238***	***100.0%***	***1,928***	***100.0%***	***186***	***100.0%***	***41,234***	***100.0%***	***26.6***	***2.6***	***9.6%***

Bike Facility[6]

To examine the relationship between bicycle facilities and crash patterns post-installation, all crashes were aggregated to the nearest roadway centerline if the crash occurred at least one year after the year the bike facility was installed[7]. The highest bike facility was assigned to each centerline (multiple facility types can be present along each block); Class I facilities were the highest and Class III facilities were the lowest. The corresponding facility install date in the data was used to screen for the crash aggregation. Class III facilities make up the largest portion of the bike network (46.4%) which may be due to their relatively minor impact on motor vehicle capacity or level of service and their relatively low cost for installation. Class II facilities comprise the second large share of network mileage (32.8%), followed by Class IV (13.8%) and Class I (7%).

***NOTE: Because the narrative and tables in this section summarize bicycle crashes that occurred along a street with a bike facility only if the crash occurred at least one year after the facility was installed, the crashes examined here are a subset of the overall sample of crashes citywide. Crashes that occurred before the facility was installed or along a street without a bike facility are excluded, as they are not influenced by the bicycle facility's presence.**

Post-installation bicycle crashes per year by bicycle facility type over the 5-year study are summarized in Table 30. Class III facilities accounted for the largest share of both overall crashes and KSI crashes per year (39.7% and 48.2%, respectively), followed closely by Class II facilities (39.2% and 31.7%, respectively). Class IV accounted for the third highest share of crashes (20.1%) and KSI crashes (19%) per year, while Class I facilities had the lowest share of crashes (1%) and KSI crashes (1.1%). While Class II facilities accounted for the large share of crashes, the percentage of crashes that *resulted in a KSI outcome* was the lowest (7.8%), followed by Class IV (9.0%). This finding suggests that the Class II and Class IV facilities and the type of physical separation they provide may help reduce the severity of crashes if they occur.

Most KSI crashes along a bike facility involved a bicyclist and a motorist (69.4%). Of the KSI crashes that occurred along a bike facility, 28.2% were a solo bicyclist, and those occurred most frequently along a Class III facility (18.8% of KSI crashes).

Interestingly, regardless of bike facility type, the largest share of crashes by relative direction of travel between the bicyclists and motorists was the same direction (47.9% of all crashes; 42.4% of KSI crashes), followed by perpendicular (33.2% of all crashes; 40.7% of KSI crashes). Exploring the same direction crashes further, the most common movement types involved a bicyclist proceeding straight and a motorist making a right turn (9% of all crashes, n=66; 5.1% of KSI crashes, n=3) while the most common movement type for KSI crashes was bike proceeding straight and the motorists stopped (5.6% of all crashes, n=41; 13.6% of KSI crashes, n=8). Five of the eight KSI crashes were dooring crashes. Exploring the perpendicular crashes further, most crashes involved both parties proceeding straight (10.7% of all crashes, n=78; 15.3% of KSI crashes, n=9) followed by the bicyclist proceeding straight and the motorist making a left turn (7.5% of all crashes, n=55; 10.2% of KSI crashes, n=6). Most of the crashes and KSI crashes involving both parties proceeding straight were cited as failure to obey a stop sign or disregarded red traffic signal.

Crashes along any type of bike facility were concentrated at intersections (81.5% of all crashes; 82.2% of KSI crashes). Most intersection crashes along a bike facility were perpendicular (35.5% of all crashes; 39% of KSI

[6] Bicycle class definitions:

- Class I: Trail or shared-used path
- Class II: Bike lane
- Class III: Route or sharrows
- Class IV: Separated or protected bike lane

[7] This deviates from the approach uses elsewhere in this analysis. All other portions of this memo separate intersection crashes from midblock crashes and assign centerline characteristics to midblock crashes and intersection crashes to crashes that occurred within 75 feet of an intersection. This approach aggregated crashes to the nearest centerline regardless of proximity to an intersection.

crashes), followed by same direction (30.3% of all crashes; 24.7% of KSI crashes). Midblock crashes largely involved both parties traveling in the same direction (65.2% of all midblock crashes and 65.4% midblock KSI crashes).

Roughly 60% of KSI crashes along a bike facility occurred at a signalized intersection, with half (49.4%) of those crashes involving both parties traveling in perpendicular direction of travel and 31% involving the parties traveling in the same direction. Additionally, most KSI crashes at signalized intersections involved a motorist proceeding straight (44.8% of signalized intersection KSI crashes) followed by a motorist making a left turn (21.8% of signalized intersection KSI crashes).

Nearly all bicyclist-motorist KSI crashes (18 of 20) that occurred along a Class II facility were at an intersection. Similarly, 11 of the 13 KSI crashes along a Class IV facility were at an intersection. For KSI crashes at an intersection along a Class II facility, 44.4% involved both parties traveling in the same direction, followed by the parties traveling perpendicularly (38.9%). For KSI crashes along a Class IV facility at an intersection, most KSI crashes involved both parties traveling perpendicularly (54.5%).

***NOTE: Crashes per mile and KSI crashes per mile columns are included in the following tables. We recommend interpreting those measures with caution, as the results do not adjust for exposure. For example, Class IV facilities comprise 13.8% of the bike network by centerline mileage, but often have the largest share of bicyclist volumes due to the comfort and safety benefits they provide. Due to concerns about the precision of the exposure data, we did not estimate crashes per bicyclist traveling along a Class IV facility or through an intersection with a Class IV facility.**

Table 30: Bicycle post-installation crashes per year by bicycle facility type, 2017-2021

					Crashes per year AFTER the year the bike facility was installed						
Bike Facility Type	*# Miles*	*% Miles*	*# Crashes*	*# KSI Crashes*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*Crashes per year per 10 miles*	*KSI Crashes per year per 10 miles*	% Crashes per year resulting in KSI
CLASS I	12.3	7.0%	9	1	1.8	1.0%	0.2	1.1%	1.5	0.2	11.1%
CLASS II	58.0	32.8%	354	27	72.9	39.2%	5.7	31.7%	12.6	1.0	7.8%
CLASS III	81.9	46.4%	368	43	73.7	39.7%	8.6	48.2%	9.0	1.0	11.7%
CLASS IV	24.5	13.8%	152	14	37.4	20.1%	3.4	19.0%	15.3	1.4	9.0%
Total	***176.8***	***100.0%***	***883***	***85***	***185.9***	***100.0%***	***17.9***	***100.0%***	***1.5***	***0.2***	***9.6%***

Map 9: Bicyclist crashes and current bicycle network, 2017-2021

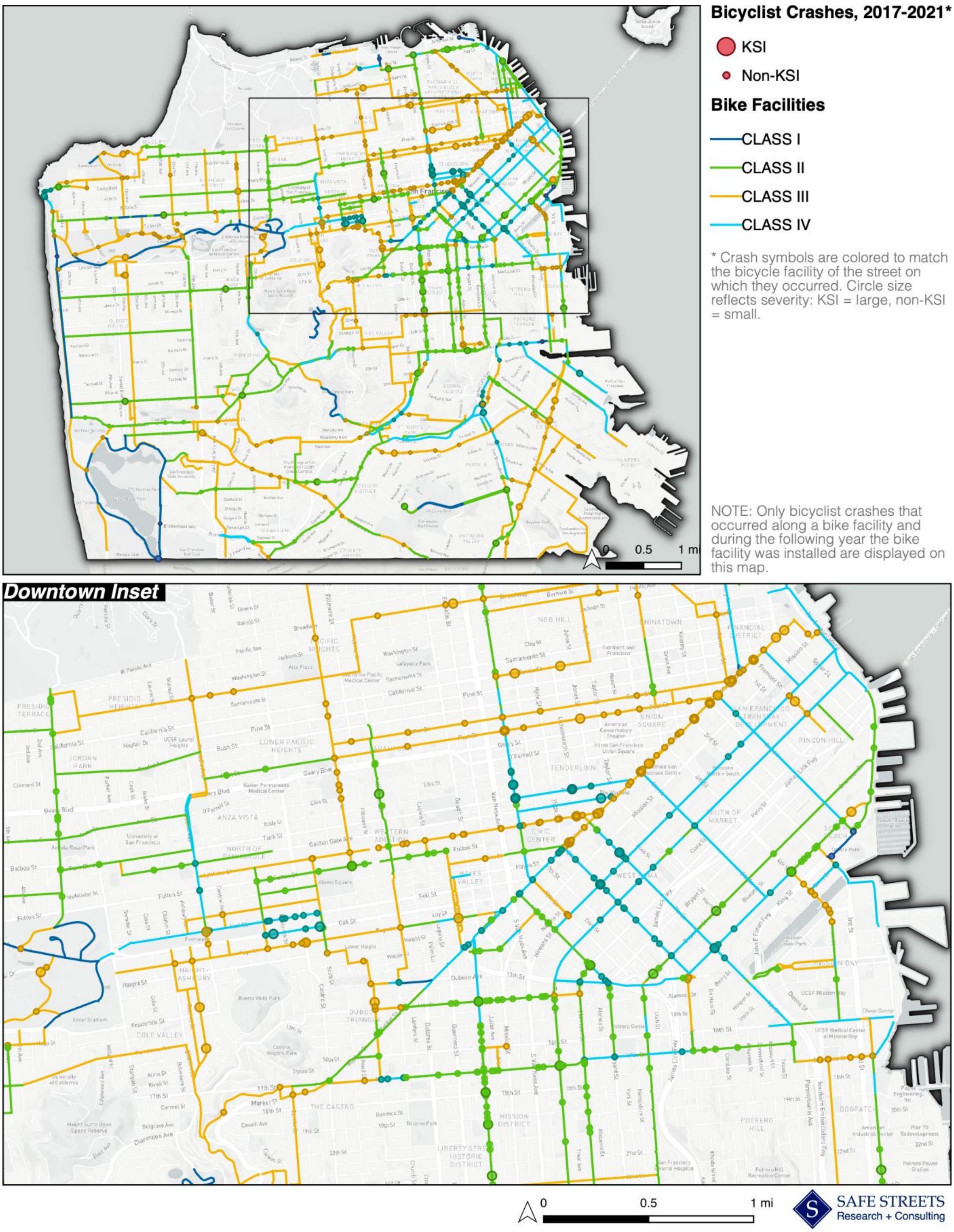


Table 31 summarizes bicycle crashes by bike facility type and bike volume estimates for the 5-year study period. Unsurprisingly, crashes rates (crashes per year) were generally highest along streets with higher bicycle volume estimates (47.7%) regardless of bicycle facility type. However, crashes generally occurred most often along high and medium volume street with a Class II or Class III facility. Crashes along those streets also tended to be more severe, with a higher percentage of crashes resulting in a KSI outcome compared to other medium to high volume streets with a Class I or Class IV facility.

Table 31: Bicycle post-installation crashes per year by bicycle facility type and bicycle volume estimates, 2017-2021

						Crashes per year AFTER the year the bike facility was installed				
Bike Volume Estimate	**Bike Facility Type**	**# Miles**	**% Miles**	**Total Cashes**	**Total KSI Crashes**	**Crashes per year**	**KSI Crashes per year**	**Crashes per year per 10 miles**	**KSI Crashes per year per 10 miles**	**% Crashes per year Resulting in KSI**
High	CLASS I	2.5	1.4%	2	1	0.4	0.2	1.6	0.8	50.0%
High	CLASS II	15.7	8.9%	160	8	33.2	1.6	21.1	1.0	4.8%
High	CLASS III	15.0	8.5%	153	16	30.6	3.2	20.4	2.1	10.5%
High	CLASS IV	11.6	6.6%	97	7	24.5	1.9	21.1	1.6	7.7%
Medium	CLASS I	5.2	2.9%	2	0	0.4	0.0	0.8	0.0	0.0%
Medium	CLASS II	28.1	15.9%	153	14	31.3	3.1	11.1	1.1	9.8%
Medium	CLASS III	39.7	22.5%	148	16	29.7	3.2	7.5	0.8	10.8%
Medium	CLASS IV	7.9	4.4%	38	3	8.7	0.6	11.1	0.8	6.9%
Low	CLASS I	4.7	2.7%	5	0	1.0	0.0	2.1	0.0	0.0%
Low	CLASS II	14.2	8.0%	41	5	8.3	1.0	5.9	0.7	12.0%
Low	CLASS III	27.2	15.4%	67	11	13.4	2.2	4.9	0.8	16.4%
Low	CLASS IV	5.0	2.8%	17	4	4.3	0.9	8.4	1.8	21.2%

Table 32 summarizes bicycle crashes by bike facility type and functional classification for the 5-year study period. Class II and Class II facilities along residential streets accounted for the largest share of crashes (Class II: 20.1%; Class III: 19.9%) and were in the top three location types in terms of percentage of KSI crashes (Class II 17.2%; Class III: 16.8%). Interestingly, crashes along residential streets with a Class II or Class III facility also tended to be less severe, with fewer crashes resulting in a KSI outcome compared to collector or arterial streets. This is likely due to lower vehicle volumes and speeds resulting in lower exposure and less kinetic energy at the time of the crash due to lower vehicle speeds.

Table 32: Bicycle post-installation crashes per year by bicycle facility type and functional classification, 2017-2021

						Crashes per year AFTER the year the bike facility was installed				
Bike Facility Type	**Functional Classification**	**# Miles**	**% Miles**	**Total Cashes**	**Total KSI Crashes**	**Crashes per year**	**KSI Crashes per year**	**Crashes per year per 10 miles**	**KSI Crashes per year per 10 miles**	**% Crashes per year resulting in KSI**
CLASS I	Arterial	2.2	1.2%	5	0	1.0	0.0	4.6	0.0	0.0%
CLASS I	Collector	4.0	2.3%	3	1	0.6	0.2	1.5	0.5	33.3%
CLASS I	Residential	6.2	3.5%	1	0	0.2	0.0	0.3	0.0	0.0%
CLASS II	Arterial	7.1	4.0%	66	6	13.2	1.2	18.7	1.7	9.1%
CLASS II	Collector	16.8	9.5%	112	7	22.7	1.4	13.5	0.8	6.2%
CLASS II	Residential	34.2	19.4%	176	14	37.0	3.1	10.8	0.9	8.3%
CLASS III	Arterial	9.1	5.2%	54	7	10.8	1.4	11.8	1.5	13.0%
CLASS III	Collector	16.9	9.6%	128	21	25.6	4.2	15.1	2.5	16.4%
CLASS III	Residential	55.9	31.7%	186	15	37.3	3.0	6.7	0.5	8.0%
CLASS IV	Arterial	5.9	3.4%	47	6	12.0	1.2	20.1	2.0	10.0%
CLASS IV	Collector	12.9	7.3%	72	6	17.5	1.7	13.6	1.3	9.5%
CLASS IV	Residential	5.4	3.0%	33	2	8.0	0.5	14.9	1.0	6.7%

Table 33 summarizes bicycle crashes by bike facility type and number of general purpose lanes for the 5-year study period. Similar to the findings reported earlier in this memo, streets with a bike lane and two general purpose lanes had a high rate of bicycle crashes per year. However, Class I and Class IV facilities, which provide the greatest level of physical separation, had the lowest crash rates and KSI crash rates per year and per mile along streets with four lanes. This is a particularly interesting finding, given that Class I and IV facilities are often installed along streets with higher levels of stress and crash risk.

When looking at all bicycle facility types along four-laned roads, most crashes occurred at intersections (89% of all crashes and 80% of KSI crashes), and particularly at signalized intersections (77% of all crashes; 80% of KSI crashes). Exploring motorist-bicyclist crashes along four-lane roads at intersections, we find that same direction crashes comprised the largest share of both overall crashes (38%) and KSI crashes (42%), followed by perpendicular movements (37.6% of all crashes; 37% of KSI crashes). For the same direction crashes, the motorist was most often making a right turn; for perpendicular crashes, the motorists were most often proceeding straight.

The majority of crashes along a bike facility on a two-lane road also occurred at intersections (60% of all crashes and 62% of KSI crashes), and most frequently at signalized intersections (38% of all crashes). Interestingly, of the intersection crashes along a two-lane road with a bike facility, signalized intersection and all-way stop controlled intersections had the same share of KSI crashes (39% of KSI crashes). Most intersection crashes along two-lane roads involved parties traveling in the same direction (43% of all crashes; 31% of KSI crashes), followed by perpendicularly to each other (37% of all crashes; 46% of KSI crashes). For both of these broad crash types, the motorist was most often proceeding straight. The same direction crashes, in particular, may indicate the need for separation in either time (e.g., via a bicycle signal) or space (e.g., via physical separation) between moving vehicle traffic and bicyclists along two-lane roads.

Table 33: Bicycle post-installation crashes per year by highest bicycle facility type and number of general purpose lanes, 2017-2021

						Crashes per year AFTER the year the bike facility was installed				
Bike Facility Type	***# Lanes***	***# Miles***	***% Miles***	***Total Cashes***	***Total KSI Crashes***	***Crashes per year***	***KSI Crashes per year***	***Crashes per year per 10 miles***	***KSI Crashes per year per 10 miles***	**% Crashes per year resulting in KSI**
CLASS I	4	2.5	1.4%	9	1	1.8	0.2	7.3	0.8	11.1%
CLASS II	1	1.1	0.6%	6	0	1.2	0.0	10.5	0.0	0.0%
CLASS II	2	39.8	22.5%	215	18	44.1	3.6	11.1	0.9	8.2%
CLASS II	3	3.8	2.2%	25	0	5.3	0.0	13.8	0.0	0.0%
CLASS II	4	10.6	6.0%	97	8	20.1	1.9	19.0	1.8	9.3%
CLASS II	≥5	2.7	1.5%	11	1	2.2	0.2	8.1	0.7	9.1%
CLASS III	1	1.8	1.0%	15	2	3.0	0.4	16.8	2.2	13.3%
CLASS III	2	59.8	33.8%	193	20	38.7	4.0	6.5	0.7	10.3%
CLASS III	3	4.1	2.3%	24	1	4.8	0.2	11.6	0.5	4.2%
CLASS III	4	13.3	7.5%	118	17	23.6	3.4	17.7	2.6	14.4%
CLASS III	≥5	2.9	1.7%	18	3	3.6	0.6	12.3	2.1	16.7%
CLASS IV	1	0.5	0.3%	2	1	1.0	0.5	21.7	10.9	50.0%
CLASS IV	2	6.2	3.5%	52	2	12.4	0.5	20.1	0.9	4.3%
CLASS IV	3	4.5	2.6%	31	4	7.0	0.9	15.5	2.0	12.8%
CLASS IV	4	10.5	6.0%	57	4	15.0	0.9	14.7	0.8	5.7%
CLASS IV	≥5	2.8	1.6%	10	3	2.0	0.6	7.2	2.2	30.0%

Table 34 summarizes bicycle crashes by bike facility type and if the street is along the HIN for the 5-year study period. Roughly 60% of bicycle crashes and 55% of KSI crashes along a bike facility of any kind occurred along the HIN. Class II and Class III facilities along the HIN had the highest rate of crashes per year, followed by Class II and Class III facilities off the HIN. KSI crashes per year were highest along the Class III facilities along the HIN, followed by Class III facilities off the HIN. These findings underscore the need for bicycle facilities along these routes, but may also indicate insufficient protection gained from Class II and Class III facilities along these routes. The data also showthat Class IV facilities along the HIN had a higher percentage of crashes resulting in a KSI (9.1%) compared to Class II facilities along the HIN (5.7%). These findings may reflect that Class IV facilities, due to their greater level of protection, tend to be installed in more complex locations with greater underlying risk factors. Additionally, these findings appear to further support the idea of separation in time via bike signal: the vast majority of crashes (94%) and all KSI crashes along a Class IV facility that is along the HIN occurred at locations *without* a bike signal.

Nearly half (47.8%) of all crashes and KSI crashes (47.1%) along any bike facility type occurred along the HIN at an intersection. Of the intersection crashes along the HIN, 82.2% of all crashes and 92.5% of KSI crashes were at signalized locations. The most common violation types at these locations include *unsafe turn or lane change* (18.2% of all crashes; 13.5% of KSI crashes), *disregard red signal* (14.1% of all crashes; 8.1% of KSI crashes), and *unsafe speed* (11.5% of all crashes; 13.5% of KSI crashes). Crashes involving a bicyclist and a motorist occurred most often between parties traveling in the same direction (42.4% of all crashes; 25% of KSI crashes), and most often along a Class II facility or Class III facility, likely related at least in part to higher bicyclist exposure in those locations, and potentially influenced by less protection for bicyclists. The most common motorist pre-crash movements for same direction crashes were proceeding straight and making a right turn. KSI crashes occurred most often between a bicyclist and motorist traveling in perpendicular directions (50% of KSI crashes), again, most often along Class II and Class III facilities. The most common motorist pre-crash movement was proceeding straight, followed by making a left turn.

Table 34: Bicycle post-installation crashes per year by highest bicycle facility type and HIN, 2017-2021

HIN	Bike Facility Type	# Miles	% Miles	Total Cashes	Total KSI Crashes	Crashes per year AFTER the year the bike facility was installed: Crashes per year	KSI Crashes per year	Crashes per year per 10 miles	KSI Crashes per year per 10 miles	% Crashes per year resulting in KSI
NO	CLASS I	11.0	6.2%	7	1	1.4	0.2	1.3	0.2	14.3%
NO	CLASS II	42.4	24.0%	142	15	28.8	3.1	6.8	0.7	10.9%
NO	CLASS III	65.9	37.3%	165	19	33.0	3.8	5.0	0.6	11.5%
NO	CLASS IV	10.3	5.8%	41	3	10.0	0.9	9.7	0.9	9.0%
YES	CLASS I	1.4	0.8%	2	0	0.4	0.0	2.9	0.0	0.0%
YES	CLASS II	15.6	8.8%	212	12	44.1	2.5	28.2	1.6	5.7%
YES	CLASS III	16.0	9.1%	203	24	40.7	4.8	25.4	3.0	11.8%
YES	CLASS IV	14.2	8.0%	111	11	27.4	2.5	19.4	1.8	9.1%

One-way vs. Two-way

Table 35 summarizes bicyclist crashes on one-way versus two-way streets during 2017-2021, including both intersection and midblock crashes. Just 0.4% of the roadways in the network did not have one- or two-way designations, and six crashes (but no KSI crashes) occurred along these facilities. Most of the roads in the network (88.2%) are two-way roads, but only 62% of all crashes and 59% of KSI crashes occurred on these facilities. In contrast, one-way facilities make up 11.4% of the network but account for a disproportionate 38% of all crashes and 41% of KSI crashes during the study period. These statistics equate to one-way roadway having 4.5 times the EPDO per 10 miles than two-way facilities.

Most crashes along one-way streets occurred at intersections (91.3% of all crashes; 90.5% of KSI crashes). Among these intersection crashes (N=210), 84.3% occurred at signalized locations, as did 95.2% of KSI crashes. One quarter of the KSI crashes along one-way streets were cited as *disregard red signal*, followed by *dooring* (11.8% of KSI crashes). The most common relative direction of travel of both parties was same direction (37.8% of all crashes; 32.4% of KSI crashes) followed by perpendicular movements (37.5% of all crashes; 45.6% of KSI crashes). Most of the same direction crashes involved the bicyclist proceeding straight and the motorist making a right turn (18.7% of all crashes, n=62; 11.1% of KSI crashes, n=3) followed by both parties proceeding straight (13.6% of all crashes, n=45; 7.4% of KSI crashes, n=2). Among the perpendicular crashes, the most frequent movement types involved both parties proceeding straight (41.1% of all crashes, n=120; 64.5% of KSI crashes, n=20), followed by bicyclist proceeding straight and the motorist making a left turn (14.5% of all crashes, n=42; 9.7% of KSI crashes, n=3).

These findings indicate that one-way facilities present significant safety issues for bicyclists that may need further study through specific roadway safety assessments. This trend is the same before (Table 36) and during (Table 37) the pandemic.

Table 35: Bicycle crashes by one-way street, 2017-2021

One-way	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes year 10 miles	KSI Crashes per 10 miles	EPDO per 10 Miles
NO	866.7	88.2%	1,509	62.2%	140	59.3	33,461	62.8	17.4	1.6	386.1
YES	111.7	11.4%	911	37.6%	96	40.7	19,745	37.1	81.6	8.6	1768.
Unknown	4.2	0.4%	6	0.2%	0	0.0%	46	0.1%	14.1	0.0	108.4
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0***	***53,252***	***100.0***	***24.7***	***2.4***	***541.9***

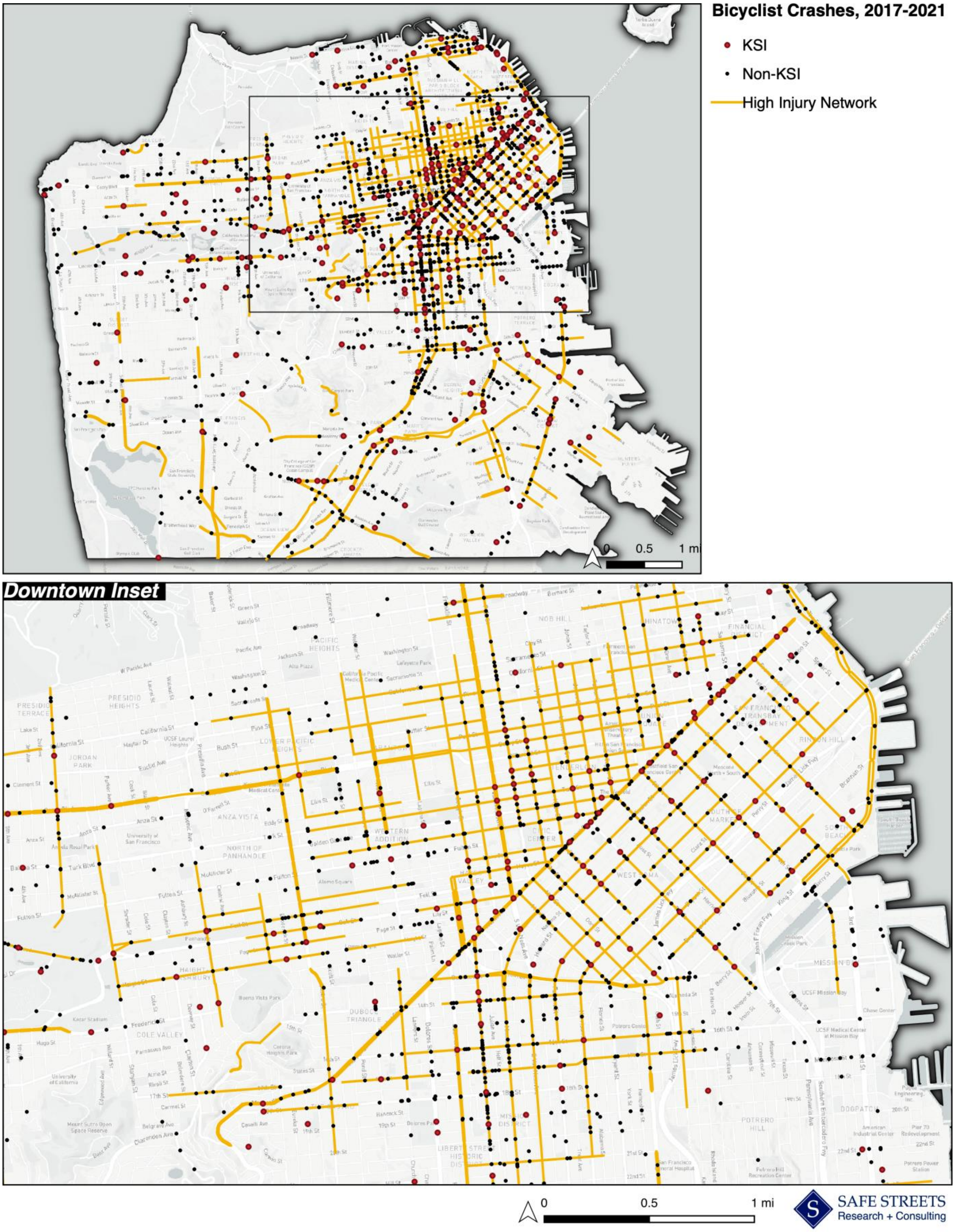
Table 36: Bicycle crashes by one-way street, 2017-2019

One-way	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes year 10 miles	KSI Crashes per 10 miles	EPDO per 10 Miles
NO	866.7	88.2%	1,004	60.4%	93	59.2%	22,125	61.8%	11.6	1.1	24.1
YES	111.7	11.4%	654	39.3%	64	40.8%	13,623	38.1%	58.6	5.7	114.9
Unknown	4.2	0.4%	5	0.3%	0	0.0%	35	0.1%	11.8	0.0	8.2
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***34.4***

Table 37: Bicycle crashes by one-way street, 2020-2021

One-way	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes year 10 miles	KSI Crashes per 10 miles	EPDO per 10 Miles
NO	866.7	88.2%	505	66.2%	47	59.5%	11,366	64.9%	5.8	0.5	131.1
YES	111.7	11.4%	257	33.7%	32	40.5%	6,130	35.0%	23.0	2.9	549.0
Unknown	4.2	0.4%	1	0.1%	0	0.0%	11	0.1%	2.4	0.0	25.9
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***178.2***

Map 10: Bicyclist crashes and one-way streets, 2017-2021



Street Slope

Table 38 shows bicycle crashes categorized by street slope between 2017 and 2021. Slopes vary somewhat evenly across the study area, with no category containing more than 28% of the network (the largest category, slope=1-2.9), and others ranging from 10-24% of the network. The steepest roadways (9+) comprise 22% of the network. The share of all crashes is distributed mostly among slopes between 1 - 6.9. KSI crashes are concentrated on roadways with slopes of 1- 4.9, which makes some sense given that steeper slopes are more difficult to access via bicycle. The most severe crashes also occur on these facilities; they have the highest EPDO per 10 miles (approximately 656.5-665.3). This five-year trend reflects the pre-pandemic period fairly well (Table 39). However, different crash trends emerge during the pandemic (Table 40), with more severe crashes on facilities with slopes between 7-8.9 (233.5 EPDO per 10 miles).

Table 38: Bicycle crashes by street slope, 2017-2021

Slope	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<1	9.1	0.9%	3	0.1%	0	0.0%	32	0.1%	3.3	0.0	35.3
1-2.9	272.7	27.8%	805	35.1%	78	34.7%	17,033	34.1%	31.2	3.0	665.3
3-4.9	230.5	23.5%	700	29.8%	67	29.2%	14,589	28.4%	31.4	3.0	656.5
5-6.9	151.8	15.4%	364	15.3%	30	13.1%	7,291	14.2%	24.5	2.0	497.6
7-8.9	102.1	10.4%	182	8.0%	19	9.3%	4,386	9.4%	18.9	2.2	492.1
9+	216.5	22.0%	265	11.4%	31	13.6%	7,022	13.7%	12.8	1.5	338.0
Total	**982.7**	**100.0%**	**2,325**	**100.0%**	**225**	**100.0%**	**50,399**	**100.0%**	***24.7***	***2.4***	***541.9***

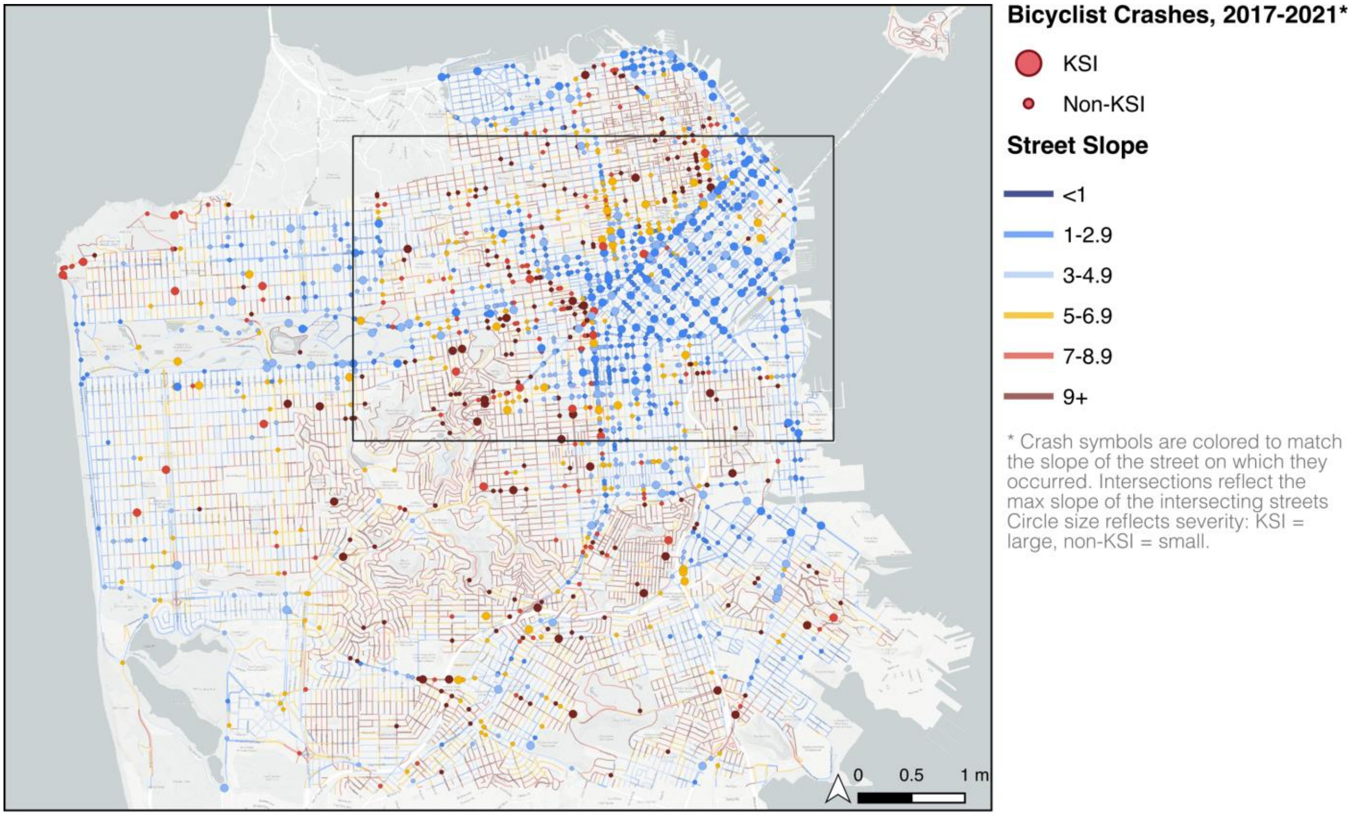
Table 39: Bicycle crashes by street slope, 2017-2019

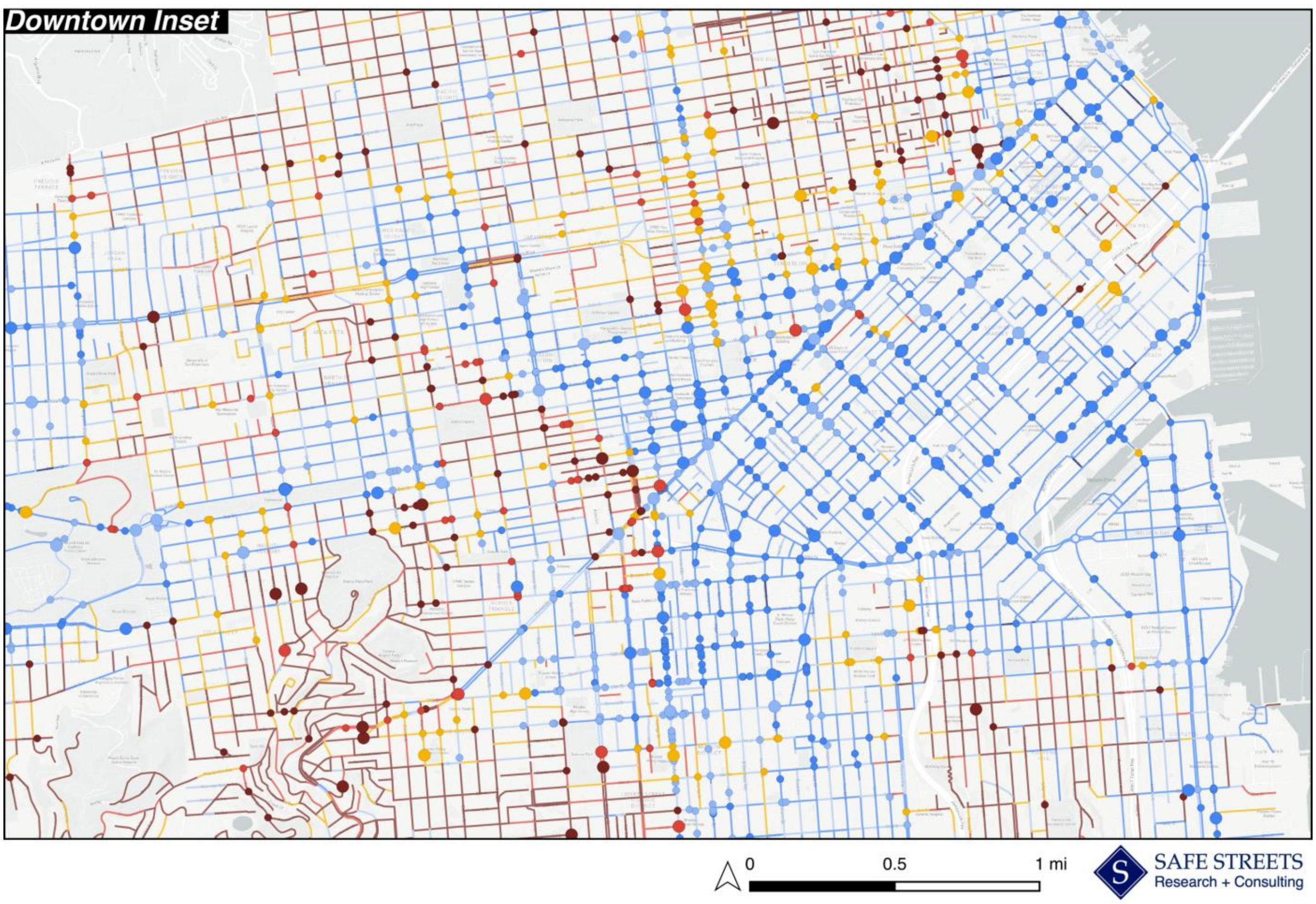
Slope	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<1	9.1	0.9%	3	0.2%	0	0.0%	32	0.1%	3.3	0.0	35.3
1-2.9	272.7	27.8%	593	37.5%	54	36.3%	12,127	36.1%	22.9	2.1	474.3
3-4.9	230.5	23.5%	474	29.3%	48	31.8%	10,106	29.6%	21.1	2.2	459.1
5-6.9	151.8	15.4%	233	14.3%	20	12.7%	4,922	13.9%	15.7	1.3	327.5
7-8.9	102.1	10.4%	129	8.2%	8	6.4%	2,227	7.4%	13.3	1.0	259.1
9+	216.5	22.0%	165	10.3%	19	12.7%	4,343	12.8%	7.9	0.9	212.3
Total	**982.7**	**100.0%**	**367**	**100.0%**	**32**	**100.0%**	**8,065**	**100.0%**	***16.9***	***1.6***	***364.1***

Table 40: Bicycle crashes by street slope, 2020-2021

Slope	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<1	9.1	0.9%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0	0.0
1-2.9	272.7	27.8%	212	29.9%	24	31.6%	4,915	29.8%	8.4	0.9	191.4
3-4.9	230.5	23.5%	226	30.9%	19	24.1%	4,494	26.1%	10.2	0.8	198.0
5-6.9	151.8	15.4%	131	17.6%	10	13.9%	2,373	14.8%	8.8	0.7	170.4
7-8.9	102.1	10.4%	53	7.5%	11	15.2%	2,164	13.6%	5.6	1.2	233.5
9+	216.5	22.0%	100	13.8%	12	15.2%	2,686	15.6%	4.9	0.6	126.2
Total	**982.7**	**100.0%**	**131**	**100.0%**	**18**	**100.0%**	**3,962**	**100.0%**	***7.8***	***0.8***	***178.2***

Map 11: Bicyclist crashes and street slope, 2017-2021





Transit

Table 41 shows reported bicyclist crashes at intersections and their proximity to transit facilities during the five-year period 2017 – 2021. Out of the 1,928 intersection crashes, 882 (or 45.7%) were near bus stops, and 85 of those were KSI crashes. Across the entire network, there were 26.6 crashes per 100 intersections, but there were notably more crashes per 100 intersections (46.8) when considering intersections with bus stops. This may point a relationship between intersections with more conflicting or complex traveler movements and bicycle crashes. This trend holds for both pre-pandemic and mid-pandemic years, as shown in Table 42 and Table 43.

Table 41: Bicycle crashes by proximity to a bus stop, 2017-2021

Near Bus Stop	*# Int*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Int	KSI Crashes per 100 Ints	Avg EPDO per crash
No	5,353	74.3%	1,046	54.3%	101	54.3%	23,532	57.1%	19.5	1.9	22.5
Yes	1,885	25.7%	882	45.7%	85	45.7%	17,702	42.9%	46.8	4.5	20.1
Total	***7,238***	***100.0%***	***1,928***	***100.0%***	***186***	***100.0%***	***41,234***	***100.0%***	**26.6**	**2.6**	***21.4***

Table 42: Bicycle crashes by proximity to a bus stop, 2017-2019

Near Bus Stop	*# Ints*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Int	KSI Crashes per 100 Ints	Avg EPDO per crash
No	5,353	74.3%	707	54.6%	70	56.0%	16,103	58.1%	13.2	1.3	22.8
Yes	1,885	25.7%	589	45.4%	55	44.0%	11,615	41.9%	31.2	2.9	19.7
Total	***7,238***	***100.0%***	***1,296***	***100.0%***	***125***	***100.0%***	***27,718***	***100.0%***	**17.9**	**1.7**	**21.4**

Table 43: Bicycle crashes by proximity to a bus stop, 2020-2021

Near Bus Stop	*# Ints*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Int	KSI Crashes per 100 Ints	Avg EPDO per crash
No	5,353	74.3%	339	53.6%	31	50.8%	7,443	55.0%	6.3	0.6	22.0
Yes	1,885	25.7%	293	46.4%	30	49.2%	6,102	45.0%	15.5	1.6	20.8
Total	***7,238***	***100.0%***	***632***	***100.0%***	***61***	***100.0%***	***13,545***	***100.0%***	**8.7**	**0.8**	**21.4**

Land Use

Table 44 summarizes bicyclist crashes by land use between 2017 and 2021, including both midblock and intersection crashes. Five different land use categories are considered: commercial, industrial, mixed use, public, and residential. The largest share of the network (64.2%) is within residential areas, followed by public land use (14.7%) and mixed uses (12.6%). Crashes in mixed used contexts seem to be slightly over-represented, as they make up 30% of all crashes. Similarly, severe crashes seem to be over-represented in commercial contexts; they make up 20% of KSI crashes despite only making up 3.9% of the network, and they have the highest crashes per 10 miles in the network. These findings may reflect the complexity of interactions among roadway users in commercial and mixed-use areas, which can impact bicycle safety outcomes. In general, this trend holds both during and before the pandemic as shown in Table 45 and Table 46, with some differences. Most notably, there were relatively more severe crashes in terms of EPDO scores near public spaces during the pandemic compared to pre-pandemic years (28.7 in 2020-2021, compared to 22.3 in 2017-2019). Additionally, there was a change in the percentage of KSI crashes near mixed land uses (31.2% in 2017-2019, compared to 20.3% in 2020-2021), which likely reflects changes in activity and travel behavior between those two periods.

Table 44: Bicyclist crashes by land use, 2017-2021

Land Use	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg. EPDO
Commercial	38.4	3.9%	419	17.3%	47	19.9%	9,472	17.8%	109.2	12.2	22.6
Industrial	44.8	4.6%	201	8.3%	18	7.6%	4,313	8.1%	44.9	4.0	21.5
Mixed Use	123.9	12.6%	714	29.4%	60	25.4%	13,297	25.0%	57.6	4.8	18.6
Public	144.8	14.7%	365	15.0%	38	16.1%	8,751	16.4%	25.2	2.6	24.0
Residential	630.9	64.2%	727	30.0%	73	30.9%	17,419	32.7%	11.5	1.2	24.0
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***22.0***

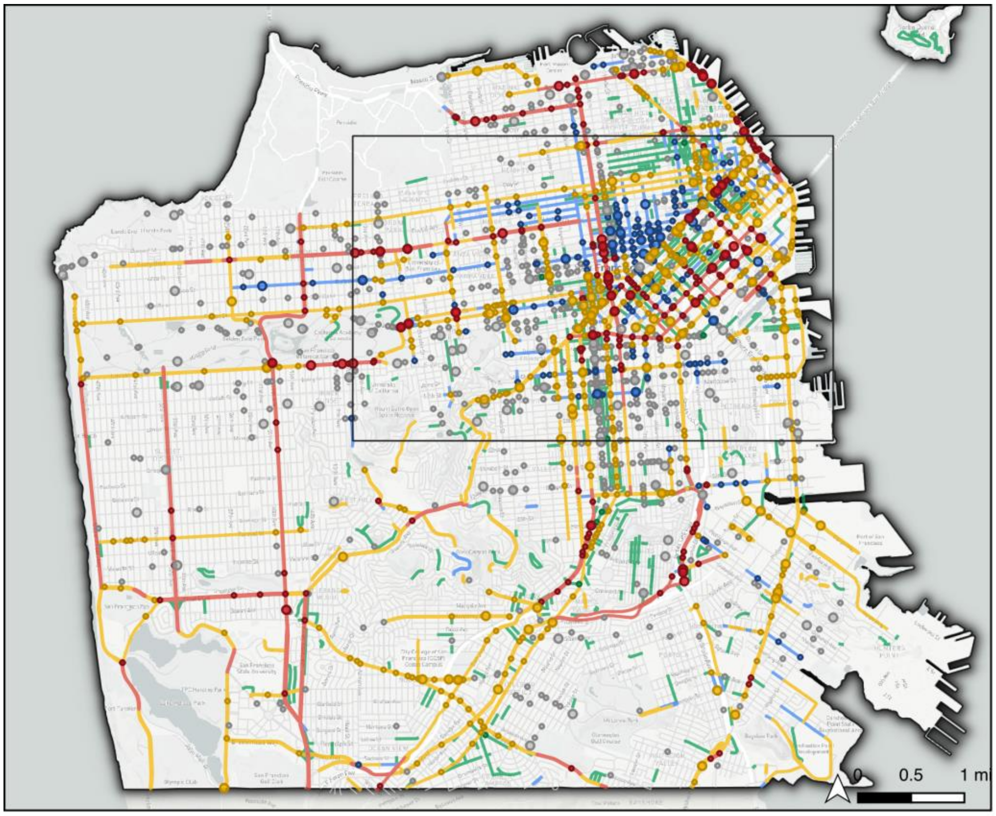
Table 45: Bicyclist crashes by land use, 2017-2019

Land Use	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg. EPDO
Commercial	38.4	3.9%	320	20.4%	25	20.0%	5,103	18.4%	1.7	0.2	19.3
Industrial	44.8	4.6%	140	8.2%	7	5.6%	2,019	7.3%	1.2	0.1	19.0
Mixed Use	123.9	12.6%	495	29.3%	39	31.2%	7,863	28.3%	2.2	0.2	20.7
Public	144.8	14.7%	229	11.9%	15	12.1%	3,444	12.4%	1.1	0.1	22.3
Residential	630.9	64.2%	479	30.3%	39	31.1%	9,321	33.6%	1.6	0.2	23.8
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***126***	***100.0%***	***27,750***	***100.0%***	***1.6***	***0.2***	***21.4***

Table 46: Bicyclist crashes by land use, 2020-2021

Land Use	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg. EPDO
Commercial	38.4	3.9%	99	13.0%	15	19.0%	2,828	16.2%	25.8	3.9	28.6
Industrial	44.8	4.6%	61	8.0%	7	8.9%	1,383	7.9%	13.6	1.6	22.7
Mixed Use	123.9	12.6%	219	28.7%	16	20.3%	3,748	21.4%	17.7	1.3	17.1
Public	144.8	14.7%	136	17.8%	18	22.8%	3,899	22.3%	9.4	1.2	28.7
Residential	630.9	64.2%	248	32.5%	23	29.1%	5,649	32.3%	3.9	0.4	22.8
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***22.9***

Map 12: Bicyclist crashes and land use, 2017-2021



Bicyclist Crashes, 2017-2021*

KSI

Non-KSI

Number of Lanes

1

2

3

4

>=5

* Crash symbols are colored to match the number of lanes of the street on which they occurred. Intersections reflect the number of lanes of the largest intersecting street. Circle size reflects severity: KSI = large, non-KSI = small.

0 0.5 1 mi

SAFE STREETS Research + Consulting

Equity Priority Communities – Citywide

Table 47 summarizes bicyclist crashes during the 5-year study period by proximity to an EPC. Slightly more than half of the reported bicyclist crashes (N=2,432) occurred not within an EPC (55.2%) and these crashes tend to be more severe, with an average EPDO score of 23.2 and 10.3% of crashes resulting in a KSI outcome. This pattern was similar when exploring crashes by pre-pandemic (see Table 48) and pandemic (see Table 49) study periods.

When looking at crashes that occurred within an EPC as they relate to the HIN, 80.5% of crashes and 79.6% of KSI crashes across all EPCs occurred along the HIN. There are several potential factors that may influence this concentration of crashes. One factor might be related to bicyclists riding along a smaller number of streets, increasing the volume along those streets, resulting in a higher crash frequency. Another potential factor might be related to systemic safety issues within these communities that increase bicyclist risk along the HIN or just expose bicyclists to greater risk due to a higher ratio of HIN streets to non-HIN streets. Acquiring comprehensive bike counts within EPCs can help us better understand bicyclist exposure and estimate crash risk within these communities.

The top three reported violations for KSI crashes within EPCs include *unsafe speed for conditions* (26.5%), *disregard red signal* (11.2%), and *unsafe turn or lane change* (10.2%). Excluding "unknown" violation types, these are also the top three report violations for crashes that occurred outside of EPCs.

Table 47: Bicyclist crashes by Equity Priority Community, 2017-2021

EPC	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
Not within EPC	1,342	55.2%	138	58.5%	31,116	59.1%	10.3%	23.2
Within EPC	1,090	44.8%	98	41.5%	21,555	40.9%	9.0%	19.8
Total	***2,432***	***100.0%***	***236***	***100.0%***	***52,671***	***100.0%***	***9.7%***	***21.7***

Table 48: Bicyclist crashes by Equity Priority Community, 2017-2019

EPC	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
Not within EPC	885	53.1%	90	57.0%	20,148	56.9%	10.2%	22.8
Within EPC	783	46.9%	68	43.0%	15,279	43.1%	8.7%	19.5
Total	***1,668***	***100.0%***	***158***	***100.0%***	***35,426***	***100.0%***	***9.5%***	***21.2***

Table 49: Bicyclist crashes by Equity Priority Community, 2020-2021

EPC	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
Not within EPC	457	59.8%	48	61.5%	10,969	63.6%	10.5%	24.0
Within EPC	307	40.2%	30	38.5%	6,276	36.4%	9.8%	20.4
Total	***764***	***100.0%***	***78***	***100.0%***	***17,244***	***100.0%***	***10.2%***	***22.6***

Map 13: Bicyclist crashes and Equity Priority Communities, 2017-2021

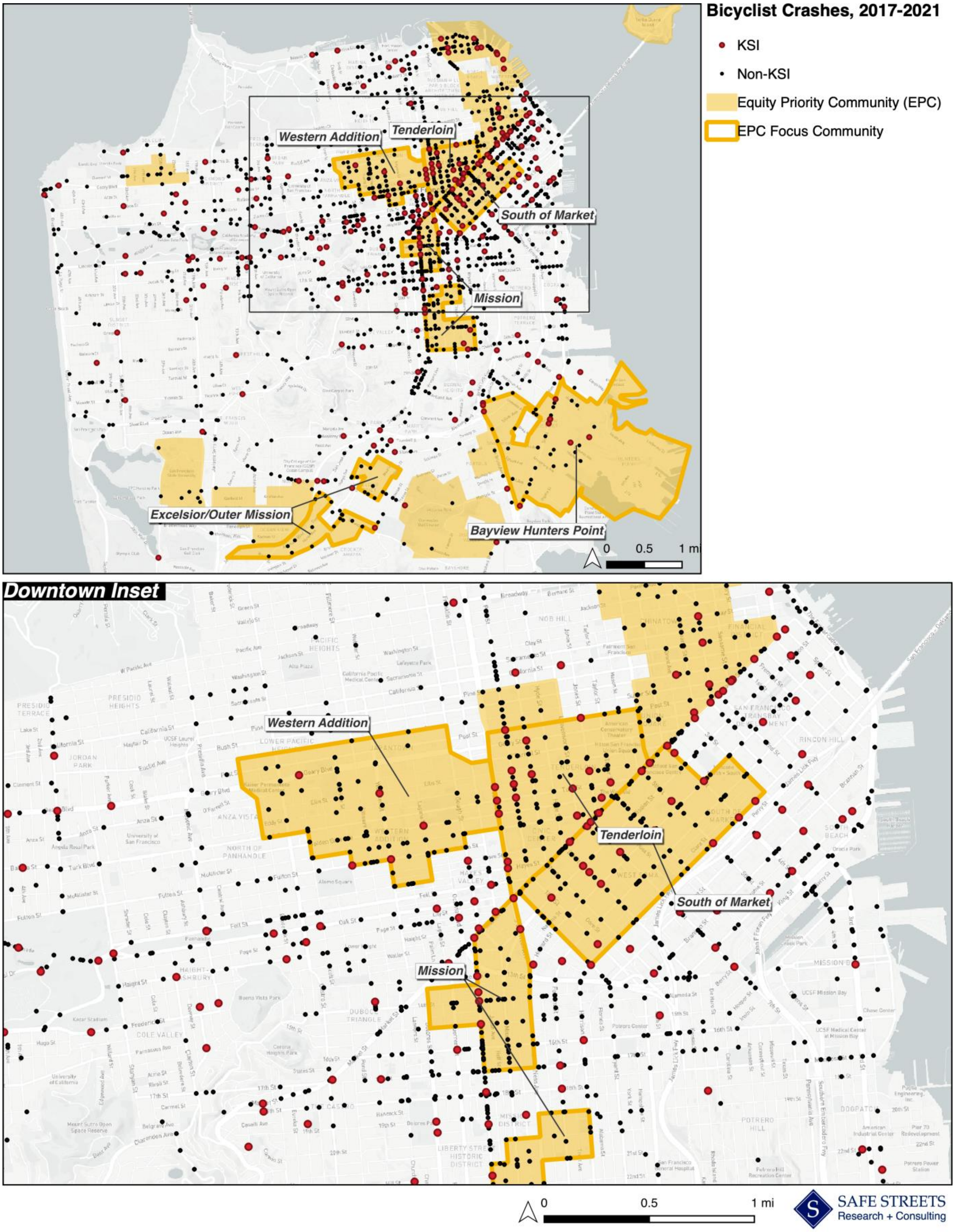


Table 50 summarizes bicyclist crashes by injury severity that occurred within the six EPC focus communities between 2015-2021. Neighborhoods that are closer to the central business district had higher crash frequencies, which is largely due to higher levels of exposure. Key findings for each neighborhood are outlined below.

Table 50: Bicyclist crashes by Focus EPC Community, 2017-2021[8]

Neighborhood	# Crashes	# KSI	# EPDO	% Crashes resulting in KSI	Avg. EPDO
Bayview Hunters Point	46	11	1,820	23.9%	39.6
Excelsior	28	1	376	3.6%	13.4
Mission	232	12	3,519	5.2%	15.2
Soma	279	23	5,488	8.2%	19.7
Tenderloin	243	26	5,167	10.7%	21.3
Western Addition	117	8	1,871	6.8%	16.0

Bayview Hunters Point

- 46 total crashes, 11 KSI crashes.
- 23.9% of crashes resulted in a KSI outcome.
- Most crashes occurred at an intersection (n=36), including 9 of the 11 KSI crashes.
- Most KSI crashes occurred at signalized intersection (7 of 11 KSI crashes).
- Failure to stop at a stop sign was the most common reported violation type (8 total crashes; 1 KSI crash), followed by unsafe speed (7 total crashes; 4 KSI crashes).
- Perpendicular crashes that involved the bicyclist and motorist proceeding straight accounted for the largest share of crashes (14 total crashes; 3 KSI crashes).
- Nearly half of the KSI crashes (n=5) occurred during dark lighting conditions.
- Half of the overall crashes (n=23) and most of the KSI crashes (n=7) occurred along the HIN.
- Most crashes occurred at or along an arterial (25 total crashes; 9 KSI crashes).
- Most crashes (n=19) and KSI crashes (n=5) occurred at or along a street with four vehicle lanes.
- Eight of the 11 KSI crashes occurred at or along streets with a posted speed limit of 30 mph or higher.

Excelsior

- 28 total crashes, 1 KSI crash.
- 3.6% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=21). The one KSI crash was midblock.
- Intersections with a stop sign accounted for most crashes (12 crashes).
- Failure to stop as a stop sign was the most common reported violation type (5 crashes) followed by unsafe speed (4 crashes).
- Perpendicular crashes that involved the bicyclist and motorist proceeding straight accounted for the largest share of crashes (6 crashes).
- 22 of the 28 crashes occurred during daylight conditions.
- Slightly more than half of the crashes occurred along the HIN (15 crashes).
- Nearly half of the crashes occurred at or along an arterial (13 crashes) .
- Most crashes (n=16) occurred at or along a street with four vehicle lanes.

[8] Crashes that are located along the boundary of two EPCs were assigned to both EPCs and summarized in this table in the following section. The crash frequencies in this section should not be aggregated to create a "grand total" as some of these crashes are assigned to multiple EPCs. A 50 foot threshold was used as part of the EPC focus community analysis process.

- 23 of the 28 crashes occurred at or along streets with a posted speed limit of 25 mph.

Mission

- 232 crashes, 12 KSI crashes.
- 5.2% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=194), including 11 of the 12 KSI crashes.
- The most common reported violation type was unsafe turn or lane change (42 total crashes; 2 KSI crashes) followed by disregard red signal (22 total crashes; 0 KSI crashes) and dooring (21 total crashes; 1 KSI crash).
- Unlike citywide trends, most crashes involved both the driver and bicyclist traveling in the same direction (105 total crashes; 5 KSI crashes).
- Perpendicular crash with both the bicyclist and driver proceeding straight was the most common crash type (26 total crashes; 1 KSI crash) followed by same direction with the bicyclist proceeding straight and the motorists making a right turn ("right hook", 23 crashes; 2 KSI crashes) and same direction with both the driver and bicyclists proceeding straight (19 crashes and 2 KSI crashes).
- Most crashes (n=201) and KSI crashes (n=10) occurred at or along the HIN.
- Most crashes (n=108) and three quarters of KSI crashes (n=7) occurred at or along a street with four vehicle lanes.
- All 232 crashes (severe and non) occurred along a street speed limit of 25 mph or less.

Soma

- 279 total crashes and 23 KSI crashes.
- 8.2% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=238), including 20 of the 23 KSI crashes.
- Just over half of the reported crashes (n=165) and KSI crashes (n=14) were at signalized intersections.
- Unsafe turn or lane change was the most common reported violation (50 total crashes; 3 KSI crashes) followed by disregard unsafe speed (36 total crashes; 4 KSI crashes) and disregard red signal (31 total crashes; 3 KSI crashes).
- Same direction of travel between the driver and bicyclist was the most common crash type (108 total crashes; 5 KSI crashes) followed by perpendicular direction (96 total crashes; 9 KSI crashes).
- Perpendicular crashes involving both the driver and bicyclist proceeding straight was the most common crash type (11 total crashes; 4 KSI crashes).
- Most crashes (262 of 279 total crashes) and all 23 KSI crashes occurred along the HIN.
- Almost half of all crashes (n=135) and most KSI crashes (n=13) occurred at or along a street with four vehicle lanes.
- Most crashes (n=250), including most of the KSI crashes (n=19), occurred along streets with a posted speed limit of 25 mph.

Tenderloin

- 243 total crashes and 26 KSI crashes.
- 10.7% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=213), including 23 of the 26 KSI crashes.
- Unsafe speed was the most common reported violation (45 total crashes; 8 KSI crashes) followed by disregard red signal (34 total crashes; 4 KSI crashes) and unsafe turn or lane change (32 total crashes; 1 KSI crash).
- Perpendicular direction of travel between the driver and bicyclist was the most common crash type (86 total crashes; 10 KSI crashes) followed by same direction (83 total crashes; 4 KSI crashes).
- Perpendicular crashes involving both the driver and bicyclist proceeding straight was the most common crash type (29 total crashes; 5 KSI crashes).

- 16.5% of the reported total crashes and 30.8% of KSI crashes in the Tenderloin EPC were solo bicyclist crashes, which is higher than the other EPC neighborhoods and citywide trends.
- Nearly all crashes (240 of 243 total crashes) and all 26 KSI crashes occurred along the HIN.
- Crashes (n=104) and KSI crashes (n=11) occurred most frequently at or along a street with three vehicle lanes.
- 238 crashes, including 24 of the 26 KSI crashes, occurred along streets with a posted speed limit of 25 mph or less.

Western Addition

- 117 total crashes and 8 KSI crashes.
- 6.8% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=95), including all 8 KSI crashes. 84 of those 95 crashes and all 8 KSI crashes were at signalized intersections.
- Unsafe turn or lane change was the most common reported violation (18 total crashes; 0 KSI crashes) followed by unsafe speed (15 total crashes; 0 KSI crashes) and disregard red signal (13 total crashes; 3 KSI crashes).
- Unlike citywide trends, crashes that involved both the driver and bicyclist traveling in the same direction accounted for the largest share of crashes (48 total crashes; 2 KSI crashes) followed by perpendicular (36 total crashes; 5 KSI crashes).
- Almost half of all crashes (44.4%) occurred at or along a street with two vehicle lanes. KSI crashes (n=4) occurred most often at or along streets with five or more vehicle lanes.
- 85 of the 117 crashes occurred along street with a posted speed limit of 25 mph; half of the KSI crashes occurred along street with 30 mph or higher.

Location-Movement Crash Typing

Location-movement crash types were developed as part of this analysis to help us understand the specific dynamics that contributed to bicyclist-motorists crashes. Solo-bicyclist and bicyclist-pedestrians are excluded from this section of the analysis given the low sample sizes and different dynamics compared to crashes involving bicyclists and motorists. The relative direction and pre-crash movements (analyzed during the Step I analysis) are in Appendix B: Relative Direction and Pre-Crash Movements for reference.

The top 15 location-movement crash types are summarized in Table 51 for crashes that involved a bicyclists and motorist during the 5-year study period. Roughly two-thirds of crashes, KSI crashes, and EPDO scores are accounted for within the top 15 crashes (there are 120 distinct location-movement crash types).

The **intersection – perpendicular – bike proceeding straight, MV proceeding straight** crash type accounted for the largest share of overall crashes (14.9%) and KSI crashes (21.8%). These crashes also tended to more severe than many other crash types with 12% of crashes resulting in a KSI and having an average EPDO score of 24. Most crashes occurred at signalized intersection (60.8% crashes; 69.4% KSI crashes) and were most had a contributing factor cited as disregarded red signal both overall crashes and KSI crashes. Of the crashes within this crash type, most occurred at an intersection with the highest functional class as a collector (36.5% of crashes), but the majority of KSI crashes occurred at intersections with an arterial (41.7% KSI crashes). Interestingly, most crashes occurred at intersections with the lowest functional classification was a residential street (80.4% crashes; 75% KSI crashes). Looking at highest and lowest functional classification collector-residential pairs accounted for the largest share of KSI crashes (27.8%) followed by residential-residential (25%) and arterial-residential (19.4%). Crashes that occurred at higher functional classifications were on average more severe than residential crashes, which is likely due to higher vehicle speed along higher functional classifications.

The **intersection – perpendicular – bike proceeding straight, MV making left turn** accounted for the second largest share of crashes (6.4%) and KSI crashes (6.1%). The distribution of KSI crashes is nearly a quarter of the share of KSI crashes than the first location-movement crash type, highlighting the severity of that crash type.

This pattern may suggest the frequencies of intersection between perpendicular bicyclists and motorists who are both proceeding straight are a critical issue. Similar to the previous crash type, most crashes occurred at signalized intersections (58.9% crashes; 80% KSI crashes). The most common reported violation type involved a motorist violating the bicyclist's right of way while making the left turn (46.5% of crashes). Most crashes occurred at residential-residential streets (32.6% crashes; only one KSI crash) followed by collector-residential intersections (26.4% crashes; only one KSI crash). Arterial-residential crashes accounted for the third share of crashes (19.4%) but also accounted for half of the KSI crashes (n=5) that occurred for this crash type.

The third most common location-movement crash type was **intersection – same – bike proceeding straight, MV making right turn** accounted for 6.2% of crashes and 4.2% of KSI crashes. These crashes tend to be less severe than other crash types with 5.6% of crashes resulting in a KSI outcome and having an average EPDO score of 16. Most crashes had a reported violation as unsafe turn or lane change (53.2%) followed by unsafe speed (7.9%). Crashes for this crash type generally occurred at arterial intersections with 41.3% of crashes having occurred at an arterial intersection and 37.3% at a collector.

Table 51: Location-Movement crash types for bicyclist-motorist crashes, 2017-2021

Location-Movement Crash Types	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
intersection - Perpendicular - Bike Proceeding Straight, MV Proceeding Straight	301	14.9%	36	21.8%	7,235	18.5%	12.0%	24.0
intersection - Perpendicular - Bike Proceeding Straight, MV Making Left Turn	129	6.4%	10	6.1%	2,300	5.9%	7.8%	17.8
intersection - Same - Bike Proceeding Straight, MV Making Right Turn	126	6.2%	7	4.2%	2,016	5.1%	5.6%	16.0
intersection - Opposite - Bike Proceeding Straight, MV Making Left Turn	118	5.8%	10	6.1%	2,233	5.7%	8.5%	18.9
intersection - Same - Bike Proceeding Straight, MV Proceeding Straight	108	5.3%	5	3.0%	1,527	3.9%	4.6%	14.1
intersection - Perpendicular - Bike Proceeding Straight, MV Making Right Turn	100	4.9%	4	2.4%	1,328	3.4%	4.0%	13.3
intersection - Same - Other	91	4.5%	6	3.6%	1,473	3.8%	6.6%	16.2
intersection - Same - Bike Proceeding Straight, MV Stopped	67	3.3%	9	5.5%	1,655	4.2%	13.4%	24.7
intersection - Perpendicular - Other	54	2.7%	5	3.0%	1,118	2.9%	9.3%	20.7
mid-block - Same - Other	50	2.5%	3	1.8%	878	2.2%	6.0%	17.6
mid-block - Same - Bike Proceeding Straight, MV Stopped	37	1.8%	4	2.4%	940	2.4%	10.8%	25.4
mid-block - Same - Bike Proceeding Straight, MV Proceeding Straight	37	1.8%	2	1.2%	635	1.6%	5.4%	17.2
intersection - Perpendicular - Bike Making Left Turn, MV Proceeding Straight	34	1.7%	3	1.8%	622	1.6%	8.8%	18.3
intersection - Same - Bike Proceeding Straight, MV Parked	29	1.4%	4	2.4%	909	2.3%	13.8%	31.3
intersection - Same - Bike Proceeding Straight, MV Changing Lanes	25	1.2%	1	0.6%	339	0.9%	4.0%	13.6
Not Top 15	*715*	*35.4%*	*56*	*33.9%*	*13,993*	*35.7%*	*7.8%*	*19.6*
Total	***2,021***	***100.0%***	***165***	***100.0%***	***39,201***	***100.0%***	***8.2%***	***19.4***

External Data and Analysis

The research team also looked at data analysis from the San Francisco Department of Public Health (SFDPH) and the USDOT Safer Streets Priority Finder (SSPF) to complement the data analysis presented above. Key findings from those analyses follow below.

San Francisco Department of Public Health

Among the many services the SFDPH provides to the city, their use of a trained epidemiologist to evaluate crashes from trauma centers relative to police-reported crash data provides an unparalleled understanding both of the degree of misclassification of injuries within the San Francisco Police Department (SFPD) data and the degree to which bicyclist crashes are underreported in the SFPD data. Due to HIPAA concerns, the research team lacked access to any detailed data for this comparison. However, high-level statistics from SFDPH suggest the following:

1. Most neighborhoods have a relatively low ratio of trauma center injuries compared to the count of SFPD injuries for the years 2017-2021. The Presidio is a clear exception in this area, given that the SFMTA and SFPD do not have jurisdiction over that area, but people injured there may still use the trauma services at ZSFG. Outside of the Presidio, the highest ratios occur in Presidio Heights, Bayview Hunters Point, Potrero Hill, and Castro/Upper Market (see Table 57 in Appendix C). The higher ratios are particularly concerning for Bayview Hunters Point and Castro/Upper Market, given their higher number of crashes overall.
2. Solo crashes are a significant problem in the city, despite appearing less frequently in the SFPD data (49% of all crashes in the SFDPH analysis, 82% of which were not linked to SFPD crashes). Paying particular attention to findings from this analysis relative to solo crashes may help ensure that these crashes are sufficiently addressed. However, the SFMTA may consider additional research specifically into solo crash dynamics through SFDPH to help clarify the extent to which solo crashes in SFPD data represent the larger population of solo crashes.
3. The difficulty of assessing injury severity at the scene results in misclassification of injury levels. Therefore, while it is critically important to focus on KSI crashes to aim to reduce the most harm in the city, it remains important to understand and address patterns of minor and moderate injury crashes, as well.

Safer Streets Priority Finder

The Safe Streets Priority Finder (SSPF)[9] was also used as a method to estimate bicycle crash risk. The SSPF is an open source too that analyzes crash data, network data, and the USDOT Pedestrian Fatality Risk Pilot data using a Bayesian statistical framework to estimate risk values across a street network for bicyclists and pedestrians separately. The general framework of the SSPF is displayed in Figure 1. For this project, the tool was only used to estimate bicycle crash within San Francisco.

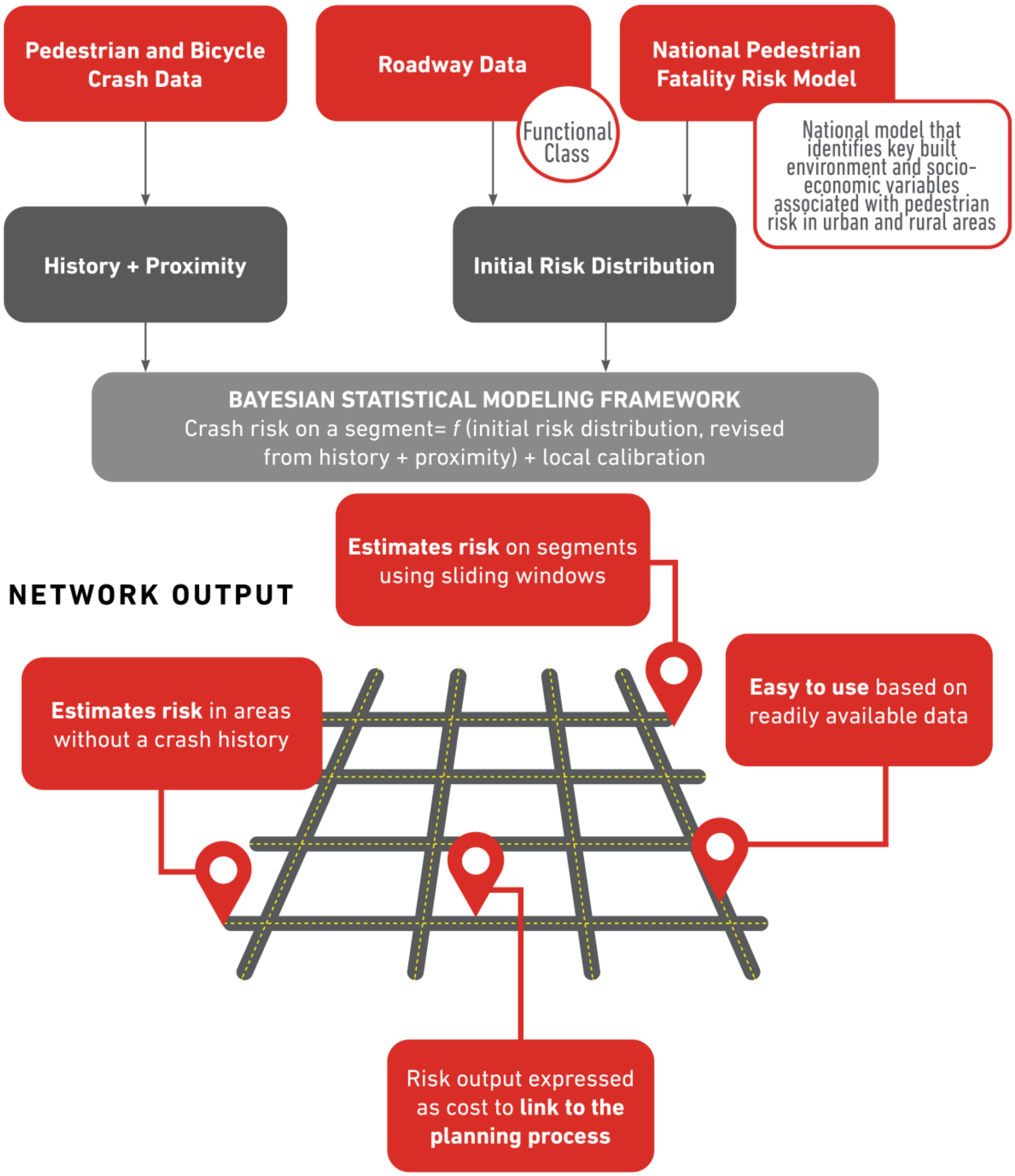


Figure 1: SSPF Framework. Image Source: https://www.saferstreetspriorityfinder.com

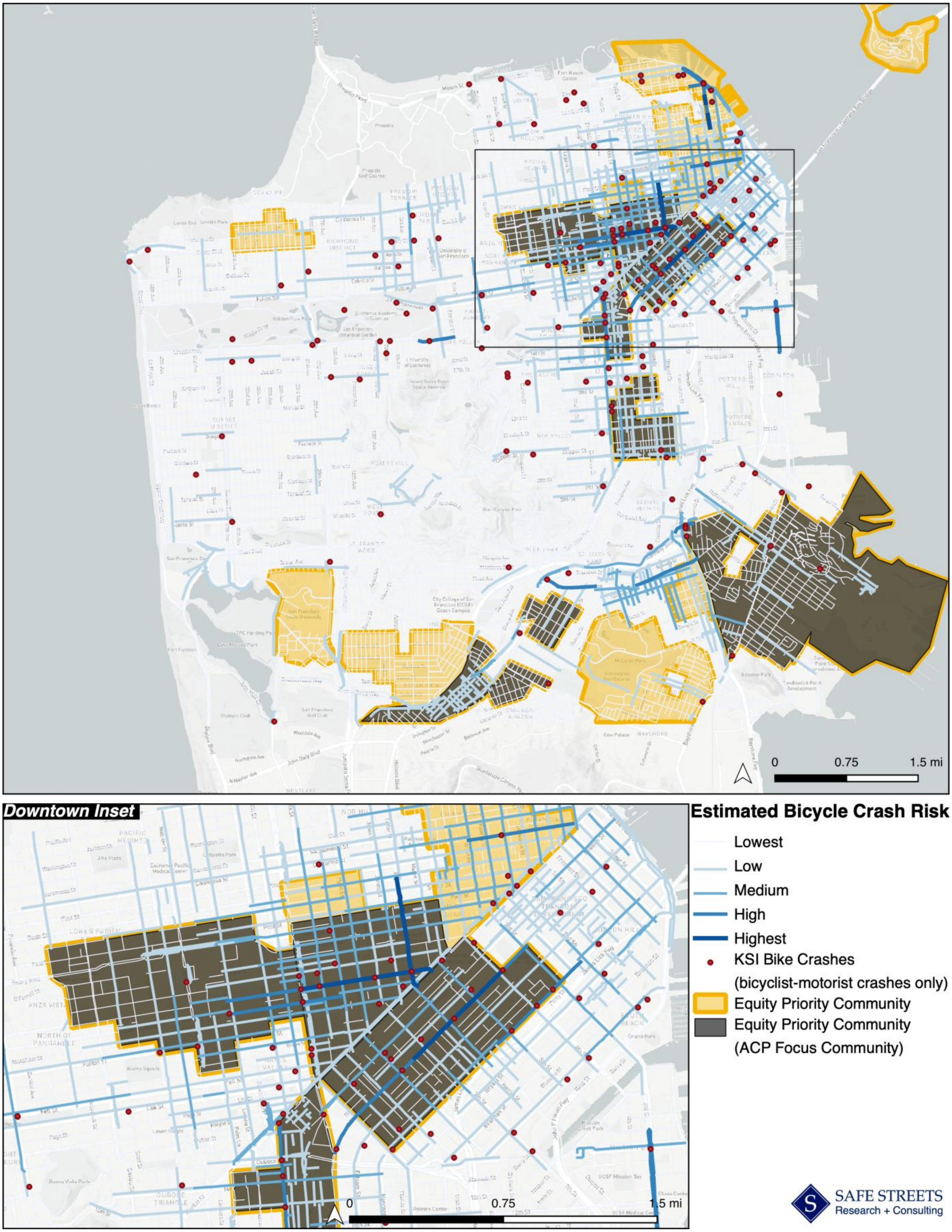
[9] https://www.saferstreetspriorityfinder.com/

The bicyclist Safe Street Model outputs from the SSPF are displayed in Map 14. The following streets had relatively high estimates of crash risk. Note: the street limits assigned to each street below are general limits to help provide some context when reviewing the results.

- **Howard St** from Van Ness Ave to 3rd St
- **Turk St** from Laguna St to Market St
- **Taylor St** from Market St to Bush St
- **Sansome St** from Broad Way to the Embarcadero (not along HIN)
- **Silver Ave** from Alemany Blvd to Madison St (not along HIN) and Princeton St to Barneveld Ave
- **3rd St** from Mariposa St to China Basin St (not along HIN)
- **Valencia St** from 7th St to Market St

Many of these higher scoring corridors are located in areas of the city that generally have higher bicycle and motor vehicle volumes, such as the Financial District, SOMA, Mission, Tenderloin, Western Addition, and North Beach. The crash risk estimates are not adjusted for those volumes. Interestingly, many of the highest scoring corridors are within EPCs, whereas much of the western and central portions of the San Francisco have very low score streets. This correlation may reflect generally higher population densities and exposure within EPCs, but it may also reflect other risk factors that contribute to both the community being classified as an EPC and having a higher estimated crash risk score from the SSPF. The outputs from the SSPF align with the HIN in that most of the highest-scored streets from the SSPF analysis are along the HIN. In fact, when looking at non-residential streets, the median estimated SSPF crash risk estimates are roughly twice as high along the HIN than segments off the HIN, indicating that the HIN is predicting higher-risk segments in line with more advanced Bayesian statistical principles.

Map 14: Estimated Bicycle Crash Risk using the SSPF Tool, 2017-2021



Conclusion

This document summarized the results of a systemic safety analysis that explored roadway, land use, and behavioral factors related to bicycle crashes within San Francisco between 2017-2021. The findings of this analysis will be used to inform the network development task of the SFMTA ACP.

Key findings include that intersections are consistently the locations of the most bicyclist crashes and specifically KSI crashes. Signalized intersections, in particular, are associated with motorist-bicyclist crashes and KSI crashes, an expected finding given that signalized intersections also tend to carry higher amounts of motor vehicle traffic and to be located on streets with more lanes – all risk factors for crashes and injury severity. Continued work to address intersection safety, including through reducing motor vehicle traffic and speed, as well as separating bicyclist and motorist movements in space (e.g., via infrastructure) and time (e.g., via signals) can help reduce the number and severity of these conflicts.

Bicycle facilities, especially those with greater separation from motorists (e.g., Class IV and Class II compared to Class III) appear to be positively associated with bicyclist safety *when a crash occurs*. While we lacked the exposure data to fully control for bicyclist crash rates, these findings are further supported by research and volume estimates from San Francisco showing that people prefer riding with greater separation and that bicyclist volumes tend to be higher along these facilities. The fact that midblock crashes tended to be more severe than intersection crashes, despite being less prevalent, further supports the need for bicycle facilities to improve bicycling safety in the city.

There is a clear correlation between Equity Priority Communities, the HIN, and bicycle crashes and crash severity, underscoring a need for greater investment in street safety for the EPCs. The HIN continues to be a helpful tool for highlighting where bicycle safety improvements are needed throughout the city. Further prioritization within the HIN can be accomplished via an examination of risk factors like functional class and number of lanes, which are general proxies for higher vehicle volumes and often higher prevailing speeds. Bus stops, which are generally correlated with higher activity levels and therefore complexity, were also positively associated with bicycle crashes.

While a more detailed analysis is needed before deciding on countermeasures for specific locations, these findings provide a broad understanding of bicycle safety and risk factors in the city, setting up the next phases of the work in a data-driven manner.

Appendix A: Network Data QC

The intersection and centerline data used in this analysis is the same data used in other tasks in the Active Communities Plan. Additional variables have been calculated as part of this analysis. Some intersection and centerline features have been omitted form this analysis as part of the data quality control process. Those instances are noted in this section.

Dual carriageways mileage

Most sections of this analysis the summarize crash frequencies by specific network characteristics that are normalized by the network mileage to help us better understand potential crash risk. Some major streets in San Francisco are represented as dual carriageways in the GIS data. Dual carriageways representing a single street with two lines, rather than one line, which would artificially reduce the estimate risk estimates as the network mileage is roughly twice the actual length for dual carriageways. To control for these network segments being represented by two features, the average length is used for each dual carriageway feature. The image below illustrates how a dual carriageway is represented by two separate network features.

Figure 2: Example of dual carriageway

Number of lanes at/along dual carriageways

The number of lanes was recalculated for both intersections and network segments to account for dual carriageway. Currently, dual carriageways are represented by two separate links in the network data and coded as one-way streets. For the purposes of this analysis, dual carriageways are treated as two-way streets and the number of lanes were aggregated to represents the total number of lanes along each block and at each intersection. If dual carriageways are not accounted in the network data using this approach, both legs at this intersection (Geary Blvd and 33rd Ave) would have the same number of lanes in the intersection data and the network segment data (2 lanes) and thereby not accurately representing the design differences between each intersecting street. See the images below showing the existing conditions of this intersection.

Figure 3: Google Street View images displaying the number of lanes at dual carriageway intersections

One-Way Streets

Errors related to the presence of one-way streets was observed in the network segment data (oneway_yn) and in the intersection data (mix_way_yn and all_one_way_yn). These errors were discovered through an aggregation process in which the number of one-way legs were counted at each intersection, which did not universally match the mix_way_yn and all_one_way_yn attributes. A review of network data values, aerial imagery, and Google Street View found most of these discrepancies are along residential streets, some of which may be an issue related to residential dual carriageways. The image below illustrates some of these potential data errors:

- **Yellow Lines** = one-way street according to TransBASE
- **Red Dots** = intersections where mix_way_yn = 'Yes'

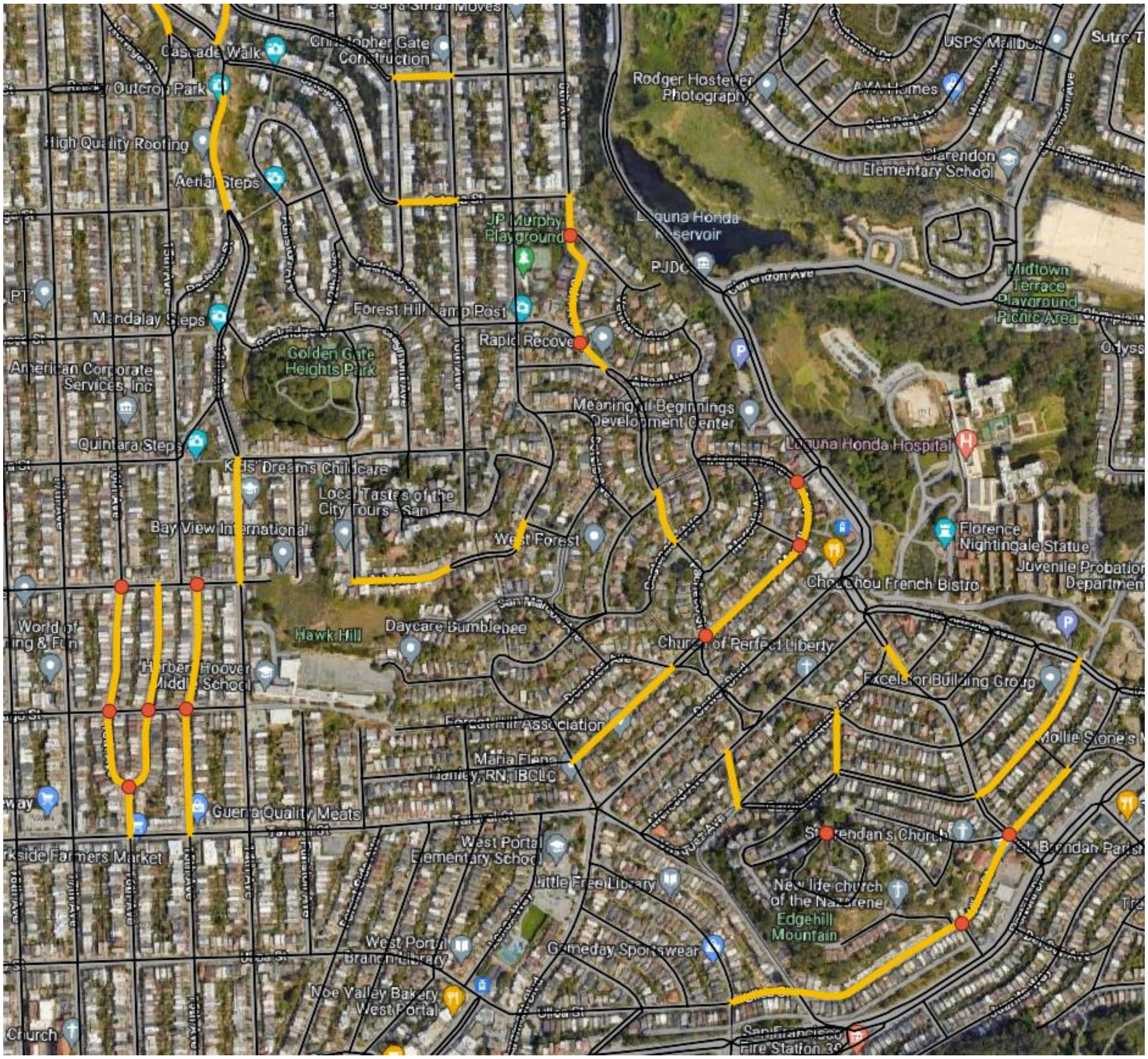


Figure 4: Example issues with one-way street classifications

Excluding Streets and Intersections

Private streets, pedestrian streets, stairs, and streets and intersections within NPS jurisdiction have been removed from the analysis. The decision to exclude streets and intersections within NPS jurisdictions was made due to SFMTA not having jurisdiction within those areas and do not maintain crash data.

To build a better understanding of crash risk within the City of San Francisco, SFMTA may consider supplementing their crash data with crash data that are located within these areas. While SFMTA does not have jurisdiction within those areas, it will help paint a better picture of crash risk within the city and inform a future systemic safety analysis.

Pseudo Intersections

Intersections between dead-end street and a typical through street are present in some locations of the city. The image below visualizes this particular type of pseudo intersection. The red box is an area in which Glendale St and Corbett Ave do not connect (excludes stairs). Other pseudo intersections include points that do not touch a network link. Most of these locations are near or along the Interstate or near/within Hunters Point. Lastly, intersection points that have fewer than three legs have been removed as these are often dead-ends, cul-de-sacs, or points where a network link is split at a non-intersection location.

Figure 5: Example where network GIS data incorrectly represent two intersecting streets.

Street and Intersection ID in crash data

The intersection ID in the crash data (*cnn_intrsctn_fkey*) has roughly 200 crashes that have an error in the intersection ID. The intersection ID should be an integer, but several are numeric with roughly 8 decimal places. These instances have been properly converted to the correct integer data type and value. After removing decimals and converting the data type to an integer, there were 159 crashes that are within 75 feet on the nearest intersection with a *cnn_intrsctn_pkey* (ID in the intersection data) that does not match the *cnn_intrsctn_fkey* in the collision data (13 severe, 71 injury (other visible), and 75 injury (complaint of pain) crashes). These have been correctly and assign the nearest intersection ID.

The segment id in the crash data (cnn_sgmt_fkey) has many errors and do not match the segment id (sgmt_infrstcr_pkey) in the centerline data. For non-intersection crashes, all crashes have been assigned the centerline ID of the centerline feature closest to the crash.

Posted Speed Limit

There are Null or 9999 posted speed limit values for all of Treasure Island, some neighborhood streets, several streets in Mission Bay, and some network links near the Interstate or highway ramps. Residential NULL speed limit values have been replaced with 25mph

Appendix B: Relative Direction and Pre-Crash Movements

The following tables were summarized in the Step I crash analysis for the pre-pandemic and pandemic study periods separately. These tables are included here for reference but for the 5-year study period.

Table 52: Relative Direction of Travel between Bicyclist and Motorists, 2017-2021

Relative Direction (Bicyclist and Motorist Crashes Only)	# Crashes	% Crashes	# KSI	% KSI	# EPDO	% EPDO	% Crashes resulting in KSI	Avg. EPDO
Perpendicular	769	38.1%	70	42.4%	15,494	39.5%	9.1%	20.1
Same	868	42.9%	61	37.0%	15,793	40.3%	7.0%	18.2
Opposite	266	13.2%	20	12.1%	5,047	12.9%	7.5%	19.0
Unknown	115	5.7%	14	8.5%	2,838	7.2%	12.2%	24.7
Missing one party direction	3	0.1%	0	0.0%	27	0.1%	0.0%	9.1
Total	***2,021***	***100.0%***	***165***	***100.0%***	***39,201***	***100.0%***	***8.2%***	***19.4***

Table 53: Pre-crash movements between Bicyclist and Motorists, 2017-2021

Bicyclist + Motorists Pre-Crash Movement	# Crashes	% Crashes	# KSI	% KSI	# EPDO	% EPDO	% Crashes resulting in KSI	Avg. EPDO
Bike Proceeding Straight, MV Proceeding Straight	495	24.5%	49	29.7%	10,684	27.3%	9.9%	21.6
Bike Proceeding Straight, MV Making Left Turn	320	15.8%	24	14.5%	5,727	14.6%	7.5%	17.9
Other	255	12.6%	19	11.5%	4,663	11.9%	7.5%	18.3
Bike Proceeding Straight, MV Stopped	147	7.3%	16	9.7%	3,333	8.5%	10.9%	22.7
Bike Proceeding Straight, MV Making Right Turn	283	14.0%	15	9.1%	4,404	11.2%	5.3%	15.6
Bike Making Left Turn, MV Proceeding Straight	70	3.5%	6	3.6%	1,361	3.5%	8.6%	19.4
Bike Proceeding Straight, MV Parked	62	3.1%	6	3.6%	1,515	3.9%	9.7%	24.4
Bike Entering Traffic, MV Proceeding Straight	19	0.9%	5	3.0%	817	2.1%	26.3%	43.0
Bike Proceeding Straight, MV Parking Maneuver	38	1.9%	4	2.4%	959	2.4%	10.5%	25.2
Bike Proceeding Straight, MV Entering Traffic	45	2.2%	4	2.4%	907	2.3%	8.9%	20.2
Bike Making Right Turn, MV Proceeding Straight	33	1.6%	3	1.8%	661	1.7%	9.1%	20.0
Bike Proceeding Straight, MV Other	14	0.7%	3	1.8%	708	1.8%	21.4%	50.6
Bike Not Stated, MV Not Stated	26	1.3%	2	1.2%	441	1.1%	7.7%	17.0
Bike Proceeding Straight, MV Slowing/Stopping	20	1.0%	2	1.2%	516	1.3%	10.0%	25.8
Bike Proceeding Straight, MV Changing Lanes	42	2.1%	2	1.2%	655	1.7%	4.8%	15.6
Bike Changing Lanes, MV Proceeding Straight	24	1.2%	2	1.2%	424	1.1%	8.3%	17.7
Bike Proceeding Straight, MV Making U Turn	58	2.9%	2	1.2%	791	2.0%	3.5%	13.6
Bike Traveling Wrong Way, MV Proceeding Straight	14	0.7%	1	0.6%	213	0.5%	7.1%	15.2
Bike Proceeding Straight, MV Backing	14	0.7%	0	0.0%	113	0.3%	0.0%	8.1
Bike Stopped, MV Proceeding Straight	28	1.4%	0	0.0%	203	0.5%	0.0%	7.2
Bike Stopped, MV Stopped	14	0.7%	0	0.0%	104	0.3%	0.0%	7.4
Total	***2,021***	***100.0%***	***165***	***100.0%***	***39,201***	***100.0%***	***8.2%***	***19.4***

Appendix C: San Francisco Department of Public Health Bicyclist Injury Summary

The following content was produced by the San Francisco Department of Public Health. The content has been formatted to match the format used throughout this document.

Summary Injury Statistics from Trauma Registry Data for Bicyclists

The current use of police collision reporting alone for transportation injury surveillance underrepresents injury to vulnerable groups, including pedestrians, cyclists, and people of color, due to differing reporting patterns and non-clinicians challenge in accurately evaluating injury severity[10]. To address this, incorporating hospital and EMS spatial data into injury surveillance systems that are historically reliant on police reports offers a trifold benefit by capturing injuries absent in police data, thus improving injury severity assessment, and informing interventions serving injury burdened populations and road users.

The San Francisco Department of Public Health and the Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG) are working to maintain a comprehensive Transportation related Injury Surveillance System (TISS) to conduct accurate, coordinated, and timely monitoring of transportation-related injuries and deaths in support of safety project prioritization, evaluation, and monitoring for the City's Vision Zero policy[11].

This system gathers and links existing transportation-related injury and fatality data collected by City and County of San Francisco agencies into a comprehensive database to provide a more complete picture of transportation-related injuries occurring in the city. The creation of this data system vastly expands the City's capacity to understand the geographic distribution, causes, costs, and consequences of transportation-related injuries in San Francisco, and provide data to inform Vision Zero's coordinated efforts to reduce preventable injuries and eliminate deaths on the city's streets.

The first (2013-2015) and second (2016-2021) versions of TISS used LinkSolv software to probabilistically link a SFPD reported traffic injury victim to a ZSFG patient record using several variables including: time of collision/time admitted to ZSFG, victim name/patient name, victim mode of travel mode/international classification of disease (ICD) v.10 E code, collision location, etc. Records can be either be matched (linked) or unmatched (unlinked) in each dataset. Linked records are found in both datasets, while unlinked records are found only in their source dataset. SFDPH is currently investigating alternatives to data record linkage with the ending of support for LinkSolv in 2021.

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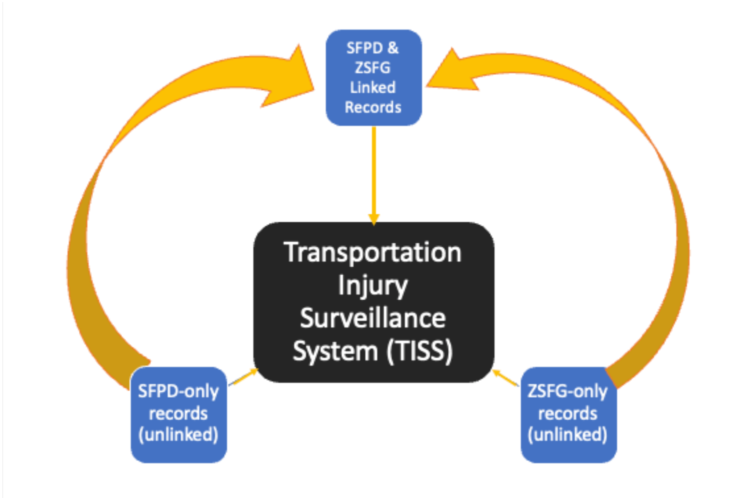
[10] Shamsi Soltani, Leilani Schwarcz, Devan Morris, Rebecca Plevin, Rochelle Dicker, Catherine Juillard, Adaobi Nwabuo, Megan Wier,
What is counted counts: An innovative linkage of police, hospital, and spatial data for transportation injury prevention, Journal of Safety Research, Volume 83, 2022, Pages 35-44, ISSN 0022-4375, https://doi.org/10.1016/j.jsr.2022.08.002. (https://www.sciencedirect.com/science/article/pii/S0022437522001074)

[11] San Francisco Department of Public Health. (2015). San Francisco's Transportation-related Injury Surveillance System: A Centralized, Comprehensive Citywide Injury Data Resource for Vision Zero. Retrieved from https://www.sfdph.org/dph/files/EHSdocs/PHES/VisionZero/Transportation_Injury_Surveillance.pdf (Last accessed: 4/20/2023).



All unintentional linked and ZSFG Trauma Registry and Emergency Department - only victims (of any severity), including ungeocoded cases, where the injury occurred in San Francisco are included. This may encompass cyclist injury crashes in the Presidio, Fort Mason, freeway ramps, and other locations not typically covered by the San Francisco Police Department.

Linked and ZSFG Unlinked Unintentional Cyclist Injuries

Error! Reference source not found. presents data on unintentional cyclist injuries seen at ZSFG's trauma registry o r emergency department in San Francisco. The injuries are categorized as "Linked" and "Not Linked," based on whether they could be linked to a victim in a SFPD crash report or not. Overall, 54% (407) of the cyclist injuries were linked to an SFPD crash report, while 46% (352) were not. The data suggests that a significant proportion of cyclist injuries in San Francisco can be linked to crash reports, providing valuable information for understanding medical outcomes related to cycling safety in the city. However, a notable percentage of cases remain unlinked, indicating potential gaps in relying only on crash reports generated solely by the police.

Table 54: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries

Link Status	2017-2019	Percent	2020-2021	Percent	Total	Percent
Linked Report	271	53%	136	54%	407	54%
Not Linked	236	47%	116	46%	352	46%

ICD-10 e-code with cyclist injury

Table 55 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by ICD-10 E-codes, solo bicyclist status, and time period (2017-2019 and 2020-2021). Note that V19.40XA and V.18.4XXA were not used by EMS in their pre-patient care reports for 2020 and 2021, and more specific codes were used instead.

- The most common injury type in both time periods was related to pedal cycle drivers injured in collisions with cars, pick-up trucks, or vans in traffic accidents (V13.4XXA). This category represented 37% of the cases in 2017-2019 and 45% of the cases in 2020-2021.
- Injuries involving solo bicyclists in non-collision transport accidents in traffic accidents (V18.4XXA) accounted for 27% of the cases in 2017-2019 and 42% in 2020-2021.

- The percentage of pedal cycle drivers injured in collisions with unspecified motor vehicles in traffic accidents (V19.40XA) dropped from 8% in 2017-2019 to unreportable in 2020-2021, likely due to the change in EMS pre-patient care reporting.

Table 55: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injury ICD-10 E-codes

E-Code 10	ICD-10 E-code Description	Solo Bicyclist	2017-2019	Pct	2020-2021	Pct	Total	Pct
V13.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	190	37%	115	45%	305	40%
V18.4XXA	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	136	27%	107	42%	243	32%
V19.40XA~	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH UNSPECIFIED MOTOR VEHICLES IN	No	43	8%	< 5	--	43	6%
V18.4XXA~	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN TRAFFIC AC	Yes	42	8%	< 5	--	42	6%
V17.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH FIXED OR STATIONARY OBJECT IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	16	3%	13	5%	29	4%
V13.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN IN T	No	15	3%	< 5	--	15	2%
V11.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH OTHER PEDAL CYCLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	11	2%	< 5	--	15	2%
V19.40XA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH UNSPECIFIED MOTOR VEHICLES IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	11	2%	< 5	--	11	1%
V14.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH HEAVY TRANSPORT VEHICLE OR BUS IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	6	1%	< 5	--	6	1%
V17.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH FIXED OR STATIONARY OBJECT IN	Yes	6	1%	< 5	--	6	1%
V19.9XXA	PEDAL CYCLIST (DRIVER) (PASSENGER) INJURED IN UNSPECIFIED TRAFFIC ACCIDENT,	Ambiguous	6	1%	< 5	--	6	1%
V12.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH TWO- OR THREE-WHEELED MOTOR	No	5	1%	5	2%	10	1%

E-Code 10	ICD-10 E-code Description	Solo Bicyclist	2017-2019	Pct	2020-2021	Pct	Total	Pct
	VEHICLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER							
V13.5XXA	PEDAL CYCLE PASSENGER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	5	1%
V18.0XXA	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN NONTRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	< 5	--	< 5	--	5	1%
V14.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH HEAVY TRANSPORT VEHICLE OR BUS	No	< 5	--	< 5	--	< 5	--
V19.9XXA	PEDAL CYCLIST (DRIVER) (PASSENGER) INJURED IN UNSPECIFIED TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Ambiguous	< 5	--	< 5	--	< 5	--
V10.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH PEDESTRIAN OR ANIMAL IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	< 5	--
V11.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH OTHER PEDAL CYCLE IN TRAFFIC A	No	< 5	--	< 5	--	< 5	--
V13.5XXA	PEDAL CYCLE PASSENGER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN I	No	< 5	--	< 5	--	< 5	--
V15.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH RAILWAY TRAIN OR RAILWAY VEHICLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	< 5	--
V16.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH OTHER NONMOTOR VEHICLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	< 5	--
V17.0XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH FIXED OR STATIONARY OBJECT IN NONTRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	< 5	--	< 5	--	< 5	--
V18.0XXA	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN NONTRAFFIC	Yes	< 5	--	< 5	--	< 5	--
V18.5XXA	PEDAL CYCLE PASSENGER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	< 5	--	< 5	--	< 5	--

E-Code 10	ICD-10 E-code Description	Solo Bicyclist	2017-2019	Pct	2020-2021	Pct	Total	Pct
V14.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH HEAVY ENCOUNTER TRANSPORT VEHICLE OR BUS IN TRAFFIC ACCIDENT, INITIAL	No	< 5	--	< 5	--	< 5	--
V19.88XA	PEDAL CYCLIST (DRIVER) (PASSENGER) INJURED IN OTHER SPECIFIED TRANSPORT ACCIDENTS, INITIAL ENCOUNTER	Ambiguous	< 5	--	< 5	--	< 5	--

*One cyclist is repeated since they have more than one bicycle crash related e-code

~Starting in 2020 more specific codes were used instead of V19.40XA and V18.4XXA

ICD-10 e-code (comparison of solo-bicyclist injury crashes and linkage)

Table 56 presents data on crash types involving solo-bicyclists and those with vehicles involved, comparing linked and unlinked cases between two time periods, 2017-2019 and 2020-2021. Solo- bicyclists crashes were classified based on the code description with assistance from trauma registry staff.

- In both time periods, a significant percentage of solo-bicyclists crashes were found only in the ZSFG (Unlinked) data: 69% in 2017-2019 and 82% in 2020-2021.
- This finding suggests that police may not be called to crashes where no vehicle was involved, as these solo-bicyclists crashes were not linked to police reports.
- The total proportion of solo-bicyclists crashes increased from 41% in 2017-2019 to 49% in 2020-2021, while crashes involving vehicles decreased from 58% to 51% in the same periods.

Table 56: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries, Solo and Vehicle Involved Crashes Based on ICD-10 E-code

Crash Type	Linked				Unlinked				Total			
	2017-2019	Percent	2020-2021	Percent	2017-2019	Percent	2020-2021	Percent	2017-2019	Percent	2020-2021	Percent
Yes - Solo Crash	43	16%	28	20%	163	69%	95	82%	206	41%	123	49%
No - Vehicle Involved	229	84%	108	79%	65	28%	21	18%	294	58%	129	51%
Ambiguous Code	< 5	--	< 5	--	8	3%	< 5	--	8	2%	< 5	--

*One cyclist is repeated since they have more than one bicycle crash related e-code

Ratio of ZSFG-only injuries by Analysis Neighborhood

Table 57 presents the ratio of unreported ZSFG-only cyclist injuries to reported SFPD cyclist injuries in various neighborhoods of San Francisco from 2017 to 2021. For counts of ZSFG-only cyclist injuries less than 5, the number is excluded due to HIPAA patient privacy regulations. The Presidio neighborhood, which is outside of SFPD's jurisdiction, and they generally do not write crash reports for, has the highest ratio of ZSFG-only cyclist reported injuries.

- The Presidio had 25 unreported ZSFG-only cyclist injuries and 2 reported SFPD cyclist injuries, resulting in the highest ratio of 12.50.
- Oceanview/Merced/Ingleside had a ratio of 0.38, with 3 unreported ZSFG-only cyclist injuries and 8 reported SFPD cyclist injuries.

- As shown on Map 15, a cluster of neighborhoods on the southeast side of the city, such as Bayview Hunters Point, Potrero Hill, and Portola, have higher ratios, indicating a higher proportion of unreported ZSFG-only cyclist injuries compared to reported SFPD cyclist injuries.

Table 57: Ratio of ZSFG-only to ZSFG-SFPD Linked/SFPD-only Unintentional Cyclist Injuries by Analysis Neighborhood

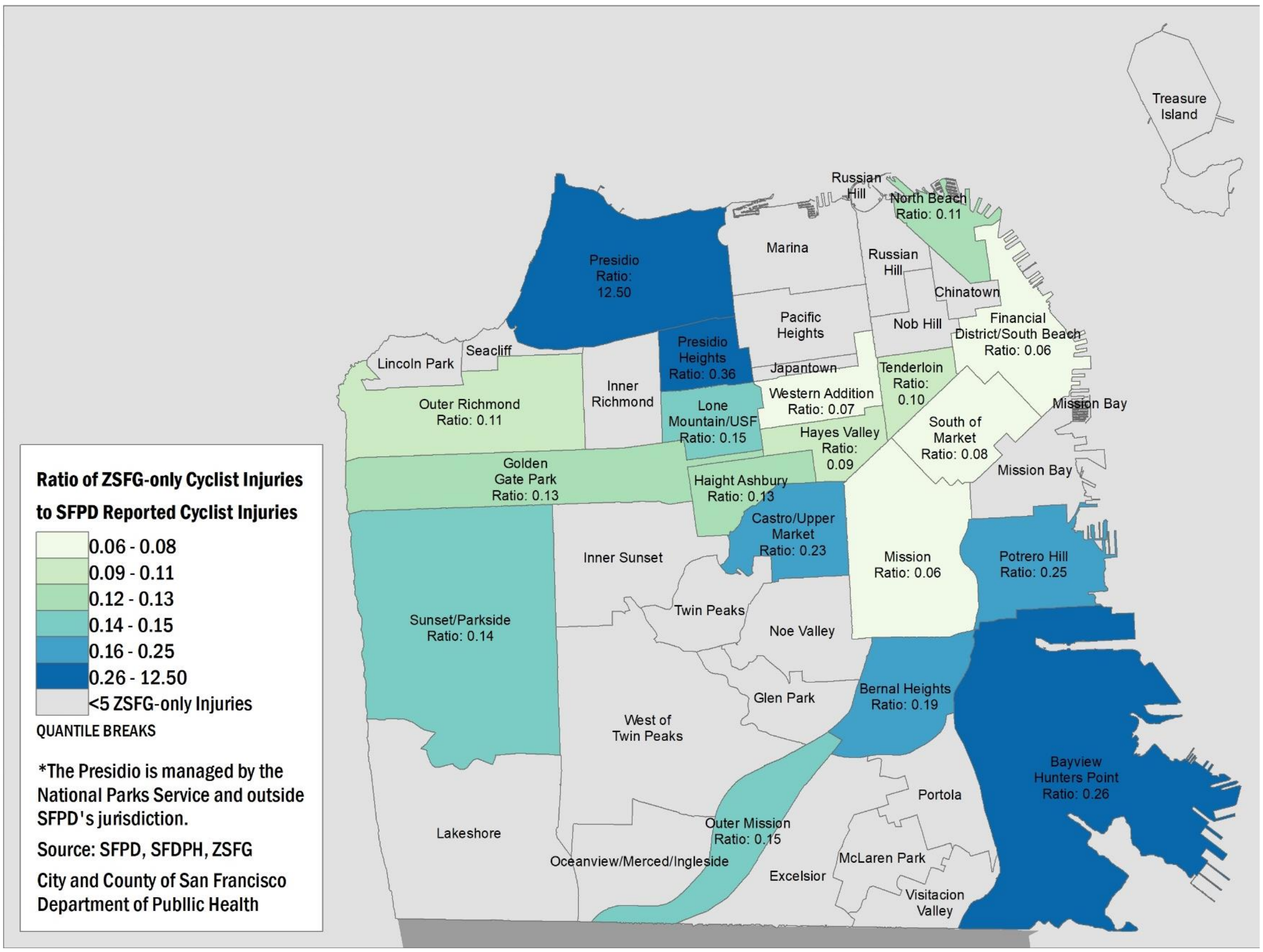
Neighborhood	Count Unreported ZSFG-only Injuries 2017-2021	Count of Reported SFPD Injuries 2017-2021	Ratio of ZSFG to SFPD Injuries
Presidio*	25	2	12.50
Presidio Heights	5	14	0.36
Bayview Hunters Point	24	93	0.26
Potrero Hill	8	32	0.25
Castro/Upper Market	18	77	0.23
Bernal Heights	10	53	0.19
Lone Mountain/USF	8	52	0.15
Outer Mission	6	40	0.15
Sunset/Parkside	7	50	0.14
Golden Gate Park	13	100	0.13
Haight Ashbury	6	45	0.13
North Beach	7	63	0.11
Outer Richmond	5	46	0.11
Tenderloin	15	154	0.10
Hayes Valley	10	108	0.09
South of Market	26	309	0.08
Western Addition	6	89	0.07
Mission	27	452	0.06
Financial District/South Beach	14	225	0.06
Lincoln Park	< 5	5	-
Noe Valley	< 5	19	-
Chinatown	< 5	25	-
Russian Hill	< 5	31	-
Inner Richmond	< 5	32	-
West of Twin Peaks	< 5	36	-
Oceanview/Merced/Ingleside	< 5	8	-
Portola	< 5	11	-
Lakeshore	< 5	17	-
Pacific Heights	< 5	28	-
Inner Sunset	< 5	33	-
Mission Bay	< 5	91	-
Glen Park	< 5	4	-
Japantown	< 5	8	-
McLaren Park	< 5	2	-
Seacliff	< 5	5	-
Twin Peaks	< 5	5	-

Neighborhood	Count Unreported ZSFG-only Injuries 2017-2021	Count of Reported SFPD Injuries 2017-2021	Ratio of ZSFG to SFPD Injuries
Excelsior	< 5	26	-
Nob Hill	< 5	40	-
Marina	< 5	58	-
Visitacion Valley	< 5	3	-
Treasure Island	< 5	4	-

* The Presidio is administered by the National Park Service and outside of SFPD's and MTA's jurisdiction.

Note that 57 out of 352 (16.2%) ZSFG-only crashes were unable to be geocoded.

Map 15: Ratio of Unlinked ZSFG-Only Cyclist Crashes to SFPD Reported Crashes by Analysis Neighborhood from 2017-2022: San Francisco, CA



ICD-10 e-code pedestrian injuries not on foot

Table 58 presents data on unintentional pedestrian injuries where individuals were traveling by means other than on foot seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by ICD-10 E-codes, and time period (2017-2019 and 2020-2021). The percentage calculated using the total of all pedestrian injuries including those injured while on foot. The table highlights trends and changes in the frequency of various types of pedestrian collisions involving alternative conveyances over the years, illustrating the evolving landscape of urban mobility and its impact on pedestrian safety.

- There was a noticeable increase between the two measurement periods in the percentage of pedestrians with other conveyances injured in collisions with cars, pick-up trucks, or vans in traffic accidents (V03.19XA) between 2017-2019 (4%) and 2020-2021 (7%), with a total of 63 incidents (5%).
- Pedestrians on skateboards injured in collisions with cars, pick-up trucks, or vans in traffic accidents (V03.12XA) remained consistent at 4% for both the 2017-2019 and 2020-2021 periods, totaling 50 incidents (4%).
- Collisions involving pedestrians on foot injured in accidents with pedal cyclists (V01.10XA) represent a very small percentage of pedestrian injuries, accounting for only 1% in 2017-2019 and 2% in 2020-2021, totaling 22 incidents (2%).

The "other conveyance" category can refer to the following: pedestrian with baby stroller, pedestrian on ice-skates, pedestrian on nonmotorized scooter, pedestrian on sled, pedestrian on snowboard, pedestrian on snow-skis, pedestrian in wheelchair (powered), and pedestrian in motorized mobility scooter. Prior to the creation of ICD-10 codes V00.031 (Pedestrian on foot injured in collision with rider of standing electric scooter) and V00.038 (Pedestrian on foot injured in collision with rider of other standing micro-mobility pedestrian conveyance) in late 2021, this category could also include standing electronic scooters and other micro-mobility devices.

Table 58: ICD-10 E-Codes of Pedestrians Not Walking on Foot Injured

E-Code 10	ICD-10 E-code Description	2017- 2019	Percent	2020-2021	Percent	Total	Percent
V03.19XA	Pedestrian with other conveyance injured in collision with car, pick-up truck or van in traffic accident	38	4%	25	7%	63	5%
V03.12XA	Pedestrian on skateboard injured in collision with car, pick-up truck or van in traffic accident	36	4%	14	4%	50	4%
V01.10XA	Pedestrian on foot injured in collision with pedal cycle in traffic accident	14	1%	8	2%	22	2%
V03.131A	Pedestrian on standing electric scooter injured in collision with car, pick-up or van in traffic accident	< 5	--	6	2%	6	0%
V03.02XA	Pedestrian on skateboard injured in collision with car, pick-up truck or van in nontraffic accident	< 5	--	< 5	--	< 5	--
V04.19XA	Pedestrian with other conveyance injured in collision with heavy transport vehicle or bus in traffic accident	< 5	--	< 5	--	< 5	--
V04.12XA	Pedestrian on skateboard injured in collision with heavy transport vehicle or bus in traffic accident	< 5	--	< 5	--	< 5	--
V03.92XA	Pedestrian on skateboard injured in collision with car, pick-up truck or van, unspecified whether traffic or nontraffic accident	< 5	--	< 5	--	< 5	--
V00.818A	Other accident with wheelchair (powered)	< 5	--	< 5	--	< 5	--
V01.19XA	Pedestrian with other conveyance injured in collision with pedal cycle in traffic accident	< 5	--	< 5	--	< 5	--
V02.19XA	Pedestrian with other conveyance injured in collision with two- or three-wheeled motor vehicle in traffic accident	< 5	--	< 5	--	< 5	--

E-Code 10	ICD-10 E-code Description	2017- 2019	Percent	2020-2021	Percent	Total	Percent
V03.99XA	Pedestrian with other conveyance injured in collision with car, pick-up truck or van, unspecified whether traffic or nontraffic accident	< 5	--	< 5	--	< 5	--
V04.11XA	Pedestrian on roller-skates injured in collision with heavy transport vehicle or bus in traffic accident	< 5	--	< 5	--	< 5	--
V05.19XA	Pedestrian with other conveyance injured in collision with railway train or railway vehicle in traffic accident	< 5	--	< 5	--	< 5	--
V01.11XA	Pedestrian on roller-skates injured in collision with pedal cycle in traffic accident	< 5	--	< 5	--	< 5	--
V01.12XA	Pedestrian on skateboard injured in collision with pedal cycle in traffic accident	< 5	--	< 5	--	< 5	--
V02.12XA	Pedestrian on skateboard injured in collision with two- or three-wheeled motor vehicle in traffic accident	< 5	--	< 5	--	< 5	--
V03.138A	Pedestrian on other standing micro-mobility pedestrian conveyance injured in collision with car, pick-up or van in traffic accident	< 5	--	< 5	--	< 5	--

ZSFG identified emerging mobility services and technologies (EMST) injuries of any ICD-10 category

In 2018, ZSFG initiated independent tracking of injuries related to the use of emerging mobility services and technologies (EMST) in their trauma registry[12], as these innovative transportation devices and technologies facilitating device-sharing saw increased usage. EMST includes: e-bikes (electric-assisted pedal bicycles), e-scooters (electric-powered stand-up kick scooters), motor-driven bicycles and mopeds (gasoline or electric-powered sit-down vehicles or assisted pedal bicycles), e-skateboards (electric-powered boards with four wheels), hoverboards/unicycles (one or two-wheeled electric-powered vehicles designed for standing), Segway-type vehicles (electric-powered, self-balancing stand-up vehicles with handlebars), Transportation Network Companies (TNCs, e.g., Uber, Lyft; motor vehicles providing ride-hail services through third-party apps), and Autonomous Vehicles (AVs; vehicles with partial or complete automation of driving, expected to increase as TNCs, shuttle services, and personal vehicles).

Table 59 presents the distribution of various EMST micro-mobility devices involved in injures seen at ZSFG during two time periods, 2018-2019 (when EMST started to be collected) and 2020-2021. The data reveals that electric bicycles and electric scooters make up most of these incidents.

- Electric bicycles constituted 43% of injuries in 2018-2019 and increased to 63% in 2020-2021, totaling 55% overall.
- Electric scooters (standup) accounted for 40% of injuries in 2018-2019 and 29% in 2020-2021, making up 33% of the total.

[12] Vision Zero SF Injury Prevention Research Collaborative. 2019. A Methodology for Emerging Mobility Injury Monitoring in San Francisco, California Utilizing Hospital Trauma Records: Version 2.0. San Francisco, CA. Available at: https://www.sfdph.org/dph/EH/PHES/PHES/TransportationandHealth.asp

- Electric skateboards injuries total 9% overall.

Table 59: ZSFG Identified Emerging Mobility Services and Technologies (EMST) Injuries of Any ICD-10 Category

EMST devices	2018-2019	Percent	2020-2021	Percent	Total	Percent
Electric bicycle	15	43%	33	63%	48	55%
Electric Scooter(standup)	14	40%	15	29%	29	33%
Electric skateboard	< 5	--	< 5	--	8	9%
Electric unicycle	< 5	--	< 5	--	< 5	--

Race

Table 60 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by race/ethnicity, link status (linked or unlinked to an SFPD crash report), and time period (2017-2019 and 2020-2021).

White cyclists (not Hispanic/Latino) represented the largest proportion of both linked and unlinked cases in both time periods, accounting for 48% and 51% of linked cases in 2017-2019 and 2020-2021, respectively, and 49% and 62% of unlinked cases in the same periods.

- The proportion of Hispanic/Latino cyclists of any race experiencing injuries was consistent across the time periods, comprising 23% and 17% of linked cases and 26% and 12% of unlinked cases in 2017-2019 and 2020-2021, respectively.
- The percentage of Black (not Hispanic/Latino) cyclist injuries saw a decline in both linked and unlinked cases between the two time periods. The proportion of linked cases decreased from 16% to 9%, and unlinked cases dropped from 11% to 7%.
- Asian (not Hispanic/Latino) cyclist injuries were relatively stable across time periods, representing 11% and 15% of linked cases and 11% and 14% of unlinked cases in 2017-2019 and 2020-2021, respectively.

Table 60: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by Race and Ethnicity

Race/Ethnicity		Linked				Unlinked				Total			
		2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct
American Indian	Not Hispanic/ Latino	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
Asian	Not Hispanic/ Latino	31	11%	20	15%	26	11%	16	14%	51	13%	42	12%
Black	Not Hispanic/ Latino	43	16%	12	9%	26	11%	8	7%	55	14%	34	10%
Other	Not Hispanic/ Latino	< 5	--	9	7%	7	3%	5	4%	12	3%	12	3%
White	Not Hispanic/ Latino	130	48%	69	51%	115	49%	72	62%	199	49%	187	53%
Native Hawaiian	Not Hispanic/ Latino	< 5	0%	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
***Nd**	Not Hispanic/ Latino	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
Any Race	Hispanic/ Latino	63	23%	23	17%	61	26%	14	12%	86	21%	75	21%

Age

Table 61 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by age group, link status (linked or unlinked to an SFPD crash report), and time period (2017-2019 and 2020-2021).

- The age group with the highest percentage of linked injuries in both time periods is 25-29 years old, accounting for 16% of linked cases in 2017-2019 and 15% in 2020-2021.
- The 30-34 age group had the highest proportion of unlinked cases in both time periods, with 12% in 2017-2019 and 16% in 2020-2021.
- The percentage of linked injuries increased with age until the 25-29 age group, then generally decreased with increasing age. A similar pattern can be observed in the unlinked cases.

Table 61: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by Age

Age Group	Linked				Unlinked				Total			
	2017-2019	Pct	2020-2021	Percent	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct
0 - 4	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
5 - 9	5	2%	< 5	--	< 5	--	< 5	--	6	1%	< 5	--
10 - 14	5	2%	< 5	--	< 5	--	< 5	--	9	2%	< 5	--
15 - 19	5	2%	< 5	--	10	4%	5	4%	15	3%	9	4%
20 - 24	22	8%	7	5%	18	8%	< 5	--	40	8%	8	3%
25 - 29	44	16%	20	15%	24	10%	9	8%	68	13%	29	12%
30 - 34	33	12%	22	16%	29	12%	19	16%	62	12%	41	16%
35 - 39	21	8%	15	11%	24	10%	14	12%	45	9%	29	12%
40 - 44	27	10%	12	9%	19	8%	16	14%	46	9%	28	11%
45 - 49	31	11%	11	8%	24	10%	5	4%	55	11%	16	6%
50 - 54	30	11%	9	7%	23	10%	12	10%	53	10%	21	8%
55 - 59	21	8%	8	6%	26	11%	8	7%	47	9%	16	6%
60 - 64	8	3%	7	5%	17	7%	8	7%	25	5%	15	6%
65 - 69	9	3%	8	6%	8	3%	8	7%	17	3%	16	6%
70 - 74	7	3%	7	5%	8	3%	5	4%	15	3%	12	5%
75 - 79	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	7	3%
80 - 84	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--

Gender

Table 62 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by gender, link status (linked or unlinked to an SFPD crash report), and time period (2017-2019 and 2020-2021).

- Males accounted for the majority of both linked and unlinked cyclist injuries in both time periods. In 2017-2019, 85% of linked and 79% of unlinked cases involved males, while in 2020-2021, the proportions were 86% and 78%, respectively.
- Female cyclist injuries represented a smaller percentage of the total cases, with 15% of linked and 21% of unlinked cases in 2017-2019, and 14% and 22% in 2020-2021.
- The distribution of injuries by gender remained relatively consistent between the two time periods, with males consistently representing a higher proportion of cases than females.
- Although the proportion of female injuries is smaller than that of males, it is noteworthy that the percentage of unlinked cases among females was slightly higher than the percentage of linked cases in both time periods.

Table 62: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by Gender

Gender	Linked				Unlinked				Total			
	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct
Male	229	85%	117	86%	187	79%	90	78%	416	82%	207	82%
Female	42	15%	19	14%	49	21%	26	22%	91	18%	45	18%

ICD-10 injuries (limited to top 20)

Table 63 displays the top 20 ICD-10 injury codes for cyclists, detailing the percentage of cyclists seen with each injury in two different time periods (2017-2019 and 2020-2021) and the total percentage across both periods. It's important to note that a cyclist can have multiple injuries.

- Abrasions and lacerations of head, knees, elbows, and hands were the most common injuries among cyclists.
- The top 3 injuries inflicted on cyclists were abrasions of other parts of the head (16%), lacerations without foreign body of other parts of the head (14%), and abrasions of the left knee (14%).
- Less common injuries included concussion without loss of consciousness (8%), contusion of scalp (8%), and abrasions of lower legs, shoulders, and forearms.
- Traumatic injuries, such as pneumothorax, skull base fractures, nasal bone fractures, and rib fractures, were also among the top 20 ICD-10 injury codes.
- Some differences in injury prevalence were observed between the two time periods (2017-2019 and 2020-2021), although most injury percentages remained relatively stable.

Table 63: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by ICD-10 Injury Diagnosis Code

Injury Diagnosis ICD-10 Code	Description	2017-2019	Percent of Cyclist with this Injury	2020-2021	Percent of Cyclist with this Injury	Total	Percent of Cyclist with this Injury
S00.81XA	Abrasion of other part of head, initial encounter	83	16%	35	14%	118	16%
S01.81XA	Laceration without foreign body of other part of head, initial encounter	82	16%	24	10%	106	14%
S80.212A	Abrasion, left knee, initial encounter	74	15%	33	13%	107	14%
S80.211A	Abrasion, right knee, initial encounter	68	13%	35	14%	103	14%
S50.312A	Abrasion of left elbow, initial encounter	51	10%	16	6%	67	9%
S06.0X0A	Concussion without loss of consciousness, initial encounter	45	9%	13	5%	58	8%
S60.511A	Abrasion of right hand, initial encounter	45	9%	23	9%	68	9%
S00.83XA	Contusion of other part of head, initial encounter	44	9%	21	8%	65	9%
S60.512A	Abrasion of left hand, initial encounter	43	8%	23	9%	66	9%
S00.03XA	Contusion of scalp, initial encounter	40	8%	21	8%	61	8%

Injury Diagnosis ICD-10 Code	Description	2017-2019	Percent of Cyclist with this Injury	2020-2021	Percent of Cyclist with this Injury	Total	Percent of Cyclist with this Injury
S80.812A	Abrasion, left lower leg, initial encounter	36	7%	19	8%	55	7%
S50.311A	Abrasion of right elbow, initial encounter	35	7%	19	8%	54	7%
S40.212A	Abrasion of left shoulder, initial encounter	33	7%	13	5%	46	6%
S27.0XXA	Traumatic pneumothorax, initial encounter	30	6%	24	10%	54	7%
S01.01XA	Laceration without foreign body of scalp, initial encounter	29	6%	21	8%	50	7%
S02.19XA	Other fracture of base of skull, initial encounter for closed fracture	29	6%	23	9%	52	7%
S80.811A	Abrasion, right lower leg, initial encounter	29	6%	21	8%	50	7%
S22.42XA	Multiple fractures of ribs, left side, initial encounter for closed fracture	27	5%	17	7%	44	6%
S01.511A	Laceration without foreign body of lip, initial encounter	26	5%	10	4%	36	5%
S06.6X0A	Traumatic subarachnoid hemorrhage without loss of consciousness, initial encounter	26	5%	35	14%	61	8%
S50.812A	Abrasion of left forearm, initial encounter	26	5%	13	5%	39	5%
S02.2XXA	Fracture of nasal bones, initial encounter for closed fracture	24	5%	13	5%	37	5%
S30.811A	Abrasion of abdominal wall, initial encounter	24	5%	9	4%	33	4%
S50.811A	Abrasion of right forearm, initial encounter	24	5%	17	7%	41	5%
S02.0XXA	Fracture of vault of skull, initial	23	5%	19	8%	42	6%

Injury Diagnosis ICD-10 Code	Description	2017-2019	Percent of Cyclist with this Injury	2020-2021	Percent of Cyclist with this Injury	Total	Percent of Cyclist with this Injury
	encounter for closed fracture						

*Cyclists can have multiple injury codes

SFPD severity change

One of the benefits of utilizing TISS linked data is injury severity for SFPD-reported injury records linked to ZSFG records can be updated to reflect a more accurate, clinical assessment of the injury outcome as diagnosed by ZSFG medical staff. SFPD assessment of injury is determined by standards outlined in the California Highway Patrol Collision Investigation Manual prior to 2021 and is primarily based on an officer's visual assessment of a victim at the scene of the collision. Police officers have been trained to classify a crash as a severe (or serious) injury if it has the following characteristics[13]:

1. Broken of fractured bones
2. Dislocated of distorted limbs
3. Severe lacerations
4. Skull, spinal, chest or abdominal injuries that go beyond "Other Visible Injuries"
5. Unconsciousness at or when taken from the collision scene
6. Severe burns

In contrast, ZSFG data provides a clinical assessment of injury severity. In accordance with the Vision Zero Severe Injury Protocol[14], SFDPH classifies the following ZSFG patients as severe injuries:

1. Any patient entered into ZSFG Hospital's Trauma Registry who was injured in or outside of a vehicle involved in a crash within the public roadway due to impact with a vehicle or road structure within the City or County of San Francisco requiring hospital admission for treatment of their injuries.
2. Any patient entered into ZSFG Hospital's Trauma Registry who was injured in or outside of a vehicle (bus, truck, car, motorcycle, bike, moped, light rail vehicle (LRV), train, etc.) involved in a crash within the public roadway due to impact with a vehicle or road structure within the City or County of San Francisco and sustained an Injury Severity Score (ISS) greater than 15.

ISS is an established medical score to assess trauma severity[15]. It correlates with mortality, morbidity and hospitalization time after trauma. Major trauma is defined as being an Injury Severity Score greater than 15 and is associated with a greater than 10% risk of mortality[16]. This definition of severe traffic-related injury is

[13] State of California, Business, Transportation and Housing Agency, Dept. of California Highway Patrol. 2003. Collision Investigation Manual. Sacramento, CA. Available at: https://www.nhtsa.gov/nhtsa/stateCatalog/states/ca/docs/CA_CHP555_Manual_2_2003_ch1-13.pdf

[14] San Francisco Department of Public Health. May 2017. Vision Zero Severe Traffic Injury Protocol. San Francisco: Program on Health, Equity and Sustainability. San Francisco, CA.

[15] Baker SP, O'Neill B, Haddon W, Long WB (1974). "The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care". *The Journal of Trauma*. Lippincott Williams & Wilkins. 14 (3): 187–196. doi:10.1097/00005373-197403000-00001. PMID 4814394

[16] Copes, W.S.; H.R. Champion; W.J. Sacco; M.M. Lawnick; S.L. Keast; L.W. Bain (1988). "The Injury Severity Score revisited". *The Journal of Trauma*. Lippincott Williams & Wilkins. 28 (1): 69–77.

consistent with previously established guidelines including those used by the American College of Surgeons, the National Trauma Data Bank, the California Department of Public Health, and the World Health Organization.

Injury severity for people in both the SFPD and ZSFG datasets was determined based on the severity as determined by ZSFG data, which could mean either upgrading or downgrading the severity classification of an injury initially assessed by SFPD at the scene. The following tables summarize changes in injury severity to linked cyclist injuries as originally assessed by SFPD based on ZSFG data using the above criteria.

Table 64 demonstrates how the injury severity assessment of SFPD-reported cases has been updated using ZSFG data, which provides a more accurate clinical assessment of injury outcomes. The data compares the severity updates between two time periods, 2017-2019 and 2020-2021.

- Of the SFPD-reported severe injuries, 28% (2017-2019) and 14% (2020-2021) were unlinked reports that remained severe since no clinical definition from ZSFG was available.
- For linked reports, 47% (2017-2019) and 57% (2020-2021) remained severe, as confirmed by the hospital data.
- The proportion of SFPD-linked reports that were downgraded to less severe based on ZSFG data was 53% (2017-2019) and 43% (2020-2021), highlighting the differences in severity assessment between SFPD and ZSFG.
- SFPD-reported other injuries (other visible injury and complaint of pain) accounted for 91% of cases in 2017-2019 and 84% in 2020-2021.
- Of these other injury reports, 5% in 2017-2019 and 14% in 2020-2021 were linked and upgraded to severe based on ZSFG data, indicating a significant increase in the proportion of injuries initially classified as less severe that were later determined to be more serious upon further clinical assessment.
- In total, 7% of SFPD-reported other injury cases were upgraded to severe after being linked to ZSFG data, emphasizing the importance of incorporating clinical assessments to determine injury severity more accurately.

This analysis highlights the potential discrepancies in injury severity classification between SFPD assessments and clinical assessments at ZSFG, underlining the need to consider both sources of data to ensure a comprehensive understanding of injury outcomes in traffic-related incidents.

Table 64: Changes in ZSFG-SFPD Linked Reported Injury Severity Based off ZSFG Trauma Registry

Injury Update	2017-2019	Pct	2020-2021	Pct	Total	Pct
SFPD report severe injuries	154	9%	82	16%	236	11%
SFPD unlinked reports that stayed severe	34	28%	10	14%	44	23%
SFPD linked reports that stayed severe (also severe per hospital)	56	47%	41	57%	97	51%
SFPD linked reports that were downgraded to less than severe	64	53%	31	43%	95	49%
SFPD report other injuries (complaint of pain or other visible)	1527	91%	440	84%	1967	89%
SFPD linked other injury reports that were upgraded to severe	79	5%	60	14%	139	7%