Roadblocks to Quality of Life

Daniel Mendoza, PhD

Mark Jansen, PhD

February 4, 2025

Roadblocks to Quality of Life

Table of Contents

Executive Summary

Commuting times in Salt Lake County have increased over the last decade and a half at a faster rate than commuter increase. A recent report shows that Salt Lake City commuters lost 25 hours per year to congestion in 2024, a 9% increase from 2023. Since 2022, Salt Lake City has ramped up traffic calming efforts throughout the city, with several ongoing and planned projects which include traffic humps and road diets. The prolonged construction has caused substantial business losses and even forced some businesses to close, especially in the Sugar House area. These changes, while aimed at improving safety and livability, may also be contributing to increased congestion and longer commute times, further compounding existing challenges. As the Salt Lake Valley struggles with poor air quality, it is critically important to consider the impacts of traffic congestion.

Road design changes have direct impacts on the intended location as well as the surrounding areas. When a road is modified to reduce traffic flow or speed, traffic may be diverted to nearby streets which could inadvertently create safety concerns for those adjacent areas. Speed humps, traffic light synchronization, and road diets are common traffic calming measures. A concern associated with these measures is that the slowdown is often accompanied by aggressive acceleration to make up time which may worsen safety and in addition to the other adverse consequences.

We estimate emission differences between a synchronized and anti-synchronized traffic light section of road. The model examines exhaust emissions as well as brake and tire wear for eight vehicle types ranging from passenger vehicles to tractor-tractor trailers during winter and summer months. The findings show increased emissions ranging from 10.2% for passenger cars to 50.9% for tractor-trailers. These estimates are conservative as factors such as idling time and multi-vehicle congestion, which accentuates the differences, were not included.

The proposed next steps include analyzing new data (e.g., vehicle specific traffic counts on each road type) as well as modeling the congestion impacts on pollution levels. As there are well-understood negative health impacts of elevated pollution and congestion, as well as personal time loss, these must be weighed against the described benefits associated with traffic calming. An economic analysis, which includes the costs of construction, loss of personal time, health outcomes, among other factors, is recommended, particularly in the development and implementation phase of any road modification projects.

Part 1: The Salt Lake City Situation

Commute Time Trends

The United States Census Bureau produces 1-year, 3-year, and 5-year estimates as part of its American Community Survey program. The 5-year estimates are recommended for most purposes as they contain the largest sample size and considered the most reliable dataset. The 5-year table was used to visualize the commute time and number of commuters in Salt Lake County from 2010 to 2023 (Figure 1) showing a general upward trend in commute times over the years (United States Census Bureau, 2025). The more recent years (2020-2023) are above the trendline meaning that commute times are longer even after considering the impact of the number of commuters. The figure also shows the trendline for the full study period and recent observations stand out as anomalies. For instance, in 2020, commute times are noticeably higher than in 2018, even though the number of commuters is comparable. Similarly, in 2022, commute times exceed those recorded in 2017, despite the two years having nearly the same number of commuters. A similar pattern is observed between 2023 and 2016.

These discrepancies suggest that factors beyond the number of commuters are contributing to increased commute times. Changes in road design, such as lane reductions, traffic calming measures, or construction projects, may be playing a significant role. Other potential influences include altered traffic patterns, shifts in transit policies, or the increased presence of delivery vehicles in the post-pandemic period. These findings highlight the need for further investigation into the underlying causes of these anomalies and their impact on commute efficiency and quality of life in the region.

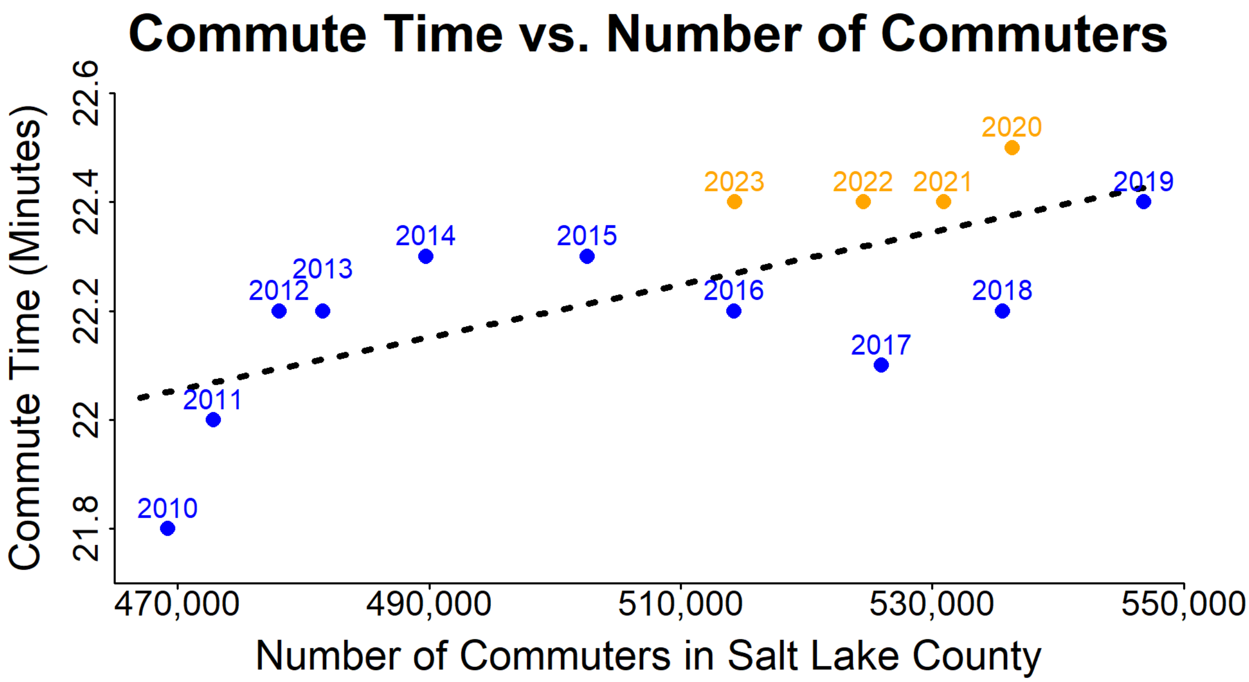


Figure 1. Commute time and number of commuters in Salt Lake County from 2010 to 2023 along with the linear trend.

Road Design Changes

Salt Lake City has been implemented several traffic calming initiatives (Salt Lake City Transportation, 2022). As part of this project, 58 speed humps installed in 2023, and 7 in 2024 (Figure 2.a). Several other areas are undergoing a review which includes public comment involving the Central Sugar House neighborhood (Figure 2.b) (Livable Streets Team, 2024) and Sunnyside Avenue at 1400 E.

a) b)

Figure 2. a) Locations of speed humps installed in 2023 and 2024 in the Capitol Hill neighborhood and b) proposed traffic calming devices in the Central Sugar House area.

Construction-Related Closures

The large number of road construction projects have caused substantial strain on the transportation network and impacted communities and businesses. Three well-known recent examples within Salt Lake City are the construction projects taking place in the Sugar House neighborhood, the 200 S development, and the South Temple Tower. The Sugar House neighborhood has endured multiple road construction projects in the past few years which have caused the loss of several businesses located along Highland Drive and 2100 S (KSL NewsRadio 102.7FM, 2024; Stuart Melling, 2024). The 200 S development which included updates to public transit infrastructure also caused strain on businesses and traffic flow due to its duration (City Weekly, 2023). The South Temple Tower project (Tony Semerad, 2024) inserted a chicane into one of the busiest intersections in Salt Lake City which has caused slowdowns and confusion in addition to reduced safety and vehicular crashes.

Air Quality Trends

Air quality is a first order problem in Salt Lake City as it consistently ranks among cities with the highest levels of particulate matter and ozone (American Lung Association, 2024). Some of the worst air quality periods occur during winter time atmospheric inversions (Bares et al., 2018) when pollutants stay trapped inside the valley. Motor vehicles are responsible for approximately 50% of overall pollution (Utah Division of Air Quality, 2021). Moreover, motor vehicle emissions are released at a height that is closer to where people breathe compared to other sources. Therefore, exposure to traffic emissions is particularly higher for individuals living, working, or commuting near roadways, leading to increased risks of respiratory and cardiovascular diseases, as well as adverse developmental effects in children (Arias-Pérez et al., 2020; Health Effects Institute, 2022).

Factors Contributing to Traffic Congestion

Several factors are associated with traffic congestion increases. Utah has consistently been one of the fastest growing states in the country for the past decade. At first, the largest contributor was natural increase (births), but recently this has shifted to net migration (62% in 2023) (Albers et al., 2022). Since most of the population lives in the Wasatch Front (2023 population > 2,800,000), an area that is naturally bound by mountains and lakes, the population density has steadily increased resulting in strain along transportation corridors.

Additional factors that have increased congestion are associated with recent events including the COVID-19 pandemic. During the pandemic, public transit use decreased substantially but had mostly recovered as in 2024 UTA reported that ridership had reached nearly 40.5 million trips (Utah Transit Authority, 2025). Furthermore, the pandemic resulted in an exponential increase in delivery services for goods and food. This nationwide trend also results in additional freight trucks, particularly those used to fulfill same-day or next-day orders.

Part 2: Literature Review

How do Road Design Changes Impact Air Quality?

Road design changes cause a variety of intended and unintended consequences. Salt Lake City has implemented a number of road design changes in an effort to reduce speed. Slowing traffic down is an intended consequence, however, congestion, lost to time with family, and the associated increased pollution is an unintended consequence. To avoid congestion, drivers may choose to travel on parallel or adjoining roads, a phenomenon called “rat running” which increases congestion and pollution on those roads, as well as decreasing safety (Tarrant, 2016).

Speed Humps

Speed humps (often referred to as speed bumps) are a relatively common traffic calming device (Ullah et al., 2016) and have been added to many streets in Salt Lake City (Figure 3) (Salt Lake City Transportation, 2024). In urban areas, speed bumps are likely to increase vehicle emissions for several reasons. During the approach to a speed bump, vehicles reduce their speed to avoid damage. Once the speed bump is cleared, drivers tend to accelerate to return to their previous speed. This brake-accelerate cycle leads to higher fuel consumption and increased emissions compared to driving at a steady speed. Repeated acceleration increases the engine load which results in higher pollutant emissions. Vehicles traveling at steady speeds achieve optimal fuel efficiency and the irregular stop-and-go cycles associated with speed humps reduce fuel efficiency and increased emissions per distance traveled. An example of this is now visible on Virginia Street where seven speed bumps were installed on a half-mile section of road leading up to 11th Avenue.

Figure 3. Speed hump example in Salt Lake City (Salt Lake City Transportation, 2024)

Speed humps can increase congestion concerns due to increased braking, accelerating, and idling. The latter is a consequence of vehicles stopping or coming to a near-stop behind vehicles navigating the speed bump. All of these behaviors can exacerbate emissions since vehicle engines consume more fuel, sometimes substantially more, to travel the same distance.

Traffic Light Synchronization

When traffic lights are synchronized (i.e., sequential green lights) they improve traffic flow and mitigate congestion (City of Laguna Niguel Department of Public Works, 2024). Poorly or anti-synchronized traffic lights often achieve the opposite effect, decreasing traffic flow efficiency (Aleko & Djahel, 2019).

Similar to speed humps, poorly timed traffic lights increase the amount of time spent accelerating, idling, and decelerating, which increases fuel consumption and pollution when compared to traveling at a constant speed (Ghazal et al., 2016). This may happen even when traffic volumes are low. We note that high traffic density areas are particularly vulnerable to degraded air quality due to increased idling at red lights. Furthermore, bottlenecks generated by anti-synchronized lights reduce overall network traffic efficiency, exacerbate congestion, and may lead to dangerous driving (Qi et al., 2016).

Road Diets

Road diets are defined as the reallocation of vehicle travels lanes to other uses such as parking, sidewalks, and bike lanes(United States Department of Transportation, 2021). There are numerous impacts of road diets on traffic flow, congestion, and emissions.

Since reducing the number of travel lanes effectively reduces travel capacity, increased congestion is a common outcome of road diets (Remache-Patino et al., 2023). The increased acceleration and deceleration cycles caused by road diets also leads to higher overall emissions. Although road diets may slow traffic by reducing unsafe lane changes, severe congestion, particularly if there is only one lane of traffic remaining is a possibility (Remache-Patino et al., 2023). Moreover, to avoid congestion, drivers may travel along parallel or adjoining roads to avoid such congestion. An example of this can be observed on 11th Avenue which has seen a large increase in vehicular traffic since South Temple was changed from a two-lane road to a one-lane road.

Although adding bike lanes, wider sidewalks, and exclusive use bus lanes may encourage alternative transportation, this is only feasible when there is sufficient support (e.g., public transportation is a door-to-door solution), people feel safe, and conditions are conducive (e.g., favorable weather).

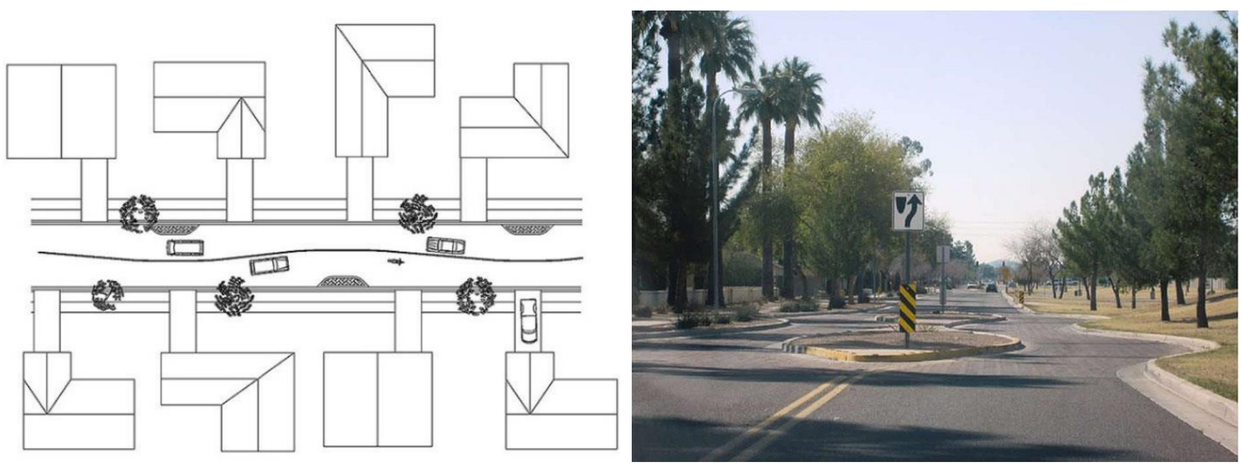
There are some important considerations regarding the effectiveness of road diets. Roads with excess capacity (e.g., underused additional lanes) may appear to be good candidates based on current usage. However, roads that are already experiencing congestion will likely exhibit negative outcomes. The availability of nearby roads that can absorb diverted traffic may mitigate some of these impacts. Additionally, it is critical to ensure proper signal timing and well-designed alternative facilities to minimize negative effects including congestion and increased emissions. A further example of a road diet is 1100 E north of 2100 S. The road was narrowed and protected bicycle lanes were added, however they are relatively difficult to navigate and are often blocked by parked vehicles.

Safety Concerns

A well-studied side effect of traffic calming, including stop signs, is the immediate rebound effect of attempting to make up for time lost due to delays (City of Portland, 2025). Drivers that encounter red lights (e.g., anti-synchronized) may accelerate aggressively and potentially, dangerously, to beat the light. This behavior leads to increased emissions and a reduction in pedestrian safety. Similar behavior can take place between speed bumps or spaces with road diets where drivers increase speed between the traffic calming features. Challenging traffic light timing may also lead to frustration and unsafe driving patterns such as frequent acceleration followed by sudden deceleration, abrupt lane-switching, among others. These behaviors not only waste fuel and increase emissions but also endanger all road users. Another consequence of traffic calming measures is that it exacerbates the accordion effect (Tournoux et al., 2009) whereby non-leading vehicles create gaps between them after navigating through a traffic calming device and often accelerate aggressively to close the gaps.

Alternative Solutions

Chicanes are horizontal deviations (Figure 4) which reduce traffic speeds (Sayer et al., 1998) but generally maintain overall traffic flow without abrupt stops, maintaining safety as well as reducing congestion impacts (Zhang et al., 2020). Chicanes are often considered an improvement over speed humps (Jassal & Sharma, 2024). Another solution is adaptive traffic signal systems which use sensors and real-time data to adjust signal timing dynamically, optimizing traffic flow and reducing unnecessary stops (Wang et al., 2018). Green wave optimization is the process of synchronizing traffic lights to maintain a steady traffic flow and reduce the need to stop at intersections (Warberg et al., 2008). The main element of these alternative solutions is the lowered congestion resulting from the elimination, or reduction, of unnecessary stops.



a) b)

Figure 4. a) Chicane schematic and b) chicane with a median (U.S. Department of Transportation, 2025b).

How do Longer Commuting Times Reduce Residents' Quality of Life?

Longer commuting times can be detrimental to residents' quality of life due to the time lost in congestion that could be spent with family, church, and other personal activities. Across the U.S., traffic delays due to congestion has substantially increased average commuting times. The American Community Survey reported that 2019 the average one-way commute reached a record high of 27.6 minutes compared to 25.0 minutes in 2006 corresponding to an overall increase of 10% in 14 years (Burd et al., 2021). These delays have been shown to increase anxiety (Baek et al., 2023) and promote aggressive driver behavior thereby reducing road safety (Haje & Symbaluk, 2014) and even workplace safety (Hennessy, 2008).

Often there are few or no viable alternatives to personal vehicles as a primary means of transportation. Public transportation may be unavailable, infrequent, inconvenient, or costly (e.g., public transit fare for a family of 4 may have a comparable cost as using a taxi or ride-share service for shorter distances) (Perrotta, 2017). Lack of developed infrastructure (e.g., lack of benches or shelters at bus stops) (Miao et al., 2019), infrequent or untimely maintenance (e.g., prompt snow removal for safe access from a bus stop to the bus), and safety concerns (e.g., lack of appropriate lighting and security) (Hsu et al., 2019) may also make public transit impractical.

Traffic calming measures are also known to cause a substantial safety concern in the form of delays experienced by public service and emergency response vehicles (U.S. Department of Transportation, 2025a). Fire trucks, buses, garbage trucks, and snowplows were found to face delays of up to 10.7 seconds per traffic calming device depending on surrounding conditions (Atkins & Coleman, 1997). "A risk/benefit analysis also demonstrated that traffic-calming devices have more of a negative impact than a positive impact to the community (Bunte, 2000)."

Congestion can cause commercial entities to move to less-congested areas to maintain travel time stability (Sweet, 2011). There are several examples of local and non-local businesses that have either moved away or remained away from urban cores due to concerns including congestion. The exodus of residents and businesses from urban cores has several downstream implications including a lowered tax base and school closings. Ultimately, the compounded effects of lowered commercial and residential activity in urban areas can debilitate and effectively hollow out a city's core (Fee & Hartley, 2011). Additionally, speed humps have been shown to reduce residential property values (Graham & Jones, 2019).

Part 3: Micro-Level Analysis

Impact on Personal Time

In June 2022, the Salt Lake City Council adopted an ordinance reducing local speed limits to 20 miles per hour (Salt Lake City, 2022). This effort involved the replacement of 575 signs from 25 to 20 miles per hour and was part of the Safe Streets and Vision Zero programs (Salt Lake City Transportation, 2022). The 2024 INRIX report shows that Salt Lake City commuters lost 25 hours per year to congestion in 2024 which is a 9% increase from 2023 (INRIX Research, 2024). The economic cost of congestion was estimated to be $16.89 per hour in 2022 which includes fuel costs and lost productivity (resilience, 2023). "Long commutes make it more difficult for families to spend time together. And when they finally get home from work, many parents are too road worn to join the kids' effort to build a fort out of pillows, chair, and blankets." (Staley & Balaker, 2006). The impact of congestion on the loss of personal time cannot be overstated.

Simulations

The U.S. Environmental Protection Agency's MOVES vehicle emissions model (Vallamsundar & Lin, 2011) was used to estimate $PM_{2.5}$ emissions for two scenarios to compare the impact of synchronized and anti-synchronized traffic lights. MOVES provides emission rates, quantified as grams per mile, for processes associated with vehicle use. The four processes modeled are: 1) running exhaust, 2) crankcase exhaust, 3) brake wear, and 4) tire wear. Emission rates are dependent on several factors including vehicle type, speed, and ambient conditions.

The road segment that we study is composed of seven city blocks, each 660 feet in length, and the six intersecting roads, each 132 feet in length. This reflects the standard dimensions of a typical street in Salt Lake City. This length was chosen because it is approximately one mile length (specifically 5412 feet). The synchronized traffic light scenario simulates free flowing traffic at 25 mph. The anti-synchronized traffic light scenario simulates a complete stop at each of the six intersections along the transect followed by an immediate acceleration towards 25 mph. This simulation does not include idling time and assumes constant and conservative acceleration and deceleration. Adding idling time or more aggressive acceleration would lead to greater a greater divergence in the two scenarios as we later discuss.

Acceleration and deceleration rates were assigned specifically to each of the eight modeled vehicle types: (1) gasoline-powered passenger vehicles, (2) diesel-powered passenger vehicles, (3) gasoline-powered light trucks (SUVs or light pickup trucks), (4) diesel-powered light trucks, (5) diesel delivery trucks, (6) diesel transit buses, (7) diesel tractor-trailers, and (8) diesel refuse trucks. These acceleration and deceleration rates determined the road distance each vehicle spent within a speed range to estimate emissions derived from the distance multiplied by the emission rate corresponding to the vehicle type, speed, and ambient conditions. The heavier vehicles, due to their lower acceleration, spend more time in the lower speed bins, with the tractor trailer never reaching 25 mph after the first speed bump.

To capture the widest range of ambient conditions, the simulations were run for the average high and low temperatures in January (25°F and 35.6°F) and July (71.5°F and 92°F). The July low and high temperature scenarios assume the use of air conditioning and its resulting increase in running exhaust emissions. The emission rates for passenger cars are shown in Figure 5. Running exhaust and crankcase exhaust emissions are highly dependent on temperature and speed as shown in Figures 5.a and 5.b, respectively. The July low and high temperature scenarios are nearly identical as the temperature difference has no meaningful impact on exhaust emissions. Brake and tire wear are independent of temperature, with the former (Figure 5.c) showing a steeper decrease at lower speed bins, and the latter (Figure 5.d) showing a linear decrease.

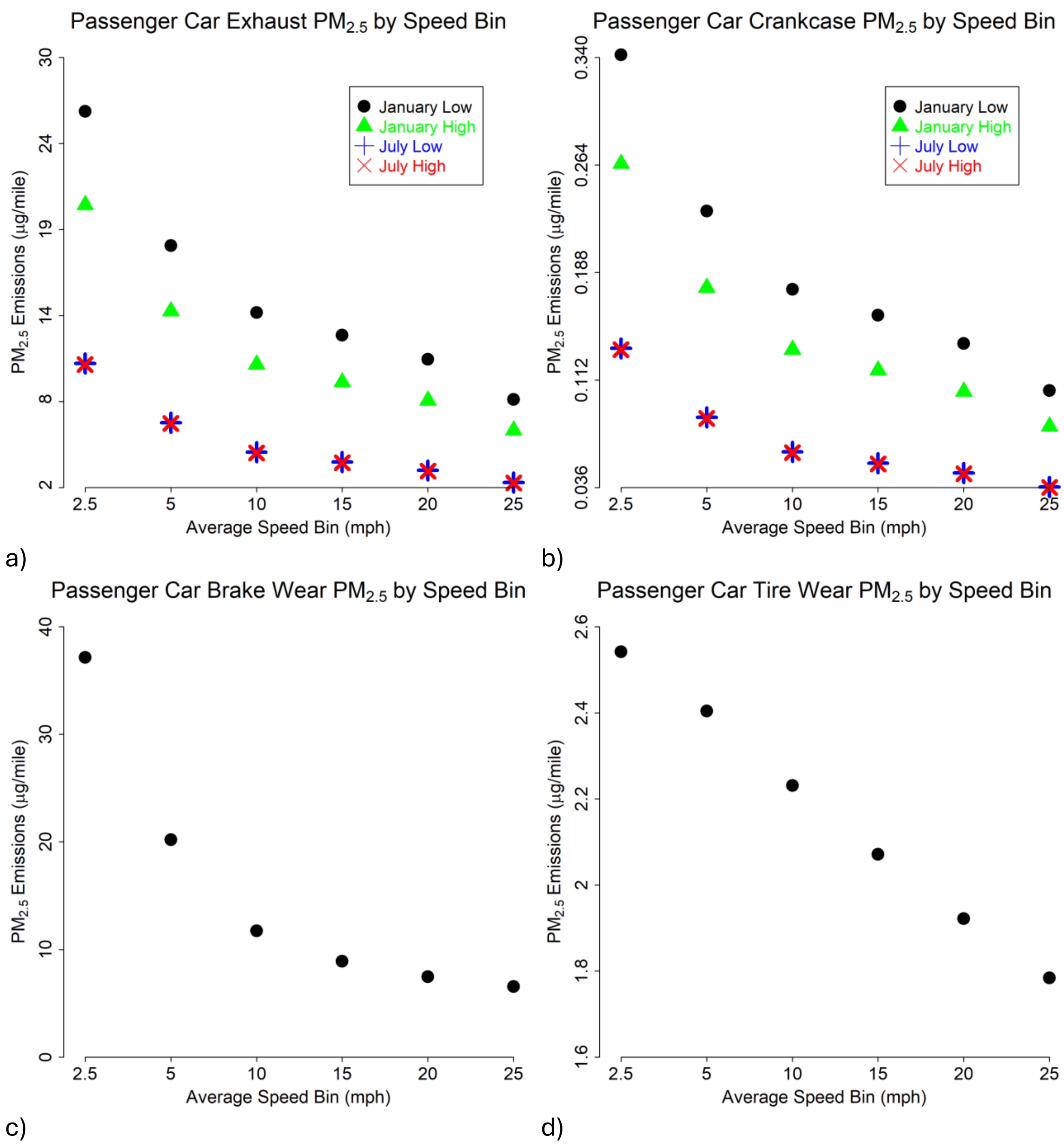
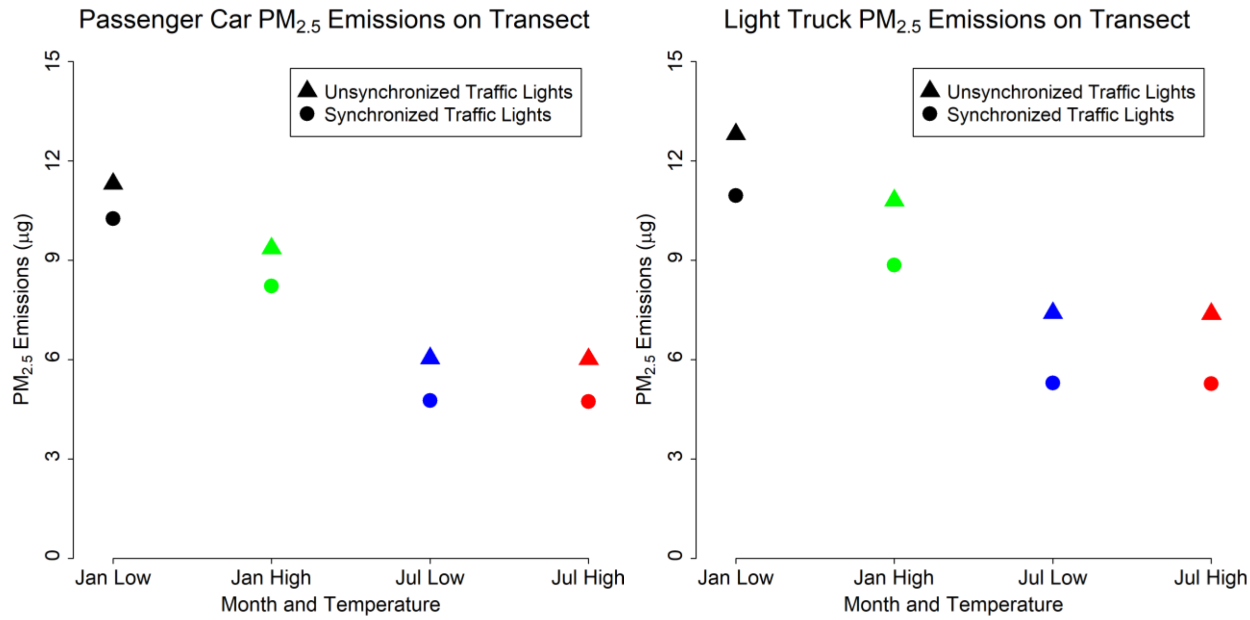


Figure 5. Modeled passenger $PM_{2.5}$ emission factors for a) running exhaust, b) crankcase exhaust, c) brake wear, and d) tire wear by average speed bin.

The resulting emissions for each of the eight modeled vehicle types are shown in Figures 6 and 7 and the emission differences are listed in Tables 1 and 2. The gasoline passenger vehicle (Figure 6.a) and light truck (Figure 6.b) emissions follow a similar pattern. Since brake and tire wear emissions are not temperature dependent, they comprise a larger share of emissions in the warmer scenarios because exhaust emissions are lower in these conditions. As diesel vehicle $PM_{2.5}$ emissions do not exhibit temperature sensitivity (Choi et al., 2010), all six diesel vehicle emission results are shown in Figure 7. Transit buses have engines optimized for frequent start-stop cycles and show the lowest differences between scenarios (Table 2). Because tractor trailers do not reach 25 mph (and lower per mile emissions), they exhibit the largest emissions difference between the synchronized and anti-synchronized scenarios. Refuse trucks, while lighter than tractor trailers, often have less advanced fuel efficiency technologies on board and are generally older.



a) b)

Figure 6. Modeled $PM_{2.5}$ emissions on stoplight transect for synchronized and unsynchronized traffic lights for gasoline a) passenger cars, b) light duty trucks for the high and low temperatures in January and July.

Table 1. Emissions increase (%) due to anti-synchronized traffic light scenario compared to consistent 25mph driving (synchronized traffic light) by gasoline vehicle type.

Month and Temperature	Passenger Car	Light Duty Truck
January Low	10.20%	16.97%
January High	13.77%	22.04%
July Low	26.85%	39.84%
July High	27.02%	40.07%

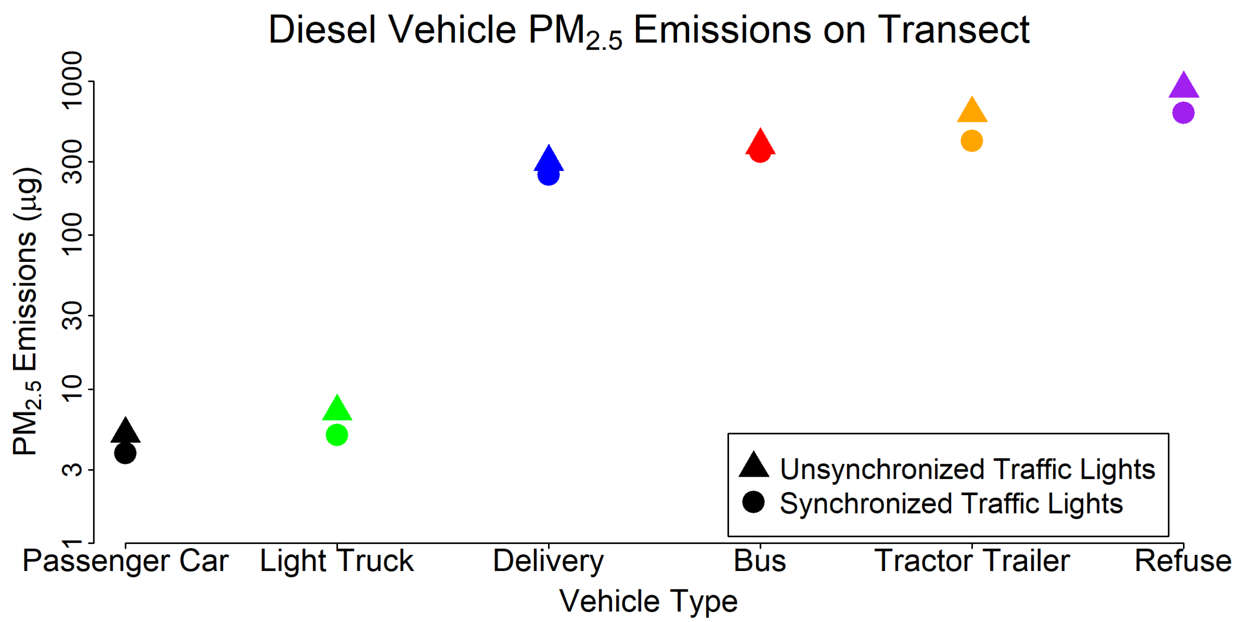


Figure 7. Modeled $PM_{2.5}$ emissions on stoplight transect for synchronized and unsynchronized traffic lights for diesel vehicles.

Table 2. Emissions increase (%) due to anti-synchronized traffic light scenario compared to consistent 25mph driving (synchronized traffic light) by diesel vehicle type.

Passenger Car	Light Duty Truck	Delivery	Transit Bus	Tractor Trailer	Refuse Truck
33.68%	42.31%	21.33%	10.38%	50.90%	43.44%

The modeled anti-synchronized scenario results in the lowest possible emissions as it does not account for idling emissions while waiting at the traffic light, assumes the smoothest acceleration, as well as controlled braking. This scenario is relatively unlikely to occur in real-world driving situations because idling time at traffic lights is rarely zero. Additionally, drivers accelerate and brake more aggressively, both due to the accordion effect (i.e., where the trailing cars take more time to accelerate to speed after a stop thus creating larger gaps) (Tournoux et al., 2009), as well as to try to beat the next traffic light. Frequent lane switching, and the associated acceleration and deceleration, is not modeled here. The inclusion of these factors could potentially increase the emissions of the anti-synchronized scenario by up to 50%.

Replacing the stop lights with speed bumps would yield similar modeled results and potentially increase the emissions difference between passenger vehicles and heavier vehicles. Speed bumps affect vehicle speed at various rates, with larger vehicles slowing down more than smaller vehicles (Teja & Jyothi, 2017).

Potential Future Analyses

The impact of road diets on vehicle emissions would vary substantially on the diet format and existing congestion levels. For example, a road diet is likely to minimally affect traffic flow during off-peak hours, but reducing the number of travel lanes during peak hours would dramatically increase congestion due to the reduced road capacity.

Although seasonal road construction also has substantial effects on congestion, the direct impacts are understudied (Castañeda et al., 2025). Similarly, mapping accident locations to specific road designs in Salt Lake City would be beneficial to quantify the efficacy of different measures. Congestion modeling is the next step to develop scenarios where traffic efficacy is included in the road network design effort.

Part 4: Next Steps

Additional Data Requirements for Macro-Level Analysis

Publicly accessible data is primarily available for large roads including highways and arterial roads. However, limited data is available on smaller roads including collector and local roads. While larger roads have automatic traffic counters, traffic on smaller roads is sometimes monitored through short-term campaigns using temporary counters. As these counters are moved around, they do not provide comparable data that can be used to assess differences over longer horizons. Additionally, vehicle speed data, residency time (i.e., the amount of time a vehicle spends in a specific location), and vehicle spacing are almost nonexistent. As the full impact of emissions is based on both the vehicle specific emission rates as well as the vehicle miles traveled on each road type, the latter needs to be estimated. While traffic counters are present in some roads, vehicle type disaggregation data is less available, particularly on smaller roads.

Framework for Analyzing the Trade-Offs of Traffic Restrictions and Road Closures

Pollution levels

Expanding the simulation study to show different scenarios as well as extrapolating results across the city and vehicle fleet would provide a more realistic set of pollution emissions. Additional traffic related pollutants such as elemental and organic carbon should also be studied (Shah et al., 2004) as they incur substantial health outcomes and can be used to evaluate the impact of traffic measures (Keuken et al., 2012). Future research can include the use of congestion models that simulate real-world traffic conditions which include vehicle interactions to portray more realistic driving conditions.

Health Impacts

When assessing the health impacts associated with road changes, one should consider not only the direct effects of slowing traffic, but also indirect effects. The additional pollution generated from traffic congestion affects drivers on the road, the surrounding neighborhoods, and the region as a whole. While the physical health effects of exposure to elevated pollution is generally well-understood, and may be quantifiable using metrics such as quality-adjusted life years (QALY) (Ryen & Svensson, 2015), there mental health impacts must also be considered. QALY is a measure of morbidity which quantifies the health status of an individual's life, rainging from 0 (death) to 1 (perfect health) (Mehrez & Gafni, 1989). A serious medical condition would score lower, and a less serious condition would score higher. Emotional distress from driving on congested roads as well as the loss of family and personal time due to increased driving time results in a non-trivial impact on QALY. Therefore, when the focus of traffic calming measures is a focus on health, the complete picture should really be considered. This would include quantifying the potential lives saved and accidents avoided with, for example,the impact of increased pollution on QALY as well as time lost due to congestion that otherwise be spent with family, work, church, or pursuing other personal activities.

Time Losses for Residents and Visitors

The time residents and visitors lose due to traffic-calming measures is significant. Traffic flow improvements, such as green wave optimization, would allow a steadier commute and more consistent traffic timing. An example of an improvement that does not need additional infrastructure is mid-block pedestrian crossings. There are several examples across Salt Lake City and at the University of Utah where the pedestrian crossing activation is not synchronized with traffic flow. In practice, this results in increased congestion and greater risks for pedestrians who are crossing. When pedestrian crossings are synchronized to traffic flow, both drivers and pedestrians benefit.

Economic Analysis to Quantify the Costs of Construction, Commuter Wage Losses, and Health Outcomes

While the increased costs of construction, wasted commuter time, and negative health outcomes were described earlier, a full economic analysis would provide a more complete picture of the costs and benefits associated with the traffic calming measures being considered and implemented in Salt Lake City. Some of the many pros and cons of traffic calming are described in Table 3.

Table 3. Summary table of pros and cons of traffic calming measures.

Pros	Cons
Perception of safety Possible walkability increase Possible bicycling increase Encouraged transit use	Increased congestion Businesses leaving congested areas Residential real estate depreciation Aggressive driving Time spent away from family Slower emergency vehicle response time Higher emissions Increased vehicle wear Lower fuel efficiency Construction and maintenance cost

Part 5: Conclusion

This study is designed to help policymakers balance traffic management goals with quality of life and environmental sustainability for the community. The study described numerous unintended consequences of traffic calming devices: increased congestion, aggressive driving, lower quality of life for residents and commuters, negative economic outcomes for affected businesses, greater wear and tear on vehicles, and higher pollution emissions. Existing studies highlight numerous negative outcomes that accompany the purported benefits of these traffic-calming measures. A thorough evaluation that includes quality-adjusted life years and the economic impact of these road changes is essential before launching any new projects.

References

Albers, E., Bateman, M., & Harris, E. (2022). State and County Population Estimates for Utah: 2022. *Retrieved from Kem C. Gardner Policy Institute, The University of Utah: https://gardner.utah.edu/utah-population-reaches-3404760-on-july-1-2022-driven-mostly-by-net-migration*.

Aleko, D. R., & Djahel, S. (2019). An IoT enabled traffic light controllers synchronization method for road traffic congestion mitigation. 2019 IEEE International Smart Cities Conference (ISC2),

American Lung Association. (2024). *American Lung Association State of the Air 2024*. Retrieved June 23 from https://www.lung.org/research/sota

Arias-Pérez, R. D., Taborda, N. A., Gómez, D. M., Narvaez, J. F., Porras, J., & Hernandez, J. C. (2020). Inflammatory effects of particulate matter air pollution. *Environmental Science and Pollution Research*, *27*(34), 42390-42404. https://doi.org/https://doi.org/10.1007/s11356-020-10574-w

Atkins, C., & Coleman, M. (1997). The influence of traffic calming on emergency response times. *Institute of Transportation Engineers. ITE Journal*, *67*(8), 42.

Baek, S.-U., Yoon, J.-H., & Won, J.-U. (2023). Mediating effect of work–family conflict on the relationship between long commuting time and workers' anxiety and insomnia. *Safety and health at work*, *14*(1), 100-106. https://doi.org/https://doi.org/10.1016/j.shaw.2022.11.003

Bares, R., Lin, J. C., Hoch, S. W., Baasandorj, M., Mendoza, D. L., Fasoli, B., Mitchell, L., Catharine, D., & Stephens, B. B. (2018). The Wintertime Covariation of CO_2 and Criteria Pollutants in an Urban Valley of the Western United States. *Journal of Geophysical Research: Atmospheres*, *123*(5), 2684-2703. https://doi.org/https://doi.org/10.1002/2017JD027917

Bunte, L. W. (2000). *Traffic calming programs & emergency response: a competition of two public goods* Citeseer].

Burd, C., Burrows, M., & McKenzie, B. (2021). Travel time to work in the United States: 2019. *American Community Survey Reports, United States Census Bureau*, *2*, 2021.

Castañeda, K., Sánchez, O., Herrera, R. F., & Mejía, G. (2025). Deficiencies causes in road construction scheduling: Perspectives from construction professionals. *Heliyon*, *11*(2). https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e41514

Choi, D., Beardsley, M., Brzezinski, D., Koupal, J., & Warila, J. (2010). MOVES sensitivity analysis: the impacts of temperature and humidity on emissions. US EPA–Proceedings from the 19th Annual International Emission Inventory Conference, Ann Arbor, MI,

City of Laguna Niguel Department of Public Works. (2024). *Why Signal Synchronization is Needed*. https://www.cityoflagunaniguel.org/ArchiveCenter/ViewFile/Item/409

City of Portland. (2025). *Stop Sign Overview*. https://www.portland.gov/transportation/traffic-operations/stop-sign-overview

City Weekly. (2023). *Endless construction on 200 South is deja vu for struggling Salt Lake City businesses*. https://www.cityweekly.net/utah/endless-construction-on-200-south-is-deja-vu-for-struggling-salt-lake-city-businesses/Content?oid=20194656

Fee, K. D., & Hartley, D. A. (2011). Urban growth and decline: The role of population density at the city core. *Economic Commentary*(2011-27). https://doi.org/https://doi.org/10.26509/frbc-ec-201127

Ghazal, B., ElKhatib, K., Chahine, K., & Kherfan, M. (2016). Smart traffic light control system. 2016 third international conference on electrical, electronics, computer engineering and their applications (EECEA),

Graham, J. E., & Jones, A. T. (2019). A bump in the road: speed bumps' impact on property values. *International journal of housing markets and analysis*, *12*(1), 43-58. https://doi.org/https://doi.org/10.1108/IJHMA-10-2017-0091

Haje, B. E., & Symbaluk, D. G. (2014). Personal and social determinants of aggressive and dangerous driving. *Canadian Journal of Family and Youth/Le Journal Canadien de Famille et de la Jeunesse*, *6*(1), 59-88. https://doi.org/https://doi.org/10.29173/cjfy21484

Health Effects Institute. (2022). Systematic Review and Meta-Analysis of Selected Health Effects of Long-Term Exposure to Traffic-Related Air Pollution. *HEI Special Report 23*.

Hennessy, D. A. (2008). The impact of commuter stress on workplace aggression. *Journal of Applied Social Psychology*, *38*(9), 2315-2335. https://doi.org/https://doi.org/10.1111/j.1559-1816.2008.00393.x

Hsu, H.-P., Boarnet, M. G., & Houston, D. (2019). Gender and rail transit use: Influence of environmental beliefs and safety concerns. *Transportation Research Record*, *2673*(4), 327-338. https://doi.org/https://doi.org/10.1177/0361198119837193

INRIX Research. (2024). *Global Traffic Scorecard*. https://inrix.com/scorecard/

Jassal, K., & Sharma, U. (2024). Replacing speed bumps with chicanes: modernizing India's traffic calming strategy. Proceedings of the Institution of Civil Engineers-Municipal Engineer,

Keuken, M., Jonkers, S., Zandveld, P., & Voogt, M. (2012). Elemental carbon as an indicator for evaluating the impact of traffic measures on air quality and health. *Atmospheric Environment*, *61*, 1-8. https://doi.org/https://doi.org/10.1016/j.atmosenv.2012.07.009

KSL NewsRadio 102.7FM. (2024). *SugarHouse Barbeque Company closing after struggles with road construction*. https://kslnewsradio.com/business-economy/road-construction-leads-to-sugarhouse-barbeque-closing/2115786/

Livable Streets Team. (2024). *Livable Streets Zone 2: Central Sugar House*. https://maps.slc.gov/portal/apps/storymaps/stories/8b59d91f548248cc991f7cb34032f71e

Mehrez, A., & Gafni, A. (1989). Quality-adjusted life years, utility theory, and healthy-years equivalents. *Medical decision making*, *9*(2), 142-149. https://doi.org/https://doi.org/10.1177/0272989X8900900209

Miao, Q., Welch, E. W., & Sriraj, P. (2019). Extreme weather, public transport ridership and moderating effect of bus stop shelters. *Journal of Transport Geography*, *74*, 125-133. https://doi.org/https://doi.org/10.1016/j.jtrangeo.2018.11.007

Perrotta, A. F. (2017). Transit fare affordability: Findings from a qualitative study. *Public Works Management & Policy*, *22*(3), 226-252. https://doi.org/https://doi.org/10.1177/1087724X16650201

Qi, L., Zhou, M., & Luan, W. (2016). Impact of driving behavior on traffic delay at a congested signalized intersection. *IEEE Transactions on Intelligent Transportation Systems*, *18*(7), 1882-1893.

Remache-Patino, B. A., Comeau, D. J., Brennan, T. M., & Park, S. (2023). Measuring congestion at road-diet reductions using probe vehicle data. *Proceedings of the Institution of Civil Engineers-Urban Design and Planning*, *176*(1), 23-34.

resilience. (2023). Lost in traffic: does your time count? https://www.resilience.org/stories/2023-01-19/lost-in-traffic-does-your-time-count/

Ryen, L., & Svensson, M. (2015). The willingness to pay for a quality adjusted life year: a review of the empirical literature. *Health economics*, *24*(10), 1289-1301. https://doi.org/https://doi.org/10.1002/hec.3085

Salt Lake City. (2022). *Changing SLC's Prima Facie Speed Limit From 25 mph to 20 mph*. Retrieved 19 January 2025 from https://www.slc.gov/transportation/wp-content/uploads/sites/11/2023/03/Transmittal-Packet-Prima-Facie-Speed-Limit-Change-compressed.pdf

Salt Lake City Transportation. (2022). *20 MPH Local Streets Initiative*. Retrieved 19 January 2025 from https://www.slc.gov/transportation/2022/07/27/20-mph-local-streets-initiative

Salt Lake City Transportation. (2024). *Traffic Calming Toolkit*. Retrieved 19 January 2025 from https://www.slc.gov/transportation/toolkit/

Sayer, I., Parry, D., & Barker, J. (1998). *Traffic calming: An assessment of selected on-road chicane schemes*. Transport Research Laboratory Crowthorne, UK.

Shah, S. D., Cocker, D. R., Miller, J. W., & Norbeck, J. M. (2004). Emission rates of particulate matter and elemental and organic carbon from in-use diesel engines. *Environmental Science & Technology*, *38*(9), 2544-2550. https://doi.org/https://doi.org/10.1021/es0350583

Staley, S., & Balaker, T. (2006). *The Road More Traveled: Why the congestion crisis matters more than you think, and what we can do about it*. Rowman & Littlefield Publishers.

Stuart Melling. (2024). Decades-old bar in the heart of Sugar House appears to have closed. *Gastronomic Salt Lake City*. https://gastronomicslc.com/2024/09/05/decades-old-bar-in-the-heart-of-sugar-house-appears-to-have-closed/

Sweet, M. (2011). Does traffic congestion slow the economy? *Journal of Planning Literature*, *26*(4), 391-404.

Tarrant, A. J. (2016). Rat-running through Walmer Estate, University Estate and Upper Woodstock during the PM peak period.

Teja, T., & Jyothi, M. (2017). Speed Profile Analysis at Speed Breakers on An Urban Road. *imanager's Journal on Civil Engineering*, *7*(1), 25. https://doi.org/https://doi.org/10.26634/jce.7.1.10370

Tony Semerad. (2024). With one SLC skyscraper stuck, developer turns to converting an office tower into apartments. *The Salt Lake Tribune*. https://www.sltrib.com/news/2024/04/23/with-one-slc-skyscraper-stuck/

Tournoux, P.-U., Leguay, J., Benbadis, F., Conan, V., De Amorim, M. D., & Whitbeck, J. (2009). The accordion phenomenon: Analysis, characterization, and impact on dtn routing. IEEE INFOCOM 2009,

U.S. Department of Transportation. (2025a). *5.3 Traffic Calming Measures Developed to Address Emergency Service Vehicle Delay Issues*. https://highways.dot.gov/safety/speed-management/traffic-calming-eprimer/module-5-effects-traffic-calming-measures-non#5.2

U.S. Department of Transportation. (2025b). *Module 3: Toolbox of Individual Traffic Calming Measures Part 1*. https://highways.dot.gov/safety/speed-management/traffic-calming-eprimer/module-3-part-1#3.5

Ullah, A., Hussain, S., Wasim, A., & Jahanzaib, M. (2016). Usage and impacts of speed humps on vehicles: A review. *Journal of Advanced Review on Scientific Research*, *28*(1), 1-17.

United States Census Bureau. (2025). *S0801 Commuting Characteristics by Sex*. https://data.census.gov/table/ACSST5Y2010.S0801?q=commute%20time%20salt%20lake%20county

United States Department of Transportation. (2021). *Road Diets (Roadway Reconfiguration)*. https://highways.dot.gov/safety/proven-safety-countermeasures/road-diets-roadway-reconfiguration

Utah Division of Air Quality. (2021). *Utah Division of Air Quality 2020 Annual Report*. https://documents.deq.utah.gov/air-quality/planning/air-quality-policy/DAQ-2021-000768.pdf

Utah Transit Authority. (2025). *Utah Transit Authority ends 2024 with big ridership gains and shares whats coming in 2025*. https://www.rideuta.com/Rider-Info/Digital-Newsroom/Utah-Transit-Authority-ends-2024-with-big-ridership-gains-and-shares-whats-coming-in-2025

Vallamsundar, S., & Lin, J. (2011). Overview of US EPA new generation emission model: MOVES. *International Journal on Transportation and Urban Development*, *1*(1), 39.

Wang, Y., Yang, X., Liang, H., & Liu, Y. (2018). A review of the self-adaptive traffic signal control system based on future traffic environment. *Journal of Advanced Transportation*, *2018*(1), 1096123. https://doi.org/https://doi.org/10.1155/2018/1096123

Warberg, A., Larsen, J., & Jørgensen, R. M. (2008). Green wave traffic optimization-a survey.

Zhang, C., Qin, S., Yu, H., Zheng, B., & Li, Z. (2020). A Review on Chicane Design based on Calming Theory. *Journal of Engineering Science & Technology Review*, *13*(4).