



May 2020

SILICON VALLEY COVID-19 IMPACTS:

TRANSPORTATION, EMISSIONS & AIR QUALITY



FORWARD

Dear Friends:

COVID-19 has been a global crisis spreading sickness and untimely deaths, and we can't yet see the end of it. The accompanying sheltering orders have amplified the tragedy, shuttering vast segments of our economy and confiscating individual livelihoods.

But this report doesn't delve into the tragedy.

This report states the obvious, that the traffic on the highways is greatly diminished, thereby creating major improvements to our air quality. All of us understand this is happening, but the pages here document the phenomenon in considerable detail, including as well the dramatically falling injury rates on our highways.

The point, however, isn't merely to document the upside to our sequestration, but to provide a point of departure for the analysis and decision making that is now to come. When the sheltering orders are lifted and the economy rebounds, will we simply resume life as we knew it? Or will the health crisis catalyze new approaches to transportation and a renewed emphasis on telecommuting? By quantifying the reductions and their associated impacts, we hope this study will inform the thinking on important questions such as these.

If the pandemic results in permanent changes to our mobility patterns and reduces greenhouse gases, then future generations will see that the tragedy of 2020 also sowed the seeds for a better world.

Yours,



Russell Hancock
President & Chief Executive Officer
Joint Venture Silicon Valley
Institute for Regional Studies

INTRODUCTION

In just two months, the regional economy has been impacted by sweeping shutdowns designed to contain the spread of COVID-19. Since then, Joint Venture Silicon Valley's Institute for Regional Studies has been mapping out the mounting economic and community impacts of the crisis, many of which are extremely concerning. But is there an upside to the shutdown?

This research brief examines the changes in Silicon Valley's regional traffic and transportation since the onset of the pandemic, as well as the impact of those changes on transportation-related injury crashes, regional air quality, and greenhouse gas emissions in our region.

Declines in transportation-related emissions of greenhouse gases and other pollutants, resultant cleaner air, and a lower rate of transportation-related injury crashes represent some of the silver-linings related to the shelter-in-place order.

As it is widely known that regional transportation has been reduced due to the shelter-in-place orders, this Institute analysis was aimed at **quantifying that reduction, comparing it to previous/historical trends, and investigating the potential impact of the reductions.**

Silicon Valley data throughout this research brief refers to the combination of Santa Clara and San Mateo Counties. Bay Area data includes the nine-county region. This analysis does not include pandemic-related changes in public transit operations or ridership. Effects on potential future emissions utilize low- and high-estimate ranges of four months and the remainder of the year, respectively.

Why is this important?

Traffic has become an increasingly troublesome issue affecting quality of life in Silicon Valley. The amount of time wasted due to long commutes and traffic delays affect the everyday lives of Valley residents – taking time away from work, participating in the community, or being with family and friends.

Transportation-related injuries, including deaths, are significantly reduced with declines in regional vehicle miles traveled, an indicator of collision exposure.

Air quality is affected by a variety of factors, including transportation-related emissions which contain pollutants (including greenhouse gases). The presence of these air pollutants – such as particulate matter, nitrogen oxides, and carbon monoxide – is associated with negative health outcomes.

Greenhouse gas emissions are reduced significantly with declines in regional transportation. These emissions affect global atmospheric concentrations and therefore play a role in global climate change.

SUMMARY OF FINDINGS

Vehicle Miles Traveled (VMT)

- Pandemic-related transportation declines in Silicon Valley and the Bay Area reduced monthly per capita freeway VMT in April to lower than any other year in the 17-year dataset; VMT per capita increased slightly in May.
- Per Capita VMT in Silicon Valley dropped 52% year-over-year in April, 2020; Monthly freeway VMT per capita declined from 290 miles in February to 222 miles in March, 147 miles in April, and an estimated 179 miles in May.
- In March and April combined, monthly freeway VMT per capita in Silicon Valley declined to a greater extent (41% below 2019 values) than in the Bay Area (-30% year-over-year) or California overall (-28% year-over-year).
- Between January and mid-May, Silicon Valley *freeway* VMT declined by 41%; Santa Clara and San Mateo County *all-road* VMT, as determined by telematics data, declined by 75% and 76%, respectively. Bay Area *all-road* VMT declines were greatest for San Francisco and Marin Counties (-83% and -82%, respectively).

Traffic Delays

- Daily vehicle hours of delay in April were lower than any other time in the nearly 20-year dataset.
- As with VMT per capita, traffic delays rebounded slightly in May
- Between February and April, average daily delays on Silicon Valley, Bay Area, and California freeways were been reduced by 94%, 86%, and 81%, respectively.
- Average April freeway delays in Silicon Valley totaled approximately 4,500 hours per day compared to 70,000 per day, on average, in February.

Transportation-Related Injury Crashes

- Due to the pandemic-related decline in vehicle miles traveled (an indicator of collision exposure), transportation-related injury crashes on Bay Area highways have declined by 69% compared to the same week in 2019; statewide, the year-over-year decline was -57% as of May 4. Between the beginning of March and the first week of May, Bay Area injury crashes declined by 63%.
- Bay Area Driving Under the Influence (DUI) crashes declined by 35% between early March and mid-May; and in contrast to the steep rise in speeding citations issued as of mid-April, Bay Area Unsafe Speed Crashes declined by 79% between early-March and mid-May.

Air Travel

- Air travel through San Francisco and Mineta San Jose International Airports *combined* have declined by 60% in March, 97% in April, and an estimated 96% in May.
- Based on reported Silicon Valley pandemic-related air travel reductions, there could be as much as a 32% year-over-year reduction in associated emissions (from flights themselves, *not* airport-attributed greenhouse gas emissions), with estimates heavily dependent upon the duration of air travel reductions. This compares to a 21 to 33% estimated worldwide reduction.

Greenhouse Gas (GHG) Emissions



- Silicon Valley's annual GHG emissions could decline by an estimated 8% to 21% year-over-year, based on measured declines in vehicle miles traveled in March and April. In comparison, global GHG emissions are expected to decrease by 4% to 8% this year due to the pandemic. One major factor making the regional estimate higher is Silicon Valley's relatively clean electricity and a greater dependence of total emissions on the transportation sector.
- Another estimate of the effect of pandemic-related transportation reductions on regional GHG emissions, based on vehicle miles traveled and average fuel efficiency of light-duty vehicles, suggests that they could decline by 0.6 to 1.6 million metric tons of carbon dioxide equivalent – an amount comparable to more than 250,000 homes' annual electricity use, or burning more than 1.7 billion pounds of coal.
- Bay Area Air Quality Management District (BAAQMD) preliminary estimates suggest that Bay Area CO₂ emissions could decline by 20 to 30% in 2020 from traffic reduction alone.

Air Quality



- As a result of transportation reductions and weather *combined*, emissions of fine particulate matter in Silicon Valley have declined by 33% and 21%, respectively, in April and the first half of May. These compare to BAAQMD preliminary estimates suggesting that Bay Area emissions due to the COVID-19 impact have declined by 15-25% for fine particulate matter (and 20-45% for nitrogen oxides) from traffic reductions alone. Because fine particulate matter is closely tied to the presence of haze, this recent reduction has undoubtedly improved visibility throughout the region.
- Overall air quality in Silicon Valley was improved to some extent between February and mid-May, with a regional average Air Quality Index (AQI) 4% below that of the same period in 2019. The extent to which the air was cleaner *as a response to reduced transportation*, however, is difficult to determine because of the non-uniformity of emissions throughout the regional air basin and the influence of weather and seasonal variability.
- Qualitatively, the negative health outcomes associated with proximity to major roads combined with the predominant influence of transportation on Bay Area air quality indicate that those living near major roadways are likely experiencing more localized improvements with associated positive health implications.

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BACKGROUND



Transportation & Related Injury Crashes

Traffic has become an increasingly troublesome issue affecting quality of life in Silicon Valley. The amount of time wasted due to long commutes and traffic delays affect the everyday lives of our residents – taking time away from work, participating in the community, or being with family and friends.

Increases in the number of commuters and the utilization of certain commute paths have led to an unprecedented level of traffic delays in Silicon Valley, with 81,000 hours lost to congestion every day in 2019 – amounting to an estimated loss in regional productivity by as much as \$3.4 billion annually.ⁱⁱ

The average number of vehicle miles traveled annually per Silicon Valley resident has been relatively steady over the past several years, and was just above 8,200 miles per person in 2018. Silicon Valley residents drove an average of 22 miles per day in 2018 (down from 24 miles per person per day a decade prior); this compares to 24 miles per person per day statewide.ⁱⁱⁱ

Transportation-related injuries including deaths are significantly reduced with declines in regional vehicle miles traveled – an indicator of transportation-related injury exposure.^{iv}



Transportation's Share of GHG Emissions

In recent decades, transportation has accounted for approximately half of all regional “community-wide” greenhouse gas (GHG) emissions in Silicon Valley, with a range of approximately 40-65%, depending on the city and specific year. More recently, this percentage has increased due to the emergence of community choice aggregation (CCA) programs which, as of mid-2019, serve 89% of Silicon Valley’s residential customers and 69% of non-residential customer.^v

In Silicon Valley Clean Energy (SVCE) territory – which includes 12 cities and towns in Santa Clara County plus the unincorporated portion – the share of GHG emissions from transportation has increased since 2015 from 45% that year, to 50% in 2017, and an estimated 55% in 2018; this increasing share is attributable to a decrease in overall emissions, as SVCE has provided cleaner electricity since mid-2016.^x Similarly, in San Mateo County, the share of overall GHG emissions from transportation increased from 57% in 2015 to 65% in 2017, with the increase attributed to the reduction in emissions as a result of Peninsula Clean Energy (covering all of San Mateo County since 2016).^{xii}

By offering cleaner power to residents and businesses, these CCA programs have reduced regional emissions associated with electricity by an estimated 64% in a span of only three years; thus, the shares of attributed to transportation and natural gas have increased.^{xiii} As of two recent regional community-wide GHG inventories, transportation now accounts for approximately 55-65% of regional GHG emissions under ‘normal’ pre-pandemic circumstances.



Greenhouse Gas Emissions

It is not currently possible to measure the reduction in atmospheric concentrations of greenhouse gases due to the pandemic alone. Due to long mixing and residence times (how long they stick around in the air) and the much larger natural/seasonal cycles of atmospheric carbon dioxide concentrations that hinder our ability to measure human-induced changes on short timescales, global average atmospheric concentrations of carbon dioxide have continued to trend upwards despite the pandemic-related decline in emissions. Based on the International Energy Agency’s expectations that global carbon dioxide (CO₂) emissions will decline by 8% (about 2.6 gigatonnes, or 2010 levels) this year due to the pandemic,^{vi} the global average concentration is expected to decline by a relatively insignificant amount of less than a tenth of a part per million (ppm) each month (for reference, global average CO₂ concentrations were nearly 413 ppm as of early May, 2020).^{vi} An analysis published in *Nature Climate Change* on May 19 estimates a 2020 decline of 4 to 7% compared to 2019.^{vii}

Silicon Valley cities and counties – as by those in many other places – typically use a widely-accepted protocol^{viii} to calculate community-wide greenhouse gas emissions for the sake of accuracy, consistency over time, and apples-to-apples comparisons with other places. The emissions totals are typically segmented by source (e.g., transportation, electricity, natural gas) or by sector (e.g., residential, commercial, industrial, transportation, waste).



Air Quality

Air quality is affected by a variety of factors, including transportation-related emissions containing various pollutants. The presence of these air pollutants – such as fine particulate matter, nitrogen oxides, and carbon monoxide – is associated with a number of negative health outcomes.^{ix}

There are many factors that affect air quality on a local/regional level. Clean air is not simply proportional to emissions of pollutants, but is also subject to normal seasonal changes. According to the Bay Area Air Quality Management District, 2020 would have had a very “clean spring” regardless of the pandemic/transportation-related emissions reductions. A clean spring, in this context, indicates that the typical air instability that occurs in the springtime when there is no atmospheric inversion,^{xv} and air parcel mixing is facilitated. This mixing disperses the pollutants throughout air columns and the result is cleaner air at the ground level. The spring of 2020 is cleaner than has been observed in the Bay Area in at least five years, regardless of the shelter-in-place effects.

In contrast to GHGs, other pollutants from vehicle emissions typically have a shorter residence times.^{xvi} These particles affect surface-level air quality for a period of hours to weeks.

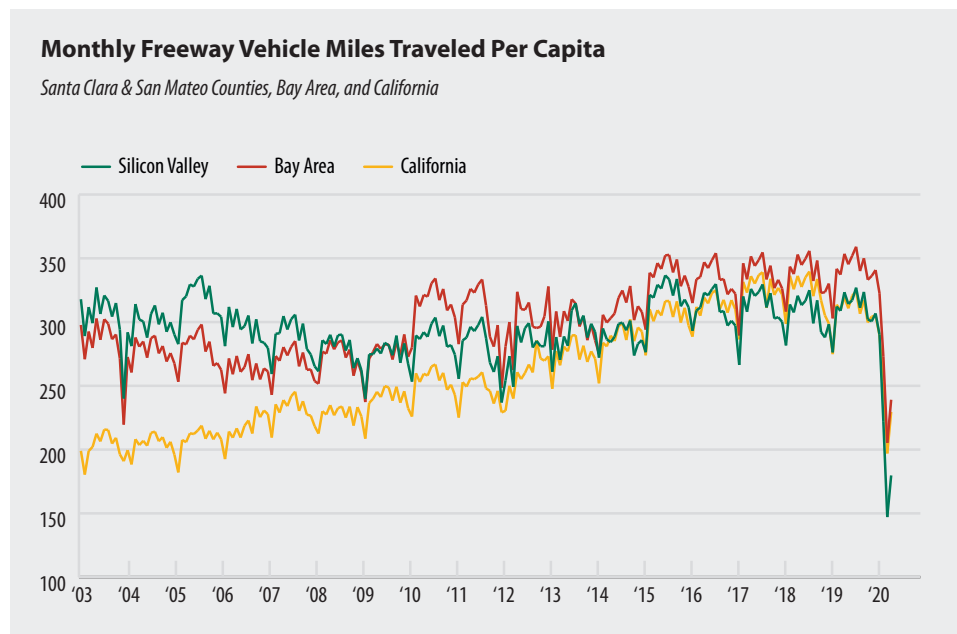
The U.S. Environmental Protection Agency (EPA) reports daily Air Quality Index (AQI) data which includes all available pollutant measurements, including those for carbon monoxide, ozone, particulate matter, nitrogen dioxide, sulfur dioxide, and lead.^{xvii}

ANALYSIS: COVID-19 IMPACTS IN THE CONTEXT OF HISTORICAL TRENDS

Vehicle Miles Traveled

Over the past decade, the number of vehicle miles traveled (VMT) per Silicon Valley resident has declined steadily from 169 miles per person per week in 2008 to an estimated 158 miles per person per week in 2018 – a decline of 6.5% over a 10-year period.^{xvii} Freeway-only VMT has increased to an even greater extent, up 9.9% over that same period (from 64 to 71 miles per person per week).

Pandemic-related transportation declines in Silicon Valley and the Bay Area have reduced monthly per capita freeway VMT to lower than they have been during anytime over the past 17 years (the length of the Caltrans Freeway Performance Measurement System monthly VMT dataset) in April, with a slight rebound in May;¹ in California, monthly VMT per capita was reduced to levels not observed since 2006.



Data Source: Caltrans PeMS

Analysis: Silicon Valley Institute for Regional Studies

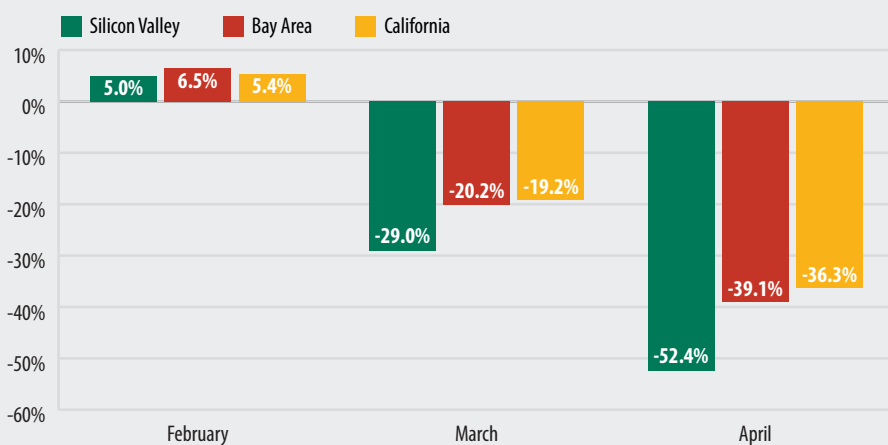
Year-Over-Year Comparisons

In March and April combined, freeway VMT per capita in Silicon Valley declined to a greater extent (41% below 2019 values) than in the Bay Area (-30%) or California overall (-28%). In April alone, Silicon Valley freeway vehicle miles traveled per capita was 52% below 2019 values.

1. As estimated using data through May 13.

Year-Over-Year Percent Change in Monthly Per Capita Freeway Vehicle Miles Traveled

Santa Clara & San Mateo Counties, Bay Area, and California
February - April 2020



Data Source: Caltrans PeMS

Analysis: Silicon Valley Institute for Regional Studies

These results are consistent with the 33% Bay Area and 28% statewide highway VMT decline (March through the first week of May, 2020) reported through the Statewide Integrated Traffic Records System (SWITRS) provisional data.^{xix}

The 41% year-over-year reduction in Silicon Valley's freeway vehicle miles traveled (in March and April) is significantly lower than the estimated share of the region's workforce in industries that are generally considered "essential" (approximately 71-78%). This is likely due to two main factors: many of the workers in those essential industries are able to do their work from home, and while some industries are considered essential (such as residential and commercial construction, for example), work was halted or significantly reduced during the early shelter-in-place mandate.

Declines Since January

In addition to the freeway-only Caltrans PEMs data, which indicates a Bay Area decline in VMT of 41% between January and mid-May, several telematics providers have also tracked regional changes in VMT. These telematics data – because they are based on smartphone and other navigation device GPS locations – also include transportation on local roads. One such provider, Streetlight Data,^{xx} reports a 75% decline in Santa Clara County and a 76% decline in San Mateo County January through mid-May. Within the Bay Area, Streetlight data reports the greatest January through mid-May declines for San Francisco (-83%) and Marin Counties (-82%).

Approximately 14% of Silicon Valley's workforce (approximately 233,000 workers) is in healthcare and residential care services, grocery store, hotel, warehousing and delivery jobs alone; these workers were likely still commuting to their jobs during the early shelter-in-place period. If no one but those workers were commuting, we would expect an 86% decline in VMT; estimates slightly lower than that – as indicated by the PEMs and Streetlight Data above – are reasonable assuming that a small *additional* share of the workforce was likely still commuting to work.

Vehicle Hours of Delay =

One vehicle stuck in traffic for one hour.

In this case, the analysis considers traffic to be speeds below 60 miles per hour on California State Freeways only (not all state highways).

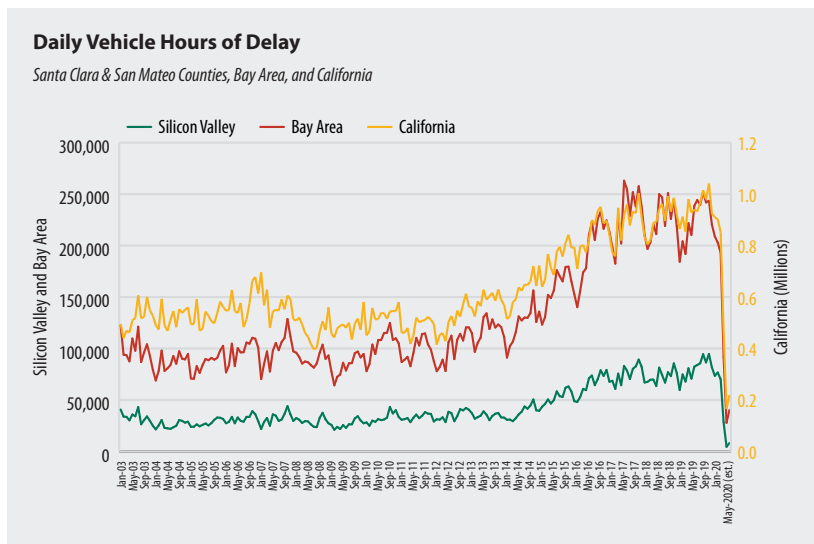
Using the 2019 estimate of regional labor productivity (\$116 per employee per hour), Silicon Valley traffic delays that year could amount to as much as a \$3.4 billion loss in productivity.¹

Traffic Delays

In 2019, Silicon Valley commuters lost more than 81,000 hours to traffic congestion every day, with triple the number of vehicle hours wasted due to traffic congestion than compared to a decade prior. Similarly, traffic delays in the Bay Area overall and statewide have increased significantly over the past decade – up 171% and 95%, respectively between 2009 and 2019.

The rapid pandemic-related decline in regional transportation has led to unprecedented low levels of traffic delays in Silicon Valley, the Bay Area, and statewide beginning with a small decline in March, a more pronounced decline in April, and a slight rebound in the first half of May. At no other time in the nearly 20-year dataset have daily vehicle hours of delay been as low as they were in April.

In Silicon Valley, average April freeway delays totaled just above 4,500 hours per day; this compares to 70,000 per day on average in February (a 94% decline). Similarly, traffic delays declined by 86% throughout the Bay Area and 81% statewide between February and April.



Data Source: Caltrans PeMS (Performance Monitoring System)

Analysis: Silicon Valley Institute for Regional Studies

This decline in traffic is consistent with a national survey indicating that while approximately one-third of employees across the nation worked from home on a regular basis pre-pandemic (based on data from survey respondents on pre-pandemic teleworking), that share rose to 89% post-COVID-19 impact.^{xxi} Based on the 2018 census data, only 5% of residents worked from home as their most-utilized “means of commute.” As such, the 5% is likely an underestimate as many people telework one or two days per week; and, nationally, while 3.6% telework the majority of days, more than ten times that share of people work remotely at some frequency.^{xxii}

**2017 – 2019 Average Annual
Transportation-Related
Injury Crashes**

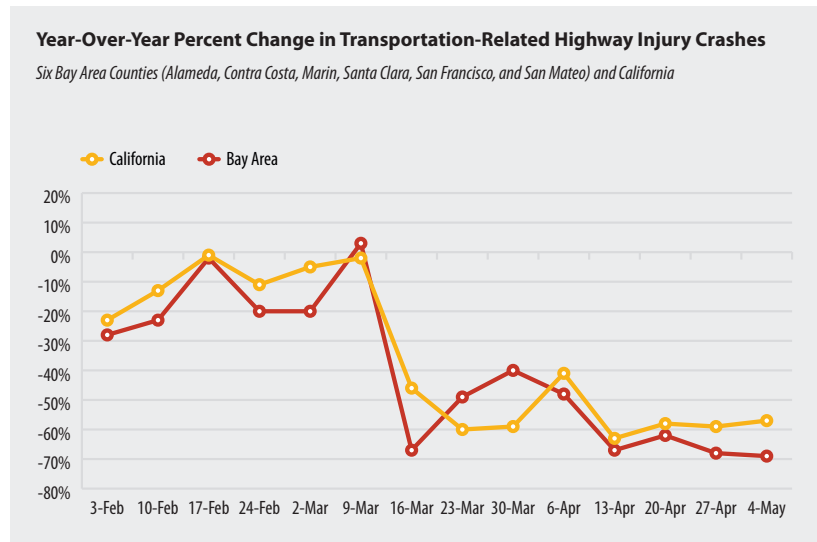
During a typical year, Silicon Valley experiences approximately 10,800 injury crashes (4,600 on state highways) including 880 bike collisions, 670 motorcycle collisions, and 130 transportation-related fatalities.²

Transportation-Related Injury Crashes

Based on provisional state highway crash data from police reports, transportation-related injury crashes across six Bay Area counties (Alameda, Contra Costa, Marin, Santa Clara, San Francisco, and San Mateo) as of the week of May 4, 2020, have declined by 69% compared to the same week in 2019 amounting to only 61 crashes,² compared to 199 the prior year); statewide, the decline was similar, at 57% below the same week in 2019.

With the decline in vehicle miles traveled, the number of crashes would be expected to decline. As such, looking at crash rates *per vehicle mile driven* is useful. As of the week of May 4, the Bay Area crash rate per vehicle mile driven was also down (-47% year-over-year, and 53% below that of the first week of March).

The number of injury crashes in February and early March were already slightly below that of the prior year, but the rapid decline in transportation-related injury crashes was most apparent beginning in mid-March – coinciding with the regional and statewide stay-at-home orders.



Data Source: Transportation Injury Mapping System, U.C. Berkeley
Analysis: Silicon Valley Institute for Regional Studies

Among those six Bay Area counties included in the provisional 2020 state highway crash data, DUI (Driving Under the Influence) crashes declined by 35% between the beginning of March and the first week of May (to eleven crashes only during the week starting May 4); Improper Turning Crashes declined 32% during that period. Additionally, in contrast to the increase in speeding citations issued statewide – which rose 87% as of mid-April year-over-year^{xxiii} – Unsafe Speed Crashes declined by 79% in the Bay Area between the week of March 9 and the week of May 4.

2. There is a lag time in reporting for this provisional data; as such, data (particularly for the most recent weeks) are likely underestimates.

About Air Travel and Greenhouse Gas Emissions

Greenhouse gas emissions associated with air travel are very roughly estimated at 0.2 kg or 0.44 pounds of carbon dioxide equivalent (CO₂e) per passenger mile.³

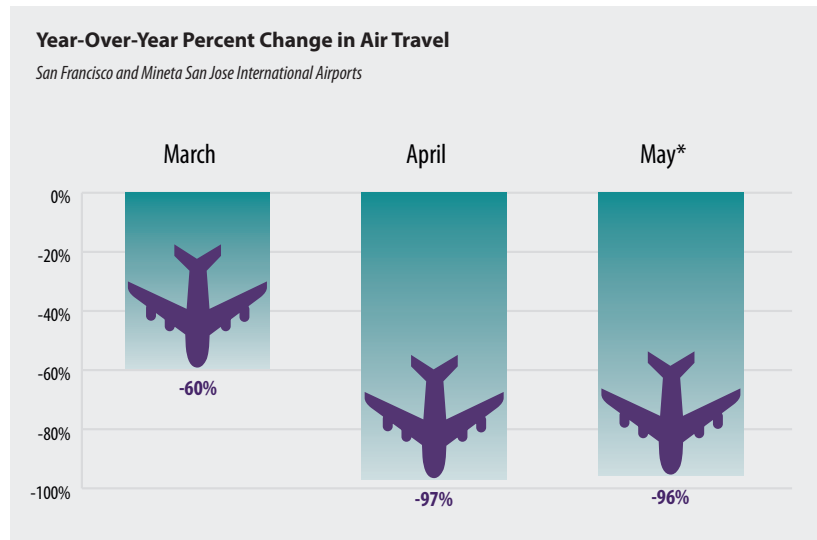
Carbon offset purchasing programs may use different methodologies for calculating per-mile emissions. Estimates from one such program, for example, range from 0.47 to 1.37 pounds per passenger mile, depending on the trip length and seat class.⁴

The International Civil Aviation Organization has a fairly complex methodology behind their carbon footprint calculation based on flight length, employing data on various aircraft types and their “fuel burn” rates.⁵

Greenhouse gas emissions for individual passengers, or as calculated per passenger mile in aggregate, are not directly attributed to any particular airport or region. Airports generally use a standardized industry protocol to calculate emissions based on factors such as landing and takeoff, taxiing, and those directly associated with airport operations.

Air Travel

Due to the impact of pandemic-related travel considerations, Silicon Valley’s two international airports have experienced unprecedented year-over-year declines in passenger counts of more than 90% since March.



*includes data through May 11 for SJC and May 14 for SFO

Data Sources: Mineta San Jose International Airport and San Francisco International Airport

Analysis: Silicon Valley Institute for Regional Studies

Air travel through Mineta San Jose International Airport (SJC) – which served almost 15.7 million passengers last year with nearly 500 peak daily departures/arrivals^{xxiv} – has been reduced by 58% in March, 97% in April, and an estimated 95% for early May (amounting to approximately 750,000 passengers per month).^{xxv} This decline is significantly more than what was documented in the period after September 11, 2001, during which SJC air traffic was reduced by approximately 20%.^{xxvi}

Similarly, San Francisco International Airport (SFO) has reported a 60% decline in individuals processed through the airport’s security checkpoints in March, a 97% decline in April, and (as of May 10) a 96% decline in May. If a 96% decline were to persist for a period of four months, then the *annual* passenger count at SFO of more than 57 million last year^{xxviii} would be reduced to 39 million (-68%) in 2020.³

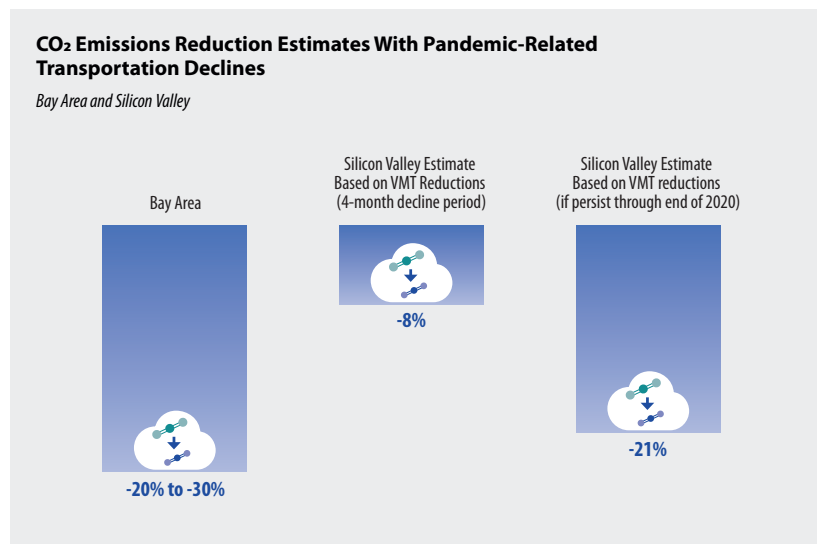
While these declines in air travel will undoubtedly be associated with a measurable decrease in associated GHG emissions, those emissions are typically calculated using an industry protocol that takes into account emissions classified as Scope 1 (direct, such as gasoline-powered fleet vehicles), Scope 2 (indirect, such as off-site electricity generation), and Scope 3 (other indirect emissions not controlled by the airport itself, such as those from landing, takeoff, and taxiing); therefore changes in passenger counts are not directly proportional to GHG emissions reductions. If they were directly proportional, a 96% decline in passenger counts for a period of four months out of the year, for example, would amount to a 32% reduction in associated CO₂e emissions in 2020 compared with 2019.

3. If individuals processed through the airport’s security checkpoints are used as a proxy for passenger reductions.

In comparison, worldwide GHG emissions from planes could drop 23 to 31% year-over-year, amounting to a *savings* of as much as 714 gigatons of CO₂e – an amount equivalent to the annual emissions of 183 coal-fired power plants, 121 million homes' electricity use, or 154 million passenger vehicles on the road.^{xxxix, xxxii}

Community Greenhouse Gas Emissions

Bay Area CO₂ emissions due to the pandemic-related transportation reductions *alone* (primarily associated with the shelter-in-place orders) have been estimated by the Bay Area Air Quality Management District (BAAQMD) to have declined by 20-30%. This preliminary estimate is based on a decline in travel of 50-85% based on traffic counts (including bridges and two sources of telematics data) and on previous data showing that 35% of CO₂ emissions throughout the Bay Area come from on-road travel.^{xxxiii}



The BAAQMD Bay Area CO₂ emissions decline estimate is consistent with Silicon Valley estimates based on vehicle miles traveled (VMT). If the decrease in Silicon Valley VMT of 41% since the onset of the pandemic and shelter-in-place orders were to remain at this low level for the remainder of the year, and with the assumption that transportation accounts for 60% of emissions, we could expect the region's 2020 community-wide GHG emissions to be an estimated 21% lower than in 2019.

How Community Greenhouse Gas Emissions are Segmented

Community greenhouse gas emissions are typically segmented by source (such as transportation including commercial and non-commercial, on-road and off-road; electricity; natural gas; and in some cases, waste). Emissions are also typically categorized by sector (e.g., residential, commercial, industrial, transportation, waste, and other).

The share of regional community-wide greenhouse gas emissions from the transportation sector has increased from 45-57% in 2015 to 54-65% in 2017 due to the availability of cleaner power through community choice aggregation programs since 2015/2016; with the impact of COVID-19-related transportation reductions (assuming they persist for a period of four months), that share could decrease to 46-57% for 2020.

Cities and counties typically use a widely-accepted protocol⁶ to calculate community-wide GHG emissions – on a semi-regular basis – for the sake of accuracy, consistency over time, and like-to-like comparisons with other places.

$$E_{2020} = 2\left(\frac{E_{2019}}{12}\right) + 10\left(\frac{(1-0.41)*0.6E_{2019}}{12}\right) + 10\left(\frac{0.4E_{2019}}{12}\right)$$

$$E_{2020} = \left(\frac{1}{6}\right)E_{2019} + \left(\frac{5}{6}\right)(0.354 \times E_{2019}) + \left(\frac{5}{6}\right)(0.4 \times E_{2019})$$

$$E_{2020} = \left(\frac{5}{6} \times E_{2020}\right)(0.2 + 0.354 + 0.4)$$

$$E_{2020} = 0.795 E_{2019}$$

$$2019 - 2020 \% \text{ Change} = \frac{(0.795 - 1)}{1} = -20.5\%$$

If the VMT decline lasted for a more conservative period⁴ of four months (March through June), then the resulting annual reduction would be 8% below last year's community-wide GHG emissions total.^{xxxiv}

$$E_{2020} = 8\left(\frac{E_{2019}}{12}\right) + 4\left(\frac{(1-0.41)*0.6E_{2019}}{12}\right) + 4\left(\frac{0.4E_{2019}}{12}\right)$$

$$E_{2020} = \left(\frac{4}{6}\right)E_{2019} + \left(\frac{2}{6}\right)(0.354 \times E_{2019}) + \left(\frac{2}{6}\right)(0.4 \times E_{2019})$$

$$E_{2020} = \left(\frac{2}{6} \times E_{2020}\right)(2 + 0.354 + 0.4)$$

$$E_{2020} = 0.918 E_{2019}$$

$$2019 - 2020 \% \text{ Change} = \frac{(0.918 - 1)}{1} = -8.2\%$$

These estimates compare to a global expected pandemic-related GHG emissions decline of 8%, according to the International Energy Agency^{xxxv} and a decline of 4-7% according to a recent analysis published in Nature on May 19.^{xxxvi} The major factor in higher regional estimates compared to worldwide estimates is our region's relatively clean electricity^{xxxvii} and greater dependence of total emissions on those related to the transportation sector (approximately 60% regionally, compared to 21% worldwide^{xxxviii}).

4. This is a more conservative time period than the "rest of the year" estimate, yet it is still arbitrary given the current knowledge of how long the crisis and shelter-in-place will last.

Why Quantify Regional Emissions Rather Than Measuring Air Concentrations?

In a local context, greenhouse gases (GHGs) are typically discussed as a quantity emitted, as opposed to local air mass concentrations. This is primarily because GHGs mix in the atmosphere, and are influenced by weather patterns and other factors affecting the carbon cycle. Thus, it becomes impossible to discern the original sources.

GHGs generally have long “residence times” meaning that they stay in the atmosphere for extended periods of time (in the range of five to more than several hundred years⁷). Because of these long lifetimes and mixing, and the many sources of GHGs (both natural and anthropogenic/human-induced) they are typically measured at high elevations throughout the world and in places where the wind predominantly comes from places far from the effects of human activity and vegetation (e.g., Mauna Loa observatory on the Big Island of Hawaii, at an elevation of more than 13,000 feet⁸ with typical trade winds coming from over the ocean to the northeast).

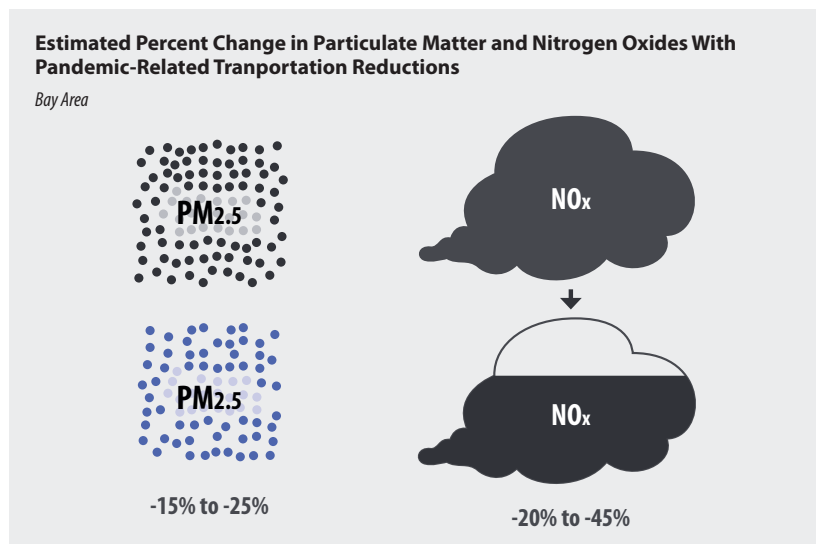
These global measurements of atmospheric GHG concentrations are useful for the purpose informing the extent to which they affect the Earth’s climate.

Other Transportation Emissions

If pandemic-related measured freeway VMT reductions were to persist for the remainder of the year, then there would be a total of 4.5 million fewer miles driven in 2020 than in 2019 on Silicon Valley’s freeways alone. Assuming a range of 22 to 25 miles per gallon^{xix} for the average light-duty gasoline- and diesel-powered vehicles, and that the share of those vehicles on the road (88%^{xii}) is proportional to miles driven, then 2020 regional GHG emissions could be reduced by 1.4 to 1.6 million metric tons of CO₂e – an amount equivalent to 250,000 homes’ electricity use for one year, or burning 1.7 billion pounds of coal.^{xii}

Using a more conservative period of pandemic-related VMT declines of four months, then the resulting savings in VMT in 2020 would be two million below that of 2019, with a GHG reduction of 0.63 to 0.72 million metric tons of CO₂e.

Regarding other transportation-related pollutants, the Bay Area Air Quality Management District has estimated that emissions of fine particulate matter (PM_{2.5}) and nitrogen oxides (NO_x) have declined by 15-25% and 20-45%, respectively due to regional pandemic-related traffic reductions alone. These preliminary estimates are based on 50-85% reductions in travel (from traffic counts including bridges and two sources of telematics data) and previous data showing that 30% of PM_{2.5} and 50% of the nitrogen oxide (NO_x) emissions come from on-road travel.^{xiii}



The estimated 15-25% decline in PM_{2.5} in the Bay Area (attributed to traffic reductions alone) compares to year-over-year declines of 33% and 21% for April and the first half of May, respectively, in Santa Clara and San Mateo Counties using EPA Outdoor Air Quality data.^{xiiii} These measured particulate matter concentration declines are a result of both transportation reductions and weather, combined.

The Value of a Healthy Environment

Studies have quantified the importance of the ecosystem services provided by the region's natural capital to the health of the economy including clean air, water quality and supply, healthy food, recreation, storm and flood protection, tourism, science and education.

A 2018 report from the Santa Clara Valley Open Space Authority, the Resource Conservation District of Santa Cruz County, and Sonoma County Ag + Op found that each year, Santa Clara County's natural and working lands provide a stream of ecosystem services to people and the local economy that range in value from \$1.6 billion to \$3.8 billion.⁹

Air quality is also a major factor in determining health outcomes for residents, particularly those in sensitive groups (including older adults and children, those with heart disease, lung disease, or diabetes). In Silicon Valley, between 6.6 and 8.2% of the population has chronic obstructive pulmonary disease (COPD),¹⁰ 12% have been diagnosed with asthma, 6% with diabetes, and 5% with heart disease;¹¹ 14% of the population is over age 65, and 22% is below age 18.¹²

Air Quality

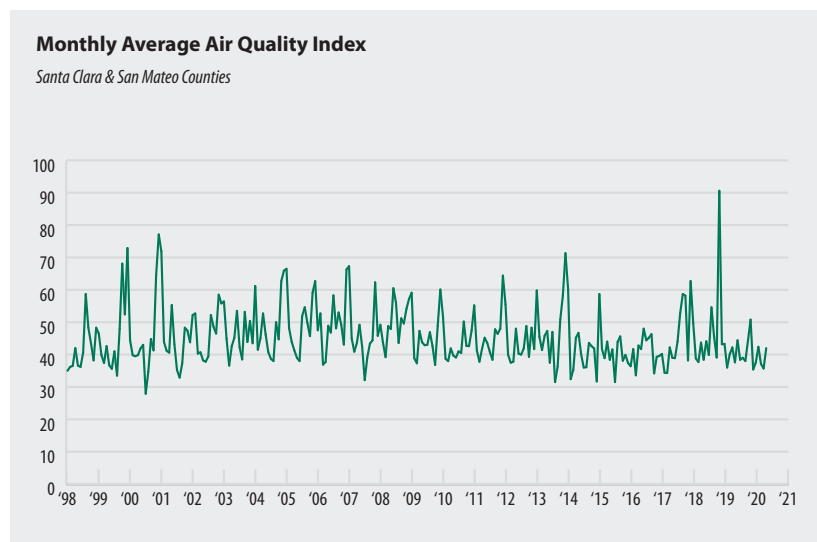
One of the things that makes Silicon Valley an attractive place to live and work is our natural ecosystem, with the region located between the Santa Cruz Mountains and the San Francisco Bay with views aplenty.

Over the past two decades, the region has had an annual average of 17 unhealthy air quality days for 'sensitive groups' (see sidebar for definition) and four unhealthy days for the general population; in 2019, there were only five unhealthy air days for sensitive groups, and none for the general population.^{xiv} Zero unhealthy air days have been reported in 2020 thus far.

Due primarily to pandemic-related transportation declines, regional emissions of pollutants such as nitrogen oxides and fine particulate matter have declined. However, it is difficult to disentangle the impact of transportation emissions from other factors affecting air quality, such as seasonal weather variability. Additionally, the reductions in light-duty traffic emissions are not uniform throughout the air basin.

While the Air Quality Index (AQI) is not directly proportional to concentrations of each individual pollutant, and despite the complex interconnections between emissions and air quality, examining AQI changes over time are a useful indicator of the extent to which potential health impacts may occur.

The air quality in the first half of May, 2020, had a slightly lower combination of AQI pollutants⁵ than earlier in the year. Silicon Valley's regional average AQI in May, 2020, was 1% below that of February, with a more pronounced decline in San Mateo County (-4.7%) combined with an increase of 2% in Santa Clara County. The March through mid-May Silicon Valley average AQI was 4% below that of the same period of 2019.



Note: 2020 data through May 14.

Data Source: United States Environmental Protection Agency

Analysis: Silicon Valley Institute for Regional Studies

5. The U.S. Environmental Protection Agency reports daily Air Quality Index (AQI) data which includes all available pollutant measurements, including those for carbon monoxide, ozone, particulate matter, nitrogen dioxide, sulfur dioxide, and lead

The Santa Clara County February through mid-May increase in AQI may be due to weather and seasonal changes more than to transportation-related emissions. The pronounced San Mateo County decline is likely tied to the high share of cross-county commuters who, under typical circumstances, would drive through the county on a daily basis and are no longer doing so.^{xiv}

The *extent* to which the air was cleaner *as a response to reduced regional transportation*, however, is difficult to determine as pollutant concentrations are not directly proportional to AQI, emissions are not uniform throughout the regional air basin, and due to the inherent difficulties in disentangling the impacts of regional emissions from natural weather variability and mixing.

Air pollution in the Bay Area is predominantly influenced by on-road transportation, and studies have illustrated the negative health outcomes associated with proximity to major roads.^{xv} Thus, while the decline in average AQI data on a *regional* level does not indicate significantly improved air quality due to pandemic-related transportation declines, those living near major roadways are likely experiencing more localized improvements with associated health implications.

Additionally, while AQI declines since February were muted and deviated widely between Santa Clara and San Mateo Counties, regional PM_{2.5} concentrations (as described in the previous section) were reduced by 33% and 21% year-over-year, respectively, for April and the first half of May. As PM_{2.5} is among the air pollutants closely tied to the presence of haze,^{xvii} this recent reduction has undoubtedly led to some marked improvements in visibility.

ANNOTATIONS

Data Sources: Caltrans PeMS (pems.dot.ca.gov); United States Environmental Protection Agency, Outdoor Air Quality Data (www.epa.gov/air-data); Bay Area Air Quality Management District (www.baaqmd.gov); Statewide Integrated Traffic Records System (<http://iswitrs.chp.ca.gov>); Transportation Injury Mapping System (<https://tims.berkeley.edu>); California Department of Transportation (www.dot.ca.gov); California Department of Finance (www.dof.ca.gov/Forecasting/Demographics/Estimates)

Notes: Vehicle Miles Traveled (VMT) and Traffic Delay data are from Caltrans PeMS (Freeway Performance Measurement System) that collects, filters, processes, aggregates, and examines traffic data from the Caltrans network of roadway traffic sensors. The reported traffic delay data are based on the detector coverage and health at the time that the data was collected by PeMS. Accordingly, actual traffic delays experienced in each county may be higher than those reported. Data includes California State Freeways only (not all state highways). Silicon Valley data include Santa Clara & San Mateo Counties. One vehicle hour of delay reflects one vehicle stuck in traffic for one hour. Delay refers to speeds less than 60 miles per hour. The California Department of Finance's E-4 Population Estimates were used to compute per-capita values. Air Quality data are from the United States Environmental Protection Agency, Outdoor Air Quality Data, and include Santa Clara and San Mateo Counties. Unhealthy days are based on Air Quality Index (AQI) of >100 for sensitive groups, and >150 for the general population. The AQI includes Air Quality Index (AQI) for all AQI pollutants including carbon monoxide, ozone, particulate matter, nitrogen dioxide, sulfur dioxide, and lead. The PM2.5 monitoring network was phased in between 1999 and 2001 in most areas, so earlier years do not include PM2.5 (a type of particulate matter) using data from the EPA AQS (Air Quality System) except the 2020 AQI and PM2.5 data, and San Mateo County October through November AQI 2019 data, which are from AirNow. AirNow data are "not fully verified and validated through the quality assurance procedures monitoring organizations use to officially submit and certify data on the EPA AQS (Air Quality System) and, therefore, cannot be used to formulate or support regulation, guidance or any other Agency decision or position." Bay Area-wide COVID-19-related emissions reduction data are from the Bay Area Air Quality Management District (BAAQMD) as of early May, 2020. Transportation-related highway injury crash data are from the Statewide Integrated Traffic Records System (SWITRS) via the Transportation Injury Mapping System (TIMS) Injury Crashes During COVID-19 tool, accessed May 28, and only include those collisions in which an injury or fatality occurred. Provisional crash data are based on police reports of crashes that occurred on state highways. Crashes are added to the California Statewide Integrated Traffic Records System (SWITRS) by the California Highway Patrol (CHP) and we download them from the I-SWITRS website on a daily basis. There is a delay related to submitting, processing, and tabulating crash data into SWITRS. Due to this lag, the data shown may exclude some relevant crashes, particularly those occurring in the most recent two to three weeks. These data do not currently include crashes that occurred on non-state roads. Airport data were obtained directly from San Francisco and Mineta San Jose International Airports, and were combined to determine percent changes regionally.

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