

# **An Updated Analysis of Commercial Truck Traffic Through Downtown Bozeman**



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## 1. INTRODUCTION

The primary objective of this study is to provide renewed attention to the impact of commercial truck use through downtown Bozeman along Main Street.<sup>1</sup> This is an opportunity to revisit and update a 2015 analysis, which was motivated by safety, noise, exhaust, and other quality of life concerns among City officials and downtown businesses about heavy commercial truck use in the downtown core along Main Street.<sup>2</sup> That study estimated that approximately 29% of commercial trucks (an average of 34 westbound trucks per day) pass through Main Street on the trip between I-90 and Four Corners, and that large trucks increase Main Street noise levels 7-16 decibels (representing a 9.3%-23.2% increase above background levels).<sup>3</sup> The study concluded by recommending further consideration of a through-truck route to shift commercial trucks from using I-90 Exit 309 (Main Street) to either I-90 Exit 305 (North 19<sup>th</sup> Avenue/Springhill Road) or Exit 298 (SR 85/Jackrabbit Lane), as well as attention in the community's subsequent transportation planning efforts. While Article 9 (Truck Traffic) of Chapter 36 (Traffic and Vehicles) of the [Bozeman Municipal Code](#) allows for designation of truck routes and alternate truck routes (Sec. 36.09.050) and prohibits through truck traffic outside designated truck routes (except for accessing an established truck route or destination) (Sec. 36.09.030), to date no such routes have been established.

### 1.1. Relevant Plans

As summarized in the 2015 report, concerns regarding through-truck impacts on traffic flow and the pedestrian-oriented character of Main Street were identified in the City of Bozeman's Downtown Urban Renewal Plan (1995), as well as both the 1998 and 2009 Downtown Bozeman Improvement Plans.

Since publication of the 2015 report, two relevant plans for the Bozeman community have been published: the 2017 [Bozeman Transportation Master Plan](#) ("TMP"), and the 2019 [Downtown Bozeman Improvement Plan](#) ("DBIP"). Section 2.3.3 Freight and Rail Network of the TMP identifies "the volume of heavy vehicle traffic in downtown Bozeman" as a major concern. Figure 2.8 of that document suggests heavy commercial trucks have fewer destinations within the [Main Street Historic District](#) (along Main Street between Rouse and Willson Avenues and parts south to Babcock) compared to other parts of Bozeman – there is only one Trucking Activity Center (the US Post Office on East Babcock Street) within the vicinity of the Main Street Historic District. The DBIP recognizes a need for heavy trucks to transport and deliver goods to downtown businesses and residences, but advocates for a "balanced approach" to a Main Street redesign that reduces its "heavy lifting" as a major regional corridor.

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<sup>1</sup> Between I-90 Exit 309 and the Four Corners intersection of US 191 and SR 85 (Jackrabbit Lane), US 191 is called East Main Street, West Main Street, and Huffine Lane.

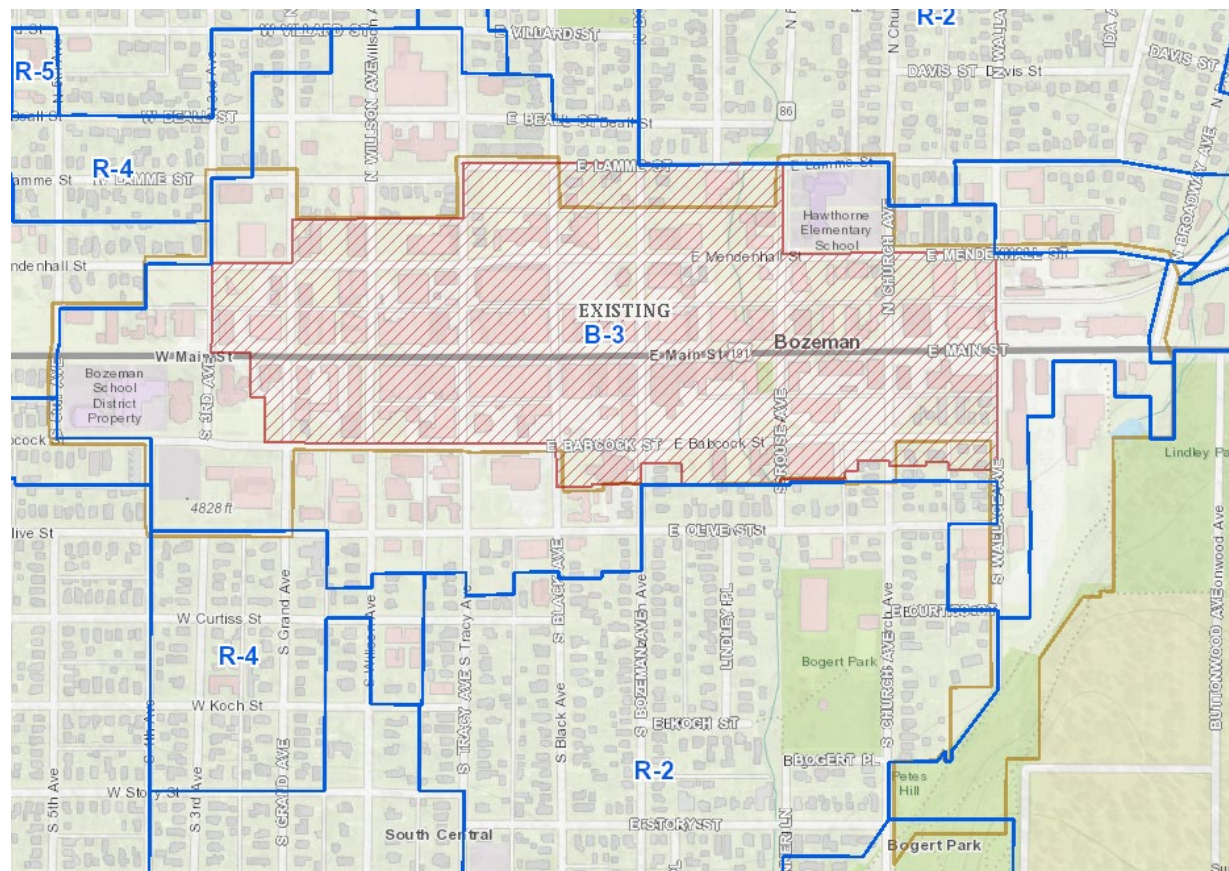
<sup>2</sup> Villwock-Witte, N. & Kack, D. (2015). *Understanding Commercial Truck Traffic Through Downtown Bozeman*. Prepared by the Western Transportation Institute at Montana State University for the Downtown Bozeman Partnership.

<sup>3</sup> Since the decibel scale is logarithmic, note that an increase of 10 decibels translates to a sound intensity (or perception of loudness) that is approximately twice as high.

Despite 25 years of concern regarding through-trucks in planning documents, a mechanism in the Municipal Code to designate truck routes, and the findings and recommendations of the 2015 report, Main Street continues to experience heavy commercial through-truck traffic that Downtown Bozeman Partnership Executive Director Chris Naumann describes as “out of scale.”<sup>4</sup> This report seeks to inform constructive efforts toward progress in reducing the impact of through-trucks on downtown Bozeman.

## 1.2. Study Area

This study is primarily motivated by the impact of commercial trucks on the [Downtown Core Area](#) (along the historic portion of Main Street between approximately Rouse and Grand Avenues). As the DBIP describes, there is no single definition of downtown Bozeman. Instead, various designations are based on zoning, historic designations, land uses, architectural styles, streetscapes, and other characteristics. For context, Figure 1 portrays the Downtown Business Improvement District (red shading), the Downtown Urban Renewal District (brown outline), and the B-3 Zoning District.



**Figure 1: Downtown Core Area**

Source: Generated by WTI using the City of Bozeman's online [Mapping & Analysis Tool](#).

<sup>4</sup> Boyer, C. (September 15, 2019). Partnership Weighs In on Semi Truck Traffic on Main Street: City Works to Reduce Number of Semis Downtown. Channel 7 KBZK Bozeman. Of note, roadwork in 2019 that prompted temporary signage to divert through-trucks off Main Street and toward use of I-90 Exit 306 (North 7<sup>th</sup> Avenue) appeared anecdotally to have limited efficacy.



## 2. LITERATURE REVIEW

Bozeman is among many communities struggling with the impact and management of freight traffic. Recent cases include: [Calera, AL](#); [Fort Smith, AR](#); [Macon, GA](#); [Moab, UT](#); and [Nampa, ID](#). [Franklin, IN](#) illustrates that even after truck rerouting is achieved, compliance can remain an ongoing challenge. The 2015 report reviewed: 1) case studies of commercial truck re-routing; 2) truck bypass implementation; 3) truck traffic restrictions outside downtowns; 4) truck route selection; and 5) truck traffic impacts on pedestrians. This report focuses on three additional issues relevant to through-truck traffic management: 1) administrative transference; 2) time restrictions; and 3) noise and exhaust impacts.

### 2.1. Transference of Main Street from States to Localities

One of the challenges with restricting through-trucks through implementation of a truck route – as authorized in the Bozeman Municipal Code and recommended by the 2015 report – is that US 191 is part of the National Highway System and managed by the Montana Department of Transportation (“MDT”). As a result, restrictions on through-trucks as well as design updates, such as the three-lane configuration recommended in the DBIP, require MDT participation and approval. Transference of Main Street to the City of Bozeman could facilitate truck route designation and other adjustments, as it could expedite local consideration of the adjustments without requirements for MDT approval. However, an important tradeoff would be the assumption by the City of Bozeman of roadway maintenance costs. Other communities have considered such a transition to reach community goals. For example, transferring Main Street ownership from the New Hampshire Department of Transportation to the Town of Plaistow was one of the key policy changes recommended in [Plaistow’s 2011 Main Street Traffic Calming Study](#). More recently, the [Oregon Department of Transportation presented the City of Carlton with options to rebuild or reroute a portion of Highway 47](#) in early 2020. The rerouting option would shift truck traffic out of the downtown area and require the return of Main Street ownership to the City.

### 2.2. Time Restrictions

In addition to alternative truck routes, the DBIP also suggests reducing the impact of truck traffic by limiting deliveries and pickups to off-peak hours. To date, most research on off-hour delivery programs has focused on the context of large cities. A recent analysis of New York City’s program suggests that context-sensitive implementation of off-hour delivery programs may mutually benefit the environment, communities, and businesses.<sup>5</sup> For small urban areas such as Bozeman, alternatives to off-hour deliveries, such as parking/loading area management, may be appropriate.<sup>6</sup>

### 2.3. Noise and Exhaust

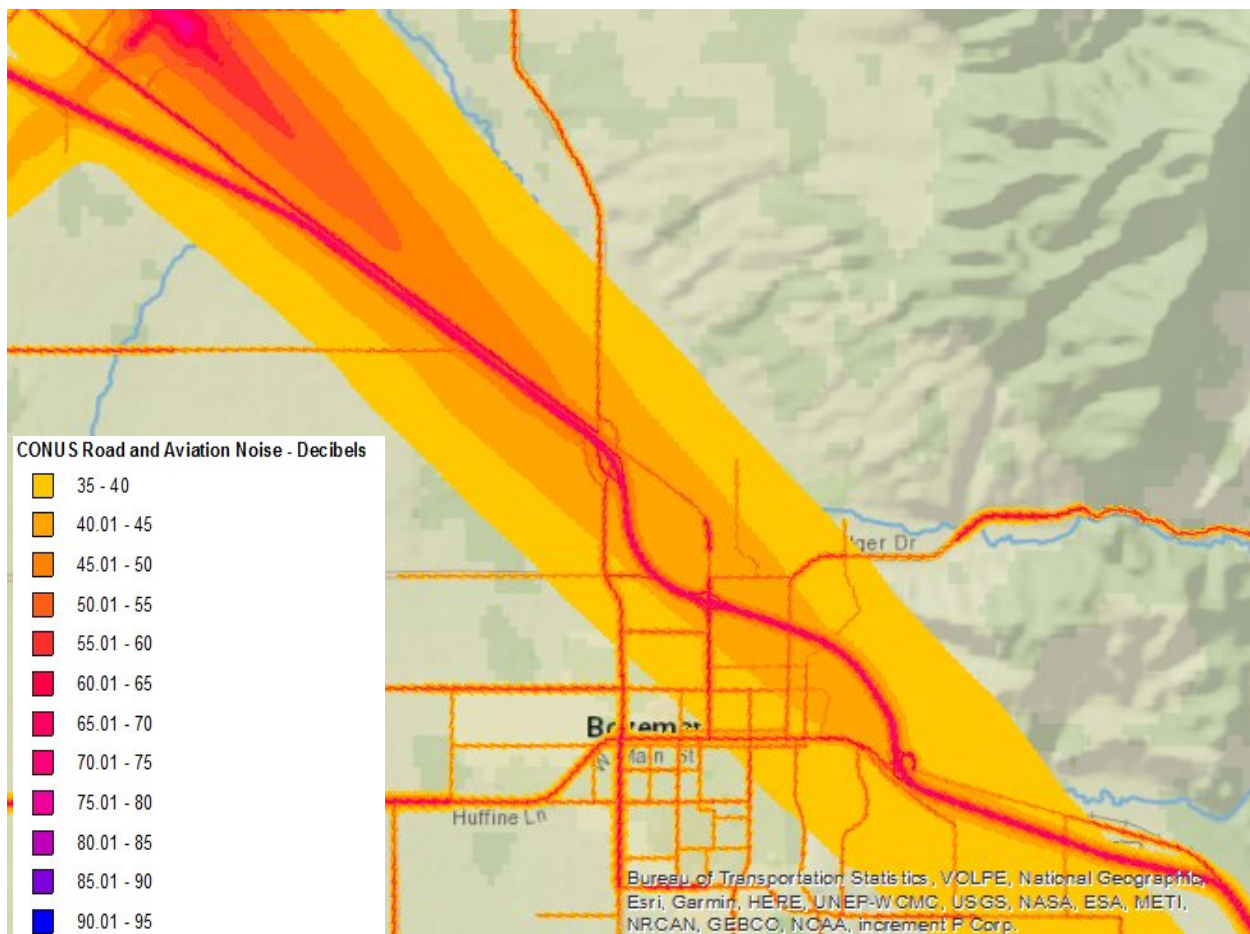
The 2015 report investigated the impact of large trucks on Main Street noise levels and reported empirical observations that large trucks increased Main Street noise levels 7-16 decibels (representing a 9.3%-23.2% increase above background levels). According to the National

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<sup>5</sup> Holguín-Veras, J., et al. (2018). *The New York City Off-Hour Delivery Program: A Business and Community-Friendly Sustainability Program*. *Interfaces*, 48(1): 70-86.

<sup>6</sup> José Holguín-Veras, personal communication (July, 2020).

Transportation Noise Map (Figure 2), much of the historic portion of downtown Bozeman has exposure to background transportation noise (principally from the Bozeman Yellowstone International Airport and I-90) at a level under 50 decibels (approximately equivalent to a refrigerator humming). Almost the entirety (98%) of the U.S. population has exposure to background transportation noise at this level and roadways are its most widespread source; transportation noise is pervasive and impacts include annoyance, sleep and communication disruptions, adverse health and productivity impacts, and reductions in property values.<sup>7</sup> Noise has been an important motivator for freight management efforts in other communities. For example, the [Main Street \(US-191\) Moab Bypass Planning Study](#) notes that shifting freight traffic away from that community's city center could result in noise reductions that create a more comfortable environment for those walking, dining, or riding bikes.



**Figure 2: Bozeman Transportation Noise Map (24-Hour Equivalent)**

Source: [USDOT Bureau of Transportation Statistics National Transportation Noise Map](#).

Notes: Map presents a 24-hour equivalent sound level noise metric as of April 19, 2018 and includes simplified noise modeling intended for the tracking of trends rather than evaluation of noise levels at individual locations or specific times.<sup>8</sup>

<sup>7</sup> Bureau of Transportation Statistics. (2016). *Transportation Statistics Annual Report: Chapter 7 Transportation Energy Use and Environmental Impacts*. US Department of Transportation.

<sup>8</sup> [USDOT Bureau of Transportation Statistics National Transportation Noise Map – Metadata](#).



Motor vehicle exhaust fumes are also an important consideration for freight management in downtown areas. According to the [USDOT](#), motor vehicle emissions are a leading source of air pollutants that affect human health, in the form of induced asthma, reduced lung capacity, and susceptibility to respiratory illnesses. Elevated levels of particulate matter from freight vehicles pose a particular concern, as they have been linked to heart attacks and lung cancer.

In general, heavy-duty vehicles generate much higher emissions than light-duty vehicles and trucks (Table 1). Most notably, diesel heavy-duty trucks (typical of most large commercial trucks) emit PM<sub>2.5</sub> (0.213 grams per mile) at a level 27 times higher than gasoline light-duty vehicles (typical of most passenger cars).

**Table 1. Estimated U.S. Average Vehicle Emissions Rates Per Vehicle (Grams Per Mile, 2018)**

	Light-Duty Vehicles		Light-Duty Trucks		Heavy-Duty Vehicles	
	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
Total HC	0.350	0.183	0.421	0.324	1.160	0.645
Exhaust CO	3.941	2.663	5.655	2.754	21.352	1.994
Exhaust NO <sub>x</sub>	0.289	0.153	0.478	1.321	1.416	5.971
Exhaust PM <sub>2.5</sub>	0.008	0.004	0.010	0.045	0.030	0.213
Brakewear PM <sub>2.5</sub>	0.003	0.003	0.003	0.003	0.009	0.013
Tirewear PM <sub>2.5</sub>	0.001	0.001	0.001	0.002	0.002	0.004

Key: HC = hydrocarbons; CO = carbon monoxide; NO<sub>x</sub> = nitrogen oxides; PM<sub>2.5</sub> = particulate matter with diameter ≤ 2.5 micrometers.

Source: Adapted from [USDOT Bureau of Transportation Statistics National Transportation Statistics Table 4-43](#).

Given these estimated emissions rates, a diesel heavy-duty vehicle traveling the historic 1-mile section of Main Street between Wallace and 7<sup>th</sup> Avenues emits 1.8 times more hydrocarbons, 21 times more exhaust nitrogen oxides, 27 times more exhaust particulate matter, 5 times more brakewear particulate matter, and 3 times more tirewear particulate matter (but only half as much exhaust carbon monoxide) compared to the levels emitted by a gasoline light-duty vehicle.

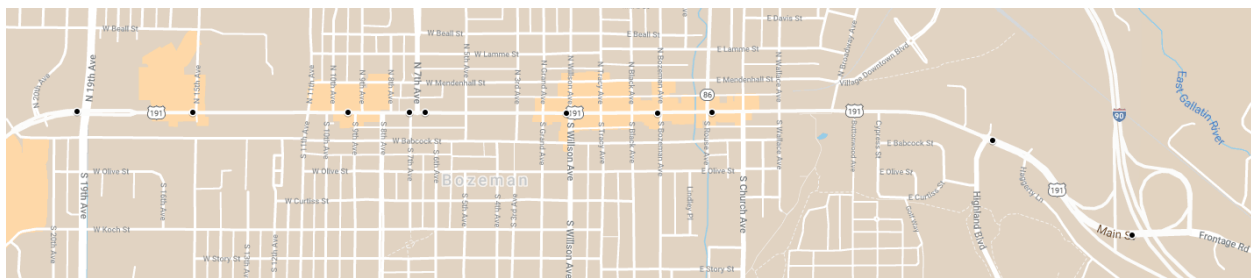
The US Department of Labor Occupational Safety and Health Administration's [Hazard Alert for Diesel Exhaust/Diesel Particulate Matter](#) notes administrative controls to reduce occupational hazards that also have relevance for communities considering freight management strategies, including modifying travel routes and restrictions on the operation of diesel-powered equipment in certain areas.

### 3. METHODOLOGY

To assess the impact of commercial truck use through downtown Bozeman along Main Street, this study replicated the approach employed in the 2015 study, with a few specific modifications: 1) in addition to the two locations utilized for video-based data collection in the fall of 2014 (East Main Street at Haggerty Lane and West Main Street at 19<sup>th</sup> Avenue), a third location was added at West Main Street and 7<sup>th</sup> Avenue in the fall of 2019; and 2) sound measurements were recorded during a total of three sessions at three locations, compared to one session at one location in the spring of 2015. The following overview summarizes the methods used for: 1) traffic level estimates; 2) through-truck counts; 3) alternative route assessments; and 4) transportation noise measurements.

#### 3.1. Travel Level Estimates

The present study compiled updated information about traffic levels along Main Street using the [Montana Department of Transportation Data Management System](#), as well as assistance from the [Montana Department of Transportation Office of Traffic Data Collection & Analysis](#). Annual average daily traffic was compiled for 2009-2019 for the ten locations most relevant to this study (Figure 3), while the estimated share of daily traffic by commercial vehicles was compiled for 2013, 2015, and 2018 for those same ten locations.



**Figure 3: AADT Traffic Count Locations**

Source: Generated using Google Maps.

#### 3.2. Through-Truck Counts

The present study collected video-based data that are essentially comparable to the data collected for the 2015 study, with the noted potential impact of a holiday weekend. Data used for the 2015 study were collected between Friday, September 5 and Friday, September 12, 2014 (for a total of 96 hours), while data used for the present analysis were collected between Sunday, August 25 and Sunday, September 1, 2019 (for a total of 83 hours).<sup>9</sup> As a result, while the 2015 study used data for an eight-day period spanning Friday-Friday, the present study used data for an eight-day period spanning Sunday-Sunday (resulting in one less weekday and one more weekend day in the present study compared to five years ago). As was the case for the 2015 study, this analysis focused on data collected between 8am and 8pm (due to lighting limitations outside daylight hours). The

<sup>9</sup> To account for the potential impact of Labor Day on travel patterns, data from September 2, 2019, were excluded from the analysis. Data collected on August 23 and 24 were also discarded due to technical issues, where several time slots only recorded a small portion of each hour.

following list summarizes the data available for through-truck counts, given intermittent data outages:<sup>10</sup>

- Sunday, August 25, 2019: 8am-5pm, 6pm-8pm
- Monday, August 26, 2019: 8am-5pm, 6pm-8pm
- Tuesday, August 27, 2019: 8am-4pm, 5pm-8pm
- Wednesday, August 28, 2019: 8am-5pm
- Thursday, August 29, 2019: 8am-5pm, 6pm-7pm
- Friday, August 30, 2019: 8am-5pm, 6pm-8pm
- Saturday, August 31, 2019: 8am-11am, 12pm-5pm, 6pm-8pm
- Sunday, September 1, 2019: 8am-1pm, 2pm-5pm, 6pm-8pm

Consistent with the 2015 study, a through-truck was considered a large commercial truck (often called an “eighteen-wheeler”) that traveled between the cameras at East Main Street at Haggerty Lane and one or both of West Main Street at 7<sup>th</sup> Avenue and West Main Street at 19<sup>th</sup> Avenue in an amount of time indicative of through-travel (no stops or detours). This was intended to capture through-trucks taking I-90 Exit 309 and traveling through downtown Bozeman toward the Four Corners intersection of US 191 and SR 85/Jackrabbit Lane. As was the case with the prior study, through-trucks were recorded by tracking whether large commercial trucks observed in the video of westbound traffic at East Main Street at Haggerty Lane were subsequently observed in the videos for West Main Street at 7<sup>th</sup> Avenue and West Main Street at 19<sup>th</sup> Avenue. Smaller commercial trucks were not included in the through-truck counts. A through-truck was assigned to the hourly slot corresponding to its timestamp observed at East Main Street at Haggerty Lane.

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<sup>10</sup> Due to the relatively labor-intensive process of reviewing the video data, the samples of video data from 2015 (96 hours) and 2019 (83 hours) represent only 2% (2.2% and 1.9%, respectively) of the total 4,380 daytime (365 X 12-hours) available over the course of the year. These sample sizes admittedly fall below the boundaries of what would customarily be considered a statistically representative sample.



**Figure 4: Example of Video Capturing a Through-Truck at 7<sup>th</sup> Ave and 19<sup>th</sup> Ave**  
Source: Screenshots from video data collected by WTI.

### 3.3. Alternative Route Assessments

This study repeated measurements from the 2015 study for travel conditions along four routes between I-90 and Four Corners. This updated information about the alternative routes is especially relevant as Bozeman experiences rapid growth and considers designating truck routes to divert through-trucks away from Main Street. On Thursday, April 16, 2020,<sup>11</sup> at approximately 11am, travel time, mileage, and traffic control devices were counted between I-90 Mile Marker 310 and Four Corners (US 191/SR 85) via each of the following four routes:

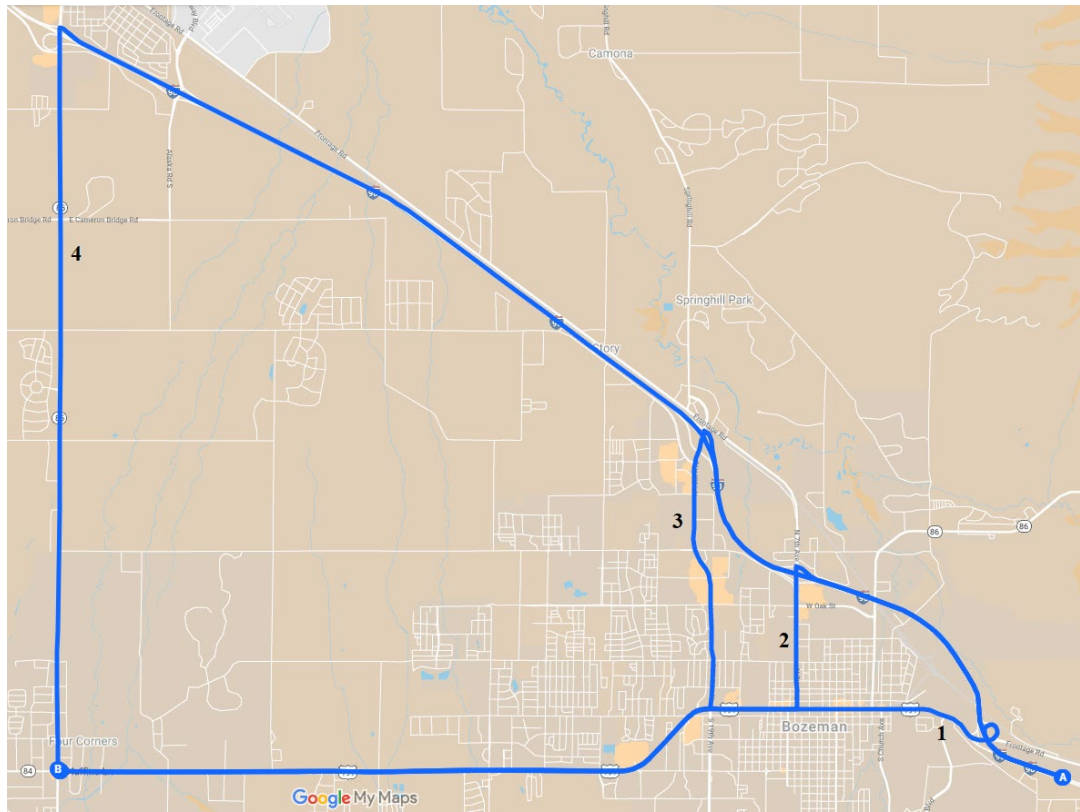
- 1) Exit 309 (Main Street)
- 2) Exit 306 (North 7<sup>th</sup> Avenue)
- 3) Exit 305 (North 19<sup>th</sup> Avenue)
- 4) Exit 298 (SR 85/Jackrabbit Lane)

While traveling the routes, drivers traveled within the facility speed limits and avoided lane changes in excess of what a large commercial truck would be expected to perform. Each route was driven in its entirety twice (once in each direction). A second set of measurements was taken

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<sup>11</sup> Measurements across the routes should be considered comparable, though travel conditions overall may have been impacted by the COVID-19 pandemic, including a Stay-At-Home Order in place at the time of the April data collection for the State of Montana.

on Thursday, June 18, 2020, for the first (Main Street) and fourth route (SR 85/Jackrabbit Lane) only; during that session, each route was driven in its entirety once.



**Figure 5: Route Alternatives**

Source: Generated using Google Maps

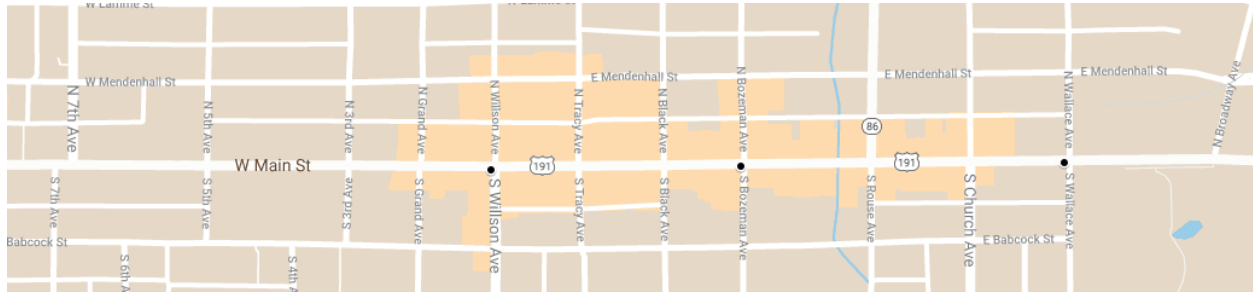
### 3.4. Transportation Noise Assessments

This study repeated and expanded upon transportation noise measurements taken for the 2015 study by adding two locations in downtown Bozeman. Using the Sound Meter smartphone application, sound readings were observed at the following times from southwest corners at each location (Figure 6):

- 1) Friday, May 8, 2020 at 2:30pm-3:00pm: East Main Street at Bozeman Avenue
- 2) Saturday, May 9, 2020 at 9:00am-9:30am: East Main Street at Wallace Avenue
- 3) Friday, May 22, 2020 at 11:30am-12:00pm: West Main Street at Willson Avenue



During each session, the minimum, maximum, and average sound levels were noted, as well as the instantaneous observed sound readings as various vehicles passed.



**Figure 6: Transportation Noise Measurement Locations**

Source: Generated using Google Maps.

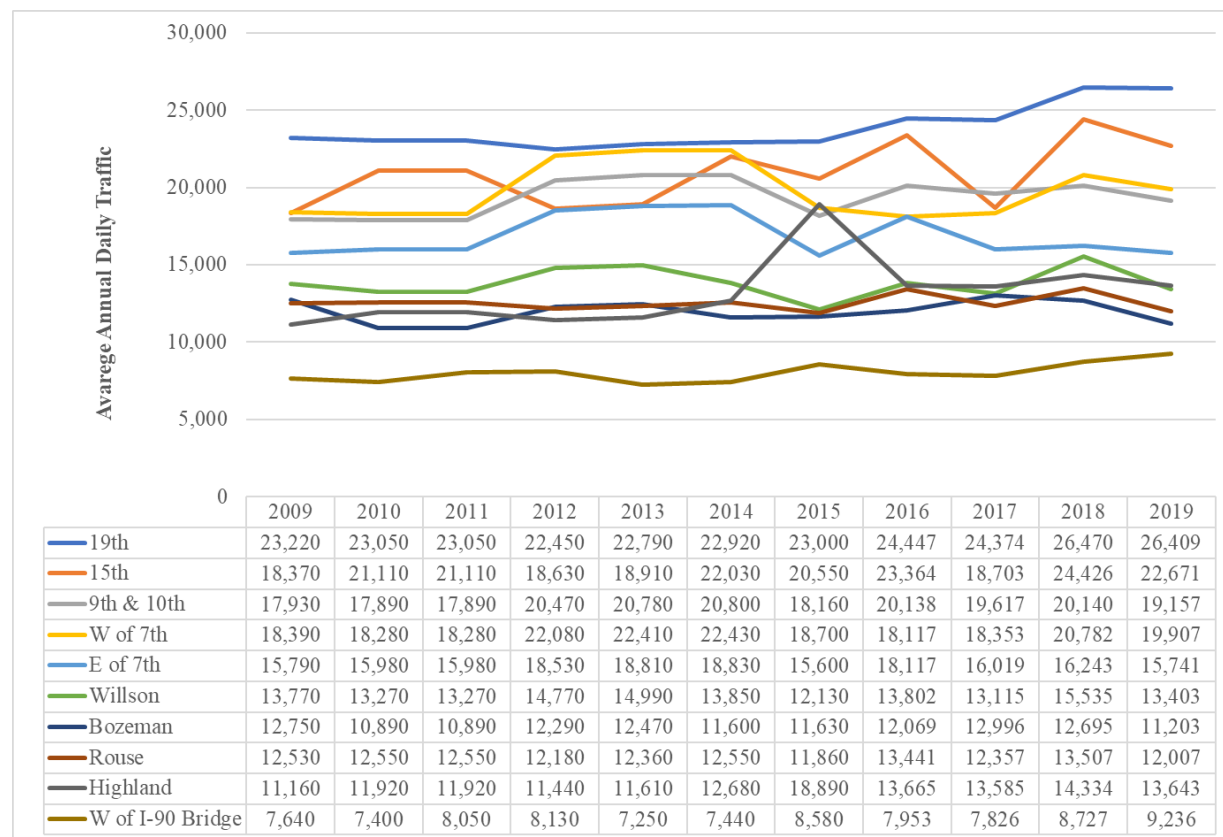
## 4. RESULTS

In this section, results are presented for traffic levels, through-truck counts, alternative routes, and noise readings.

### 4.1. Traffic Level Estimates

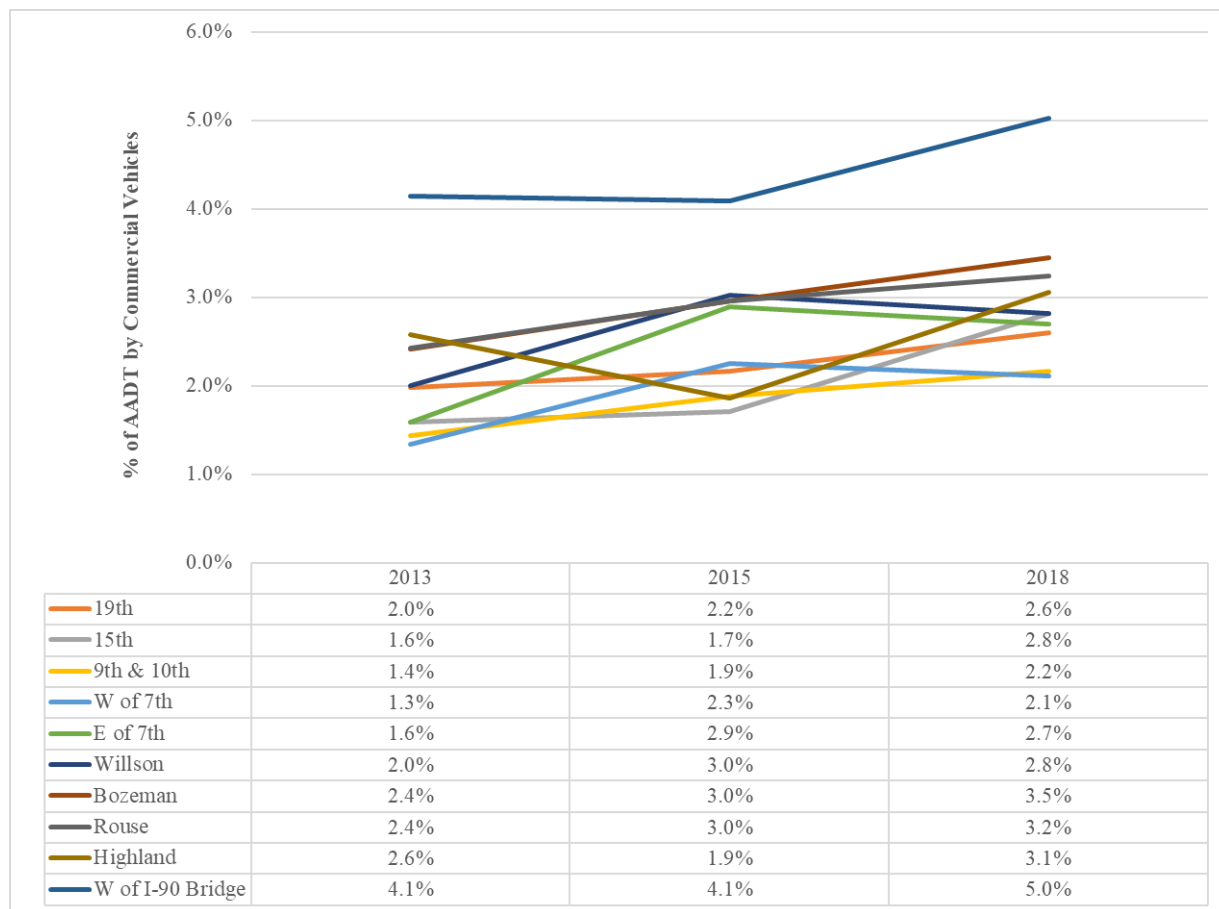
Average annual daily traffic (“AADT”) counts between 2009 and 2019 at the ten Main Street count locations (Figure 3) most relevant to this study were compiled in Table 2. Overall, it appears traffic along Main Street has increased over the past ten years. AADT increased at six of the ten locations, including adjacent to I-90 Exit 309 and at West Main Street at 19<sup>th</sup> Avenue. However, AADT remained level at 7<sup>th</sup> Avenue, and showed a decline at three downtown locations (Willson, Bozeman, and Rouse Avenues). Across the ten locations combined, AADT increased 8%.

**Table 2: AADT Traffic Counts**



Source: Compiled using the [Montana Department of Transportation Data Management System](#).

Table 3 presents the estimated share of the AADT taken up by commercial vehicles. Overall, the share of commercial vehicle traffic has increased across all ten locations between 2013 and 2018, by a combined average of 44%. The highest increases were at 15<sup>th</sup> Avenue and 7<sup>th</sup> Avenue, which increased 77% and 70% respectively. The location with the highest share of AADT by commercial vehicles, across all three years, was the location adjacent to the interstate.

**Table 3: Estimated Percent Commercial Vehicles**

Source: Compiled with assistance from the [Montana Department of Transportation Office of Traffic Data Collection & Analysis](#).

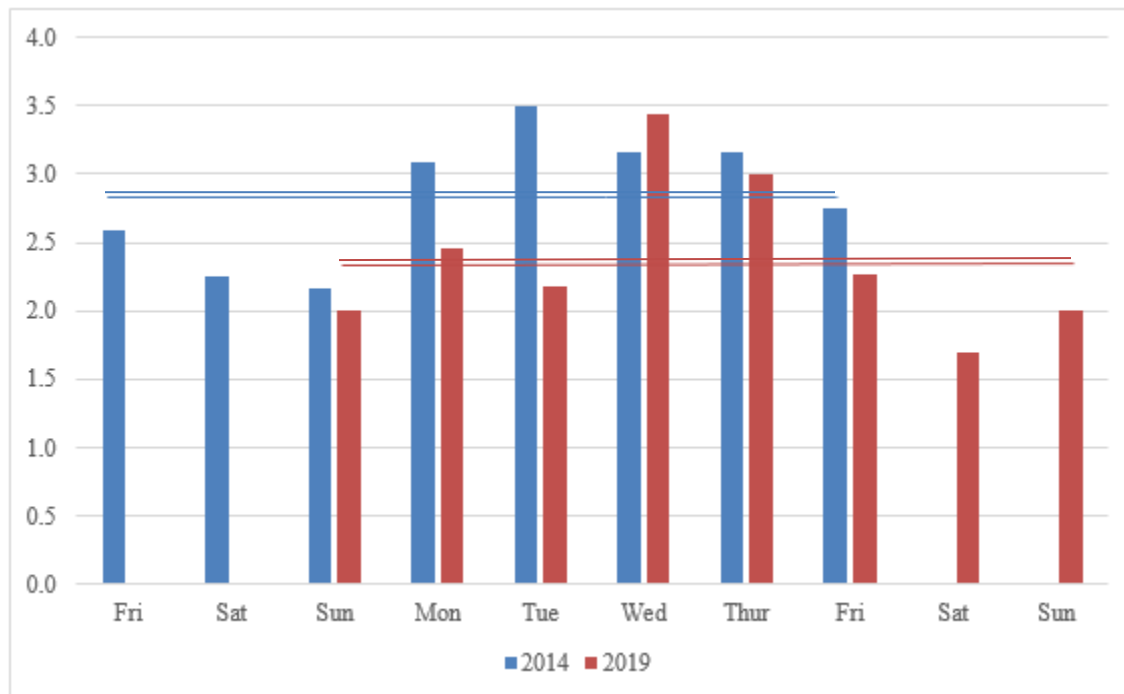
## 4.2. Through-Truck Counts

As summarized in Table 4, on average over half (53%, or 196 out of 373) of the large commercial trucks observed at East Main Street at Haggerty Lane travel through all the way to 19<sup>th</sup> Avenue. For comparison, the overall average was 34% (272 out of 796) for the 2014 dataset. As many as 9 large commercial trucks were observed traveling through between East Main Street at Haggerty Lane and 7<sup>th</sup> Avenue within one hour, while as many as 8 were observed traveling through to 19<sup>th</sup> Avenue within one hour. The prior study reported as many as 7 through-trucks within one hour making it to 19<sup>th</sup> Avenue. Average through-trucks per hour for 7<sup>th</sup> Avenue ranged from 1.8 to 4.0 and for 19<sup>th</sup> Avenue ranged from 1.7 to 3.4. In the 2014 dataset, through-trucks per hour at 19<sup>th</sup> Avenue had a higher range, between 2.3 and 3.5.

Across all observations, an average of 4.5 large commercial trucks per hour were observed at East Main Street at Haggerty Lane, while the average number of through-trucks was 2.7 at 7<sup>th</sup> Avenue and 2.4 at 19<sup>th</sup> Avenue. In the 2014 dataset, a slightly higher average of 2.8 through-trucks per hour was observed at 19<sup>th</sup> Avenue. Across all dates included in the present study, the highest rate of through-trucks per hour (3.4) was observed on Wednesday, August 28, 2019 while the lowest (1.7) was observed on Saturday, August 31, 2019. Through-trucks per hour were higher during weekdays than weekends for both the prior and present study.

**Table 4: Large Commercial Through-Truck Counts (08/25/2019-09/01/2019)**

	Sun (8/25)			Mon (8/26)			Tue (8/27)			Wed (8/28)			Thur (8/29)			Fri (8/30)			Sat (8/31)			Sun (9/01)		
	East Main	7th	19th	East Main	7th	19th	East Main	7th	19th	East Main	7th	19th	East Main	7th	19th	East Main	7th	19th	East Main	7th	19th	East Main	7th	19th
8am – 9am	3	3	3	10	6	3	5	1	0	6	2	2	9	4	4	6	3	3	3	1	1	2	2	2
9am – 10am	1	1	1	7	4	3	9	3	3	4	4	4	5	2	1	4	3	3	4	4	4	3	3	3
10am – 11am	5	5	5	9	5	4	5	4	4	5	1	1	10	6	5	7	4	3	3	2	2	0	0	0
11am – 12pm	3	3	3	4	1	1	8	4	4	6	5	5	12	9	4	4	1	1	NA	NA	NA	3	3	3
12 pm – 1pm	2	2	2	7	2	2	4	2	2	6	4	4	10	8	5	4	4	4	5	4	4	1	1	1
1pm – 2pm	1	1	1	8	2	0	3	2	2	4	3	3	6	2	2	9	4	3	1	0	0	NA	NA	NA
2 pm – 3pm	3	3	3	2	0	0	6	4	2	10	9	8	7	1	1	6	1	1	2	1	0	4	4	4
3pm – 4pm	1	1	1	10	6	6	9	2	2	3	2	2	6	2	2	7	4	3	2	2	2	3	2	2
4pm – 5pm	3	3	2	8	6	6	NA	NA	NA	2	2	2	2	2	2	7	3	2	1	1	1	4	4	4
5pm – 6pm	NA	NA	NA	NA	NA	NA	2	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6pm – 7pm	1	1	1	5	2	1	5	3	2	NA	NA	NA	4	4	4	1	0	0	2	2	2	1	1	1
7pm – 8pm	0	0	0	1	1	1	3	2	2	NA	NA	NA	NA	NA	NA	2	2	2	1	1	1	1	0	0
Total	23	23	22	71	35	27	59	28	24	46	32	31	71	40	30	57	29	25	24	18	17	22	20	20
Hours	11	11	11	11	11	11	11	11	11	9	9	9	10	10	10	11	11	11	10	10	10	10	10	10
Trucks/ Hour	2.1	2.1	2.0	6.5	3.2	2.5	5.4	2.5	2.2	5.1	3.6	3.4	7.1	4.0	3.0	5.2	2.6	2.3	2.4	1.8	1.7	2.2	2.0	2.0



**Figure 7: Through-Trucks Per Hour to 19<sup>th</sup> Avenue by Year and Day of Week**

Notes: As described in Section 3.2 above, 2014 dates spanned Friday, September 5 to Friday, September 12 while 2019 dates spanned Sunday, August 25 to Sunday, September 1. Horizontal bars approximate the through-truck per hour average for 2014 and 2019 observations, respectively.

A difference-in-means test<sup>12</sup> indicates that the mean level of through-trucks per hour was significantly lower in 2019 compared to data collected in 2014 at the 5% level ( $p=0.031$ ), though in practical terms the magnitude of the difference is relatively slight (from an average of about 3 to 2.5 through-trucks per hour).<sup>13</sup> This equates to an average decline of 5 trucks over the course of the day, from 34 trucks during a 12-hour period to 29, or a decline from about 235 through-trucks per week to 202. Comparing only Monday-Friday observations from the 2014 and 2019 datasets, the average rate of through-trucks per hour has declined from 3.1 to 2.7.

**Table 5: Comparison of Through-Trucks Per Hour (2014, 2019)**

Year	Observations	Mean	Std. Error	Std. Dev	95% Confidence Interval	
2014	96	2.83	0.177	1.733	2.48	3.18
2019	83	2.36	0.177	1.612	2.01	2.71
t=1.88; df=177; Ha: 2015≠2019, p=0.0623; Ha: 2015>2019, p=0.031						

Travel times varied by time of day, as well as by day of the week (Table 6). For the present study, the trip between East Main Street at Haggerty Lane and 19<sup>th</sup> Avenue took on average 0:09:37, and ranged from an hourly average of 0:07:20 in the 6 o'clock hour to as long as 0:11:55 in the 5 o'clock hour (a difference of 0:04:35), and a daily average between 0:09:03 on Sunday, August 25, 2019, to as long as 0:10:08 on Wednesday, August 28, 2019 (a difference of 0:01:05).

<sup>12</sup> Two-sample t-test with equal variances.



**Table 6: Average Through-Truck Trip Times by Time of Day and Day of Week**

Time Period	Avg Trip Time	Day of Week	Avg Trip Time
08:00 - 09:00	0:08:30	Sunday 08/25/2019	0:09:03
09:00 - 10:00	0:08:27	Monday 08/26/2019	0:09:25
10:00 - 11:00	0:09:33	Tuesday 08/27/2019	0:09:54
11:00 - 12:00	0:10:03	Wednesday 08/28/2019	0:10:08
12:00 - 13:00	0:10:46	Thursday 08/29/2019	0:09:36
13:00 - 14:00	0:11:45	Friday 08/30/2019	0:09:55
14:00 - 15:00	0:09:42	Saturday 08/31/2019	0:09:37
15:00 - 16:00	0:10:31	Sunday 09/01/2019	0:09:10
16:00 - 17:00	0:09:28	Overall Average: 0:09:37	
17:00 - 18:00	0:11:55		
18:00 - 19:00	0:07:20		
19:00 - 20:00	0:09:50		

### 4.3. Alternative Route Assessments

Table 7 summarizes conditions along the four alternative routes (see Figure 5). Over the past five years, travel conditions among the routes have changed. In particular, as the western part of the region has grown, a few traffic control devices have been added. In addition, average speeds along the 7<sup>th</sup> Avenue, 19<sup>th</sup> Avenue and SR 85 routes have declined while the average speed along the Main Street route has increased. As a result, while the average speed of the SR 85 route was 37.4 mph faster than the Main Street route in 2015, it is now only 25.0 mph faster. Total travel times between Route 1 and 4 have essentially inversed as well. The Main Street route previously had the longest trip time among the four routes. However, in the present study, this route averaged the shortest trip time (about equal to the trip time for the second route).

**Table 7: Alternative Route Conditions**

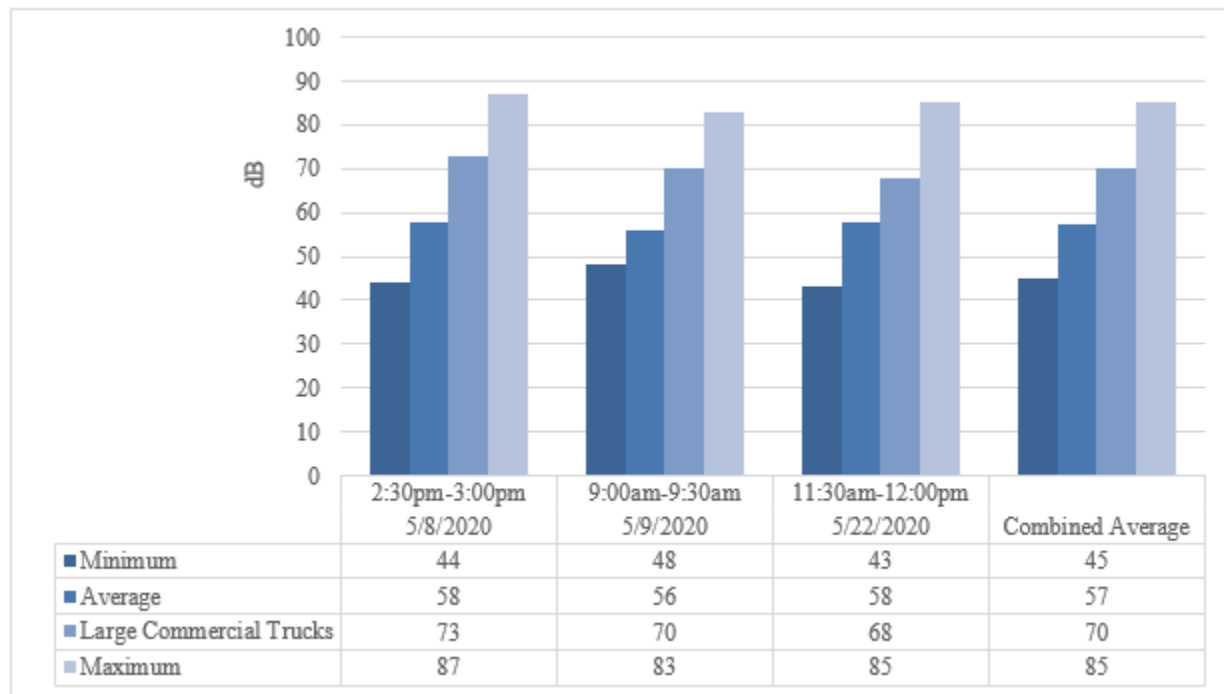
Route	Traffic Control Devices		Length (mi)	Time (min)		Average Speed (mph)	
	2015	2020	2015	2015	2020	2015	2020
1 - Main St	24	25	8.7	20	18	26.1	29.0
2 - 7th Ave	19	20	10.8	17	18	38.1	36.0
3 - 19th Ave	17	18	12.9	15	19	51.6	40.7
4 - SR 85	5	7	18.0	17	20	63.5	54.0

Notes: Trip lengths were carried forward from 2015 to aid in average speed comparisons. Trip time was rounded to the nearest minute. For 2020, the trip length and time values represent measurement averages for each route (two measurements for Routes 2 and 3, and three for Routes 1 and 4, as described in Section 3.3).

### 4.4. Transportation Noise Measurements

The results of sound measurements taken at three locations along Main Street in downtown Bozeman are summarized in Figure 8 and Table 8. Across the three sessions, the readings ranged between 45 decibels and 85 decibels, with a combined average of 57 dB. The two loudest

vehicles observed during the sessions were an unmuffled sedan (85 dB) and motorcycle (87 dB). Observed readings for several additional vehicle types were noted during the sessions as well. Across the three sessions, a total of 11 large commercial trucks were observed. Instantaneous observed sound readings for these vehicles ranged from a low of 65dB to a high of 82 dB, with a combined average across the three sessions of 70 dB. This amounts to a level 22% higher than the three-session overall sound level average of 57 dB.



**Figure 8: Transportation Noise Measurements**

**Table 8: Transportation Noise Measurements**

	5/8/2020	5/9/2020	5/22/2020	Combined Average
	2:30pm-3:00pm	9:00am-9:30am	11:30am-12:00pm	
	Bozeman Ave	Wallace Avenue	Willson Avenue	
Minimum	44	48	43	45
Average	58	56	58	57
Maximum	87	83	85	85
Large Commercial Trucks				
1	71	69	65	
2	78	73	65	
3	66	67	73	
4	71			
5	82			
Average	73	70	68	70
Average Increase Over Overall Average	26%	24%	17%	22%
Concrete Mixer			68	
Express Delivery Truck	68	75		
Large RV	74			
Pickup with Diesel			69	
Pickup Truck with Livestock Trailer	77	67	69	
Small Commercial Truck	70	67	62	
Streamline Bus	70	68		
Unmuffled Sedan			85	
Unmuffled Motorcycle	87			
dB	Common Reference Levels Provided by Sound Meter			
40	Quiet Library; Park			
50	Quiet Office; Quiet Street			
60	Normal Conversation at 3ft			
70	Busy Traffic; Vacuum			
80	Busy Street; Alarm			
90	Diesel Truck; Power Tools			

Source: Observations collected in May 2020, and compiled by WTI staff using the Sound Meter application.

## 5. CONCLUSIONS

Together, the increase in the estimated share of AADT by commercial vehicles at 7 out of the 10 locations between 2015 and 2018 (Table 3) along with the increase in the overall proportion of large commercial trucks traveling through from East Main Street at Hagerty Lane to 19<sup>th</sup> Avenue between the 2014 (34%) and 2019 (51%) datasets (see 4.2 above) indicate a trend toward a greater presence of large commercial trucks along Main Street in downtown Bozeman.

While the through-truck counts presented in Section 4.2 do suggest a slight decline in overall commercial through-truck traffic (from an average of 2.8 to 2.4 through-trucks per hour) between 2014 and 2019, it is important to stress that the magnitude of the change is relatively slight (from an average of about 3 to 2.5 through-trucks per hour). In addition, as noted above (3.2), the sample sizes of video data for both the 2014 and 2019 datasets were very small (about 2% of a year's worth of data). In contrast, the traffic levels described in 3.1 and presented in 4.1 draw from data collected as part of the Montana Department of Transportation's [count station program](#). It is possible the observed decline in through-truck counts could be related to changes in commercial truck activity over Labor Day Weekend, which would have had a greater impact on the 2019 dataset; Labor Day took place on Monday, September 1, 2014, four days before the first date of that year's data collection.

The prior study recommended that through-trucks take Route 4 (SR 85/Jackrabbit Lane), based largely on travel time savings over the Route 1 trip through downtown Bozeman. In this updated study, that travel time saving seems to have eroded, as the trip times between Routes 1 (Main Street) and 4 (SR 85/Jackrabbit Lane) have inversed (see Table 7). It is likely that changes in the average speeds and travel times for the four routes included in this study may be due to traffic signal adjustments implemented in the intervening years.<sup>14</sup> In addition, it is possible that overall reductions in travel related to the COVID-19 pandemic had more of an impact on the travel time for Route 1 compared to Route 4, as the congestion typically experienced traveling downtown was significantly reduced. Nevertheless, travel along Route 1 is likely to remain more vulnerable to variability in travel conditions due to the significantly higher number of traffic control devices (Table 7) as well as the greater likelihood of intermittent disruptions due to parallel parking, left turns, and the overtaking of slower travelers (i.e. bicyclists).

This study is an opportunity to bring forward renewed consideration of the human health risks from the elevated particulate matter emissions (see Table 1) from heavy-duty diesel vehicles as well as the transportation noise these vehicles generate. The transportation noise measurements presented in Figure 8 and Table 8 (indicating a large commercial truck average reading of 70 dB for a 22% increase above the overall average) are largely consistent with those reported in the 2015 study, which found large trucks increased sound levels 7 to 16 dB for an increase in noise levels of 9 to 23%. While evidence for the travel time savings from an alternative truck route along SR 85 may have eroded, a case for designating an alternative truck route based on the health and quality of life impacts (as measured by exhaust pollution and noise) for pedestrians, cyclists, and those patronizing local businesses remains strong.

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<sup>14</sup> See the "SF 139 – Bozeman Signal Safety" project listed for MT-85 and US-191 in the section on District 2 Major Highway Projects in the Montana Department of Transportation [2017-2021 Statewide Transportation Improvement Program](#).

***Key Takeaways***

- *Traffic along Main Street has increased on average about 8% between 2009 and 2019;*
- *Commercial vehicles are taking up a larger proportion of overall traffic;*
- *Through-trucks per hour may have slightly declined; and,*
- *An alternative truck route could offer reliability improvements for commercial traffic, and public health and quality of life improvements for the Bozeman community.*



## APPENDIX

This appendix provides photos showing the scale (physical size) of large commercial trucks as compared to other vehicles (Figure 9), as well as travelers (Figures 10-12) in Downtown Bozeman.

These Figures 9-12 and the cover photo were taken by report author Andrea Hamre. See the 2015 report for additional photos, courtesy of the Downtown Bozeman Partnership.



**Figure 9: Large Commercial Truck at East Main Street and Bozeman Avenue**



**Figure 10: Bicyclist and Pedestrian along East Main Street**





**Figure 11: Bicyclist Riding Along East Main Street at Bozeman Avenue**



**Figure 12: Pedestrian with Pet and Bicyclist Crossing Main Street at Wallace Avenue**