File No. 221212 **Committee Item No.** _____
Board Item No. 31

COMMITTEE/BOARD OF SUPERVISORS

AGENDA PACKET CONTENTS LIST

Committee: _____ **Date:** _____
Board of Supervisors Meeting **Date:** December 6, 2022

Cmte	Board	
☐	☐	**Motion**
☐	☒	**Resolution**
☐	☐	**Ordinance**
☐	☐	**Legislative Digest**
☐	☐	**Budget and Legislative Analyst Report**
☐	☐	**Youth Commission Report**
☐	☒	**Introduction Form**
☐	☐	**Department/Agency Cover Letter and/or Report**
☐	☐	**MOU**
☐	☐	**Grant Information Form**
☐	☐	**Grant Budget**
☐	☐	**Subcontract Budget**
☐	☐	**Contract/Agreement**
☐	☐	**Award Letter**
☐	☐	**Application**
☐	☐	**Public Correspondence**

OTHER

☐	☒	MTA Letter to NHTSA 092122
☐	☒	SFCTA - TNCs Today Rpt 0617
☐	☐	
☐	☐	
☐	☐	
☐	☐	

Prepared by: Arthur Khoo **Date:** December 1, 2022
Prepared by: _____ **Date:** _____

FILE NO. 221212 RESOLUTION NO.

[City Policy - Autonomous Vehicles Declaration of Policy]

Resolution declaring the official policy of the City and County of San Francisco regarding Autonomous Vehicle (AV) services and programs, by urging the National Highway Traffic Safety Administration (NHTSA), state and local agencies to condition the granting of permits and incentives on addressing San Francisco's safety concerns.

WHEREAS, San Francisco continues to support innovations in the technology sector, and in particular is interested in about the potential for improved public safety and mobility benefits (including for low vision/sight-impaired people and people with disabilities) that autonomous vehicles (AV) Passenger Services may provide to the extent they can demonstrate a higher level of safety performance than human-controlled driving; and

WHEREAS, As new mobility services and technologies emerge, from ride-hailing services to electric scooters to AV passenger services, San Francisco continues to seek to appropriately regulate or otherwise influence them to protect the general public interest and public safety; and

WHEREAS, San Francisco has adopted a Vision Zero Safety Strategy across all Departments emphasizing investments in street safety engineering, education, enforcement, policies, and other policy measures to achieve zero traffic fatalities; and

WHEREAS, San Francisco has adopted other foundational transportation policies, including its Transit First Policy and a Climate Action Strategy, which identify mobility services as one potential tool in decreasing our carbon footprint, along with public transportation, cycling and walking; and

WHEREAS, In order to minimize our carbon footprint, as outlined in our Climate Action Strategy (1) AV Passenger Services should be offered in zero emission vehicles, and (2) to

minimize negative secondary effects of congestion on more efficient travel modes or excessive miles traveled with low vehicle occupancy, AV Passenger services should seek to achieve maximum occupancy that exceeds personally owned passenger vehicles; and

WHEREAS, San Francisco has a limited amount of street space, and more than a million people use the public roadways within its forty-nine square miles to get around the city everyday, and city officials have a responsibility to consider and minimize negative unintended consequences on other street users, including ensuring a manageable scaling of all AV fleet programs and removal of vehicles from the public right of way if and when they fail or become paralyzed; and

WHEREAS, The City and County administers Proposition D, San Francisco's 3.25% per-trip fee on drivered and driverless ridehail trip services to help fund Vision Zero street safety upgrades and more reliable Muni transit services and therefore has an interest in transparent and reliable reporting of ridehail trips to/from and within the city; and

WHEREAS, The San Francisco Municipal Transportation Agency (SFMTA) is responsible for managing competing mobility needs within that limited public road space, and protecting the public interest in a safe and reliable transportation network that serves everyone's needs; and

WHEREAS, The San Francisco County Transportation Authority (SFCTA) is the regional congestion management agency tasked with managing public investments for San Francisco's comprehensive transportation system, including advancing Vision Zero initiatives and conducted its own in-depth analysis of Transportation Network Companies' (TNC's) traffic circulation and congestion on San Francisco streets in its 2017 "TNC's Today" Report, which showed the significant impact of TNC vehicles on congestion in the city's downtown core, and which is hereby declared to be a part of this resolution as if set forth fully herein; and

WHEREAS, San Francisco has learned from the roll out of previous mobility services and "sharing economy" products that it is very important to establish clear policy goals at the outset of the deployment of new innovation programs and technologies, set user and permitted vendor expectations that are sustainable over the long term, ensure strong reporting and evaluation protocols to enable data-drive policy-making, and to "get things right the first time"; and

WHEREAS, While San Francisco supports the potential benefits of automated driving, including improving street safety and realizing first/last mile transit solutions, the City and County of San Francisco continues to have reasonable concerns over granting permits by state and federal agencies for driverless vehicles without adherence to and consideration of evidence-based protocols, data sharing and transparent reporting; and

WHEREAS, San Francisco transportation agencies need transparent and accurate data from AV companies on collisions, travel lane failures, and other safety concerns in order to effectively evaluate the best congestion and transportation demand management solutions in the public interest; and

WHEREAS, While San Francisco does not have permitting authority over AV Passenger Services, there are many other incentives and support that the City provides to potential operators using the public right-of-way, including but not limited to fleet charging, fleet deployment, curb management tools, tax incentives, fee waivers, and other approvals and incentives which could apply to AV Passenger Services; and

WHEREAS, San Francisco has provided lengthy recommendations to NHTSA (the "Letter"), which is hereby declared to be a part of this resolution as if set forth fully herein, on the City's valid safety concerns, emphasizing that AV's should improve safety for everyone, and that AV's should be safe and courteous defensive drivers that comply with all state and local traffic laws, as well as minimize conflicts on the road, especially with vulnerable road

users such as cyclists and pedestrians, including 1) pulling to the curb and other safe available spaces for picking up and dropping off passengers and 2) minimizing and timely mitigating failures in travel lanes that create hazards for other road users and obstruct the safe and efficient flow of traffic; and

WHEREAS, Given that the economic vitality of the city depends on the transportation network providing good mobility options that serve everyone, including people with disabilities and low-income people who live in areas that reflect historic disinvestment, there should be a clear equity nexus in all AV Passenger Service programs; now, therefore, be it

RESOLVED, That the Board of Supervisors of the City and County of San Francisco urges the NHTSA to condition any grant of petition for temporary exemption from critical safety standards on addressing the safety concerns raised in San Francisco's public comment Letter to the satisfaction of both the SFMTA and SFCTA; and, be it

FURTHER RESOLVED, That it is the official policy of the City and County of San Francisco to condition the approval or issuance of discretionary permits, licenses or other approvals, other city support, resources, or incentives to private AV service providers on addressing the valid safety concerns as outlined in the Letter; and, be it

FURTHER RESOLVED, That the Board of Supervisors directs the Clerk of the Board to transmit this Resolution declaring the official city policy to the Mayor, City Attorney, SFMTA, SFCTA, Planning Department and NHTSA.

September 21, 2022

U.S. Department of Transportation
Docket Operations, M-30, Rm. W12-140
1200 New Jersey Avenue, S.E.
Washington, D.C. 20590

Filed digitally at www.regulations.gov
Docket # NHTSA-2022-0067 – General Motors
Docket # NHTSA-2022-0066 – Ford

Dear NHTSA,

The City and County of San Francisco ("San Francisco" or "SF") files these comments in response to the NHTSA notice ("NHTSA Notice") and request for public comment in Docket 2022-0067 on a petition for temporary exemption from Federal Motor Vehicle Safety Standards ("FMVSS") filed by General Motors for its ADS-equipped vehicle, the "Cruise Origin" ("the Petition" or "GM Petition"). San Francisco has observed General Motors' automated driving for several years. We have not observed Ford or Argo AI automated driving. Because these comments address some issues that are relevant to the similar petition from Ford in Docket 2022-0066, we are filing them in both dockets.

The **San Francisco Municipal Transportation Agency ("SFMTA")** is a City department that has uniquely broad responsibility for designing San Francisco's streets and traffic control devices, regulating the use of curbs, operating the seventh largest public transit system in the country ("Muni"), enforcing parking regulations, and regulating taxis and emerging mobility. The **San Francisco County Transportation Authority ("SFCTA")** is San Francisco's congestion management agency with responsibility for monitoring and analyzing travel activity and long term transportation planning. The SFMTA and SFCTA submit the attached comments on behalf of the City and County based on close collaboration with San Francisco Police and Fire Departments ("SFPD", "SFFD"), the Department of Emergency Management ("DEM")—which operates the 911 Public Safety Answering Point for San Francisco, the Mayor's Office, and the Mayor's Office on Disability.

San Francisco is excited about the opportunity for automated driving to significantly improve street safety, and we look forward to the time when automated driving technology demonstrates a higher level of safety performance than human driving. The GM Petition offers an exciting vision and illustrates areas of impressive design, many of which we have witnessed on San Francisco Streets. But it falls short of documenting or analyzing the safety

performance of either Cruise's existing modified Chevrolet Bolt (the "Cruise AV") or the forthcoming Origin. These comments neither support nor oppose the Petition, but document safety hazards and street capacity issues raised by the operation of the Cruise AV on S an Francisco streets, some of which San Francisco has discussed with Cruise since 2018.

There are three primary ways in which the scale of the GM Petition raises concern. First, we understand that under 100 Cruise AVs are currently operating without a safety driver in San Francisco. If even half of the 5000 vehicles that could be authorized by approval of the GM Petition were to operate in San Francisco—the focal point for Cruise operations in recent years—this 25x fleet expansion could significantly undermine street performance for all San Francisco travelers. For comparison, San Francisco County Transportation Authority research found that during the peak period of an average weekday in 2016, more than 5700 Uber and Lyft (known in California as Transportation Network Company or "TNC") vehicles were operating on public roads. With this fleet size in San Francisco, TNC driving *caused 25% of all travel delay* (as measured by vehicle hours of delay) on an average weekday.[1]

Second, the shift from the existing driverless operation of Cruise AVs to operation of the Origin without human controls makes the spate of recently observed travel-lane Cruise AV failures far more consequential. While a Cruise AV can be recovered when a human driver is dispatched to a failure site, to manually retrieve the vehicle, it is our understanding that the Origin can only be removed from San Francisco streets by towing. Performance with a larger fleet or during daytime hours that is not *far superior* to recent Cruise AV performance could quickly exhaust emergency response resources and could undermine public confidence in all automated driving technology.

Finally, while the Petition notes that the Origin will use the same automated driving system ("ADS") as the Cruise AV, the Origin is much larger and heavier than the Cruise AV and has a very different shape. While the Origin's size and shape offers clear benefits, it may also exacerbate hazards discussed in San Francisco comments.

As such, San Francisco recommends that NHTSA evaluate the core driving competencies of the Origin before allowing operation of as many as 5000 vehicles on city streets. NHTSA should launch a rulemaking proceeding to prescribe minimum standards for performance of all automated driving systems operating on public roads—whether or not the vehicles have human driver controls. If NHTSA is inclined to approve the GM Petition in the absence of such analysis or standards, we urge the Agency to consider our attached recommendations for expanded conditions of approval, expanded data collection, and future research.

[1] SFCTA, *TNCs & Congestion*, p. 7 (2017). https://www.sfcta.org/sites/default/files/2019-05/TNCs_Congestion_Report_181015_Finals.pdf

As stated in the U.S. Department of Transportation's National Roadway Safety Strategy, "Roadway safety is a shared responsibility, and the actions of Federal, State, regional, local, and Tribal governments; industry; advocacy organizations; research and academia; and the traveling public are all instrumental." San Francisco holds our door open to collaboration with federal and state agencies and with industry, and we believe such collaboration will be necessary to incorporate driving automation into cities in a way that best serves the public interest. Thank you for your consideration of San Francisco recommendations.

Sincerely,

Jeffrey Tumlin
Director of Transportation, SFMTA

Tilly Chang
Executive Director, SFCTA

Attachment: San Francisco Comments and Recommendations

San Francisco Comments & Recommendations

Section 1: San Francisco Street Regulation & Observations of Cruise AVs

Given its mild climate, proximity to Silicon Valley, and county population density that is second only to the boroughs of New York City, San Francisco has become the epicenter of testing for automated driving in the U.S. Because there has been no national reporting of automated vehicle miles traveled by location, we cannot understand San Francisco's role with precision; however, we note that two-thirds of the ADS-involved crashes reported to NHTSA under the Standing General Order issued in June, 2021 occurred on San Francisco streets.

San Francisco street space—the largest body of real estate in the city—is in high demand from many users. Many San Francisco roads were developed and designed in the 19th or early 20th century. The city sits at the end of a peninsula surrounded on three sides by water and is fully developed. San Francisco will not be widening roads. San Francisco regulates to manage competing uses of the streets and curbs while maximizing

public safety and other city and state climate, equity, economic, accessibility, and environmental goals. There are many elements of this regulation, including, for example:

- Safety-informed allocation of curb space for transit vehicle and commuter shuttle stops, passenger zones (for pick up and drop off of passengers by anyone), metered and unmetered short-term parking, commercial vehicle loading, general loading zones (for passengers and goods), taxi zones, parking for people with disabilities, motorcycle parking, etc.;
- Safety-informed allocation of street and sidewalk space for bike share docks, bicycle parking, and scooter and other device parking;
- Safety-informed design, installation, and maintenance of bicycle lanes, pedestrian crossings, curb ramps, and dozens of other features that provide access to sidewalks for pedestrians, including people who use wheelchairs;
- Safety-informed design, installation and maintenance of colored curbs and signs that advise the public of proper uses curb space, as well as traffic signs and signals; and
- Safety-informed approval of public requests for temporary closures of streets for community events and construction activities and temporary modifications of traffic controls to accommodate First Amendment activities and/or travel to and dispersal from major public events.

Given the wide range of San Francisco road users, new vehicles that cause frequent obstructions on San Francisco streets have a significant and negative effect on the overall safety and performance of the transportation network. To meet the stated vision of driving more safely than human drivers, automated vehicles must have the technical ability and programming to comply with all applicable permanent and temporary street regulations, except where otherwise directed by city traffic control or public safety officers, and they must be able to timely follow that direction. They must, for example, be able to search for and recognize lawful on-street stopping and parking spaces, parallel park in a typical parking or loading space with an average length of 20 feet, and pull into driveways, parking lots and garages. Furthermore, they must have on-road failure rates that do not reduce road capacity unreasonably and do not interfere with first responder operations. Vehicles that do not have these capabilities may be ready to operate in cities with newly designed wide streets, but they are not ready for commercial operation in San Francisco's older, narrower, and more varied streets.

1.1 Cruise AV Travel Lane Road Failures

Until very recently, all observation of automated driving on San Francisco streets was affected by a key limitation: when there is a safety driver behind the wheel, it is impossible for even informed observers to know whether they are witnessing automated driving or driving by the human safety operator. This limitation stopped confounding public observations when Cruise began testing without a human safety driver in June 2021. In the six months between June 1 and November 30, 2021, Cruise reported approximately 6,000 miles of driverless operation using 20 vehicles.[1] From September 1, 2021 until May 31, 2022, Cruise reported 16,000 miles of driverless operation in passenger service testing using 50 vehicles.[2] This represents a small fraction of overall Cruise AV driving in San Francisco.

San Francisco has no data on Cruise AV fleet size or miles of Cruise driverless testing after May 2022; however, it appears that driverless operation has significantly increased. Starting in late May 2022, managers in the City's Department of Emergency Management began to notice a number of calls to 9-1-1 from people who witnessed or were inconvenienced by Cruise operations. Some San Francisco Police officers also observed driverless AVs disabled in travel lanes. Some callers complained of erratic driving (including signaling in one direction while moving in the other direction) or a Cruise AV blocking a transit vehicle, but the most common complaint to 9-1-1 has been about Cruise AVs blocking travel lanes for extended periods causing traffic backups. In some cases, callers reported evasive maneuvers by others such as driving on a sidewalk to get around the blockage. One third of the reported incidents involved multiple non-operational Cruise AVs and affected multiple travel lanes. Even some single vehicle incidents affect two lanes or two directions of traffic because of the angle and location at which the Cruise AV comes to rest. One incident in June 2022 involved 13 Cruise AVs stopped on a major arterial street. Two additional large group incidents were reported in August, 2022. We lack reliable information about the duration of these road blockages;

[1] DMV. 2020-21 Autonomous Mileage Reports (Driverless), https://www.dmv.ca.gov/portal/vehicle-industry-services/autonomous-vehicles/disengagement-reports/ Accessed 5/18/2022

[2] CPUC. AV Passenger Service Pilot Quarterly Reports. https://www.cpuc.ca.gov/regulatory-services/licensing/transportation-licensing-and-analysis-branch/autonomous-vehicle-programs/quarterly-reporting

however, they range from minutes (extending through many traffic light cycles) to hours. Cruise has informed us that when a Cruise AV faces circumstances in which it is uncertain of the best response, it "falls back" to a "minimal risk condition"[3], from which it can only be moved by on-street field staff. The City has no information about whether the total of 28 incidents reported to 9-1-1 between May 29 and September 5, 2022 reflect recurrence of the same issues, or whether each reflects a unique issue. The large majority of these reported incidents occurred between the hours of 10 pm and 6 am when Cruise has been authorized by the California Public Utilities Commission to offer commercial service in 30 driverless Cruise AVs. We have identified an additional 20 incidents posted on social media during this three-month time period. It is reasonable to assume that the number of incidents reported to 9-1-1 and posted on social media or observed by San Francisco Police Officers are a fraction of actual travel lane road failures because few people are on the street during these hours to observe and make such reports.

What we can observe is that these reported incidents create hazards. They can cause other vehicles to make dangerous abrupt lane changes, brake or accelerate rapidly, or veer into bike lanes or crosswalks. To put these reported incidents into context on the San Francisco street network, 68% of the failures occurred on streets on which Muni buses, light rail vehicles, and streetcars provide transit service; 32% occurred on the San Francisco bike network, and more than 80% occurred on the City's High Injury Network—the 13% of San Francisco streets that account for more than 75% of severe or fatal injury crashes. (*See Reported Incident Map in Exhibit A*.) In many cases, the reports triggered a non-critical dispatch of a San Francisco Police vehicle, and San Francisco's 9-1-1 dispatchers contacted the Cruise First Responder hotline to alert Cruise that one or more vehicles were reported to be stalled and needed retrieval. Cruise has informed City emergency responders that the way to address an unresponsive Cruise AV in the event of an incident is to call the Cruise Critical Response Line so that Cruise field staff can move the vehicle. In some cases, Cruise staff identified an expected retrieval time that was not

[3] While "fallback" and "minimal risk condition" are terms of art defined in the SAE taxonomy, we question the assumption that stopping in a travel lane is necessarily a location of "minimal" risk and we understand there is ongoing discussion of the term "minimal risk condition" in SAE committee work. GM describes five degraded state levels in Table G-1 on pages G-2 through G-4 of its Petition. Three of these five states require retrieval of the vehicle by a vehicle support team. It is not clear how many of these states might occur in a travel lane rather thanalong a curb or off the public street.

fulfilled. On one occasion on August 4, 2022, a City dispatcher placed four calls over six minutes to the Cruise Critical Response Line; none of these calls were picked up.

These incidents trigger concern that street failures in travel lanes by Cruise AVs and/or Origins will not only cause immediate hazards for other road users but also increase congestion and affect response time to medical emergencies and fires. This concern was accentuated by an incident in April 2022 that affected San Francisco Fire Department response. At approximately 4:00 a.m., on April 5, 2022, a SFFD vehicle responding to a three-alarm fire with lights and sirens needed to pass a working Recology garbage collection truck using the opposing lane. As it did so, a driverless Cruise AV came to a stop immediately adjacent to the garbage truck, blocking the only available travel lane. The driverless Cruise AV did not reverse, as a human driver would be likely to do,[4] and the engine could not proceed until the Recology driver ultimately returned to move the garbage truck. Stopping in a travel lane—apparently without the ability or timely supervision to reverse course—creates hazards and slows emergency response. The City understands that the Cruise AV perceived and correctly classified the oncoming fire vehicle and its lights and sirens and "phoned home" to Cruise Remote Advisors for guidance. However, the Cruise AV yielded to the fire vehicle in a way that obstructed its movement. SFFD is extremely concerned about vehicles stopping and failing in travel lanes and the potential negative impact of this driving behavior on fire department response times.

San Francisco believes these incidents reflect the simple reality that the Cruise AV automated driving system is still under development. We do not expect perfection. However, these incidents demonstrate that travel lane failures that block roadways should be considered a key performance indicator for driverless readiness and that NHTSA should collect data on the number and rate of these incidents in relation to both vehicle miles traveled and the severity of the road impact (lanes affected and duration of impact). Further, the incident in which failure of the Cruise Critical Response Line to pick up a call

[4] Because of this SFFD incident, San Francisco was concerned to learn of a press report showing a Cruise AV (in this case appropriately stopped at a curb) that was unable to shift into reverse in order to move around a vehicle in front of it and start a ride without human support. https://www.today.com/video/fully-autonomous-taxi-service-comes-to-san-francisco-147981893910 Cruise described the failure as "caused by a bug that very infrequently causes the [autonomous vehicle] to shut down when it attempts to go in reverse."

from San Francisco 9-1-1 dispatchers illustrates that NHTSA should also collect data on multiple response time metrics: the time it takes for calls to the Critical Response Line to be picked up and the time it takes for General Motors to clear a roadway blockage from affected public streets. To the extent these functions may rely on the same personnel providing operational direction to vehicles that have encountered a circumstance they cannot navigate alone, response time to vehicle calls for support should also be considered as a key performance indicator. We urge NHTSA to collect this information both as part of its evaluation of whether to grant the GM Petition as well as on an ongoing basis during the service life of any vehicle operating under an exemption that may be granted in response to the GM Petition. Finally, these reported incidents, including especially the multiple vehicle incidents, illustrate the kind of profound road impacts that could materialize if a cybersecurity incident were to simultaneously affect the full Origin fleet, or even a substantial part of it. NHTSA's conditions appropriately call for immediate reporting of such incidents to NHTSA, but do not consider reporting to relevant Public Safety Answering Points (such as the San Francisco Department of Emergency Management). With these issues in mind, San Francisco makes the following recommendations:

> RECOMMENDATION 1.1.1 If NHTSA is inclined to approve the GM Petition, San Francisco recommends that NHTSA require General Motors to submit quarterly data on Cruise AV and Origin[5] requests for remote advisor assistance as they operate on public roads and in-lane failures that affect a travel lane on a public road, including bike lanes and lanes designated for transit or other vehicles. Incidents should be reported in relation to the vehicle model, date, time, location and in relation to the vehicle miles traveled both on an individual vehicle and aggregate fleet basis by market area. [6]

[5] While the GM Petition addresses the Origin, it notes that the Origin will be operated by the same automated driving system that operates the Cruise AV. It is possible that the majority of Cruise automated driving will continue to be logged by Cruise AVs. Collection of data from both models could support more rapid development of automated driving standards, as well as help evaluate the safety record of the Origin in relation to the Cruise AV.

[6] This recommendation is informed by years of San Francisco's use of "mean distance between failures" as a metric for evaluating the reliability, mechanical performance and state of good repair for our trolley bus, motor coach, historic streetcar and light rail vehicles. Performance on this metric varies in relation to many factors—including the stage in the

RECOMMENDATION 1.1.2: If NHTSA is inclined to approve the GM and Ford Petitions, San Francisco recommends that in addition to informing NHTSA, in the event of any cybersecurity incident that warrants issue of a "stop order" because it presents an unreasonable or unforeseen risk to the safety of vehicles on the road, NHTSA should require General Motors and Ford to immediately report to all relevant Public Safety Answering Points the existence of the risk and what actions will be taken to cease operations in a safe manner.

RECOMMENDATION 1.1.3: If NHTSA is inclined to approve the Petitions, NHTSA should use data reported by GM and Ford to develop key performance indicators for human advisor response to AV requests for assistance, in-lane failures on public roads, Critical Response Line pickup time, road clearance time and other measures of safety performance and road impact.

RECOMMENDATION 1.1.4: If NHTSA is inclined to approve the requested exemptions, NHTSA should initially approve the GM petition in a way that limits the geographic deployment in the San Francisco market by number of vehicles and time of day and expands authorization only after GM or Ford demonstrate reasonable performance based on key performance indicators.

San Francisco recognizes and appreciates that our streets offer one of the most challenging driving environments in the country and that the performance along key performance indicators may reasonably vary from one road environment to another. Performance should improve as automated driving technology matures. Tracking performance in different road environments could help NHTSA develop minimum safety standards. We have no opinion about what minimum performance is needed in road environments that may be fundamentally different from San Francisco. We understand that NHTSA has not previously issued exemptions in a way that considers the geographic areas or markets in which exempted vehicles are deployed. However, automated driving is creating new transportation challenges and calls on regulators to consider new approaches to exemptions and regulations.

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lifecycle of a fleet. Even old or antique fleets measure mean distance between failures in the thousands of miles while fleets at the peak of their performance measure in the tens of thousands of miles. See, https://www.sfmta.com/reports/muni-mean-distance-between-failure

1.2 Observations of Cruise AV Driving: Passenger Pick-Up and Drop-Off Stops

Pick-up and drop-off stops in travel lanes generate congestion, extend travel times, and reduce road capacity. SFCTA research found that pick-up and drop-off stops by Uber and Lyft significantly increased congestion in San Francisco between 2011 and 2016.[7] The impact of pick-up and drop-off stops in travel lanes is shorter in duration than the travel-lane road failures described in Section 1.1. Still, routine travel-lane pick-up and drop-off stops create hazards and delays that impact all road users. As the size of the Cruise AV and Origin fleet grows, these impacts could become very substantial.

For example, where a vehicle waits to pick up a blind passenger in a place where they must step off the sidewalk and into an active travel lane without any fixed guidance—or drops off a passenger who uses a wheelchair in a location from which they must wheel half a block against the stream of traffic to reach a curb ramp, the vehicle is putting the passenger in a place of peril. Cyclists and other drivers may have to swerve to avoid hitting either the Origin or a passenger left in the stream of traffic. Even where passenger or other road users are not affected by disability, stopping in a travel lane to pick up or drop off passengers generates safety hazards for passengers and other road users, congestion, longer travel times, and reduced road capacity. Thus, a small percentage of travelers can have an outsize effect on travel for all San Francisco travelers.

For these reasons, San Francisco has been discussing the importance and priority of safe and legal curb-side stops for passenger pick-up and drop-off with both Cruise and other AV developers since at least 2018. In November 2021, Cruise released two videos to the public documenting early driverless operations with no safety operator behind the wheel.[8] These videos show Cruise AVs stopping to pick up and drop off passengers in travel lanes—even where curb space dedicated to or available for passenger loading and unloading was adjacent to the passenger or to the vehicle. In early 2022, San Francisco held two meetings with Cruise in which we discussed specific

[7] SFCTA, *TNCs & Congestion*, p. 7 (2017). https://www.sfcta.org/sites/default/files/2019-05/TNCs_Congestion_Report_181015_Finals.pdf

[8] These videos can be found at the following two locations:
https://www.youtube.com/watch?v=dmvZBiWYkFQ
https://www.youtube.com/watch?v=svebS-uR7wc

concerns with the driving Cruise documented in its own videos. In May 2022, San Francisco evaluated video showing approximately 100 pick up and drop off stops—including video posted by Cruise and video posted by individual passengers on social media and did not find a single stop in which the Cruise AV pulled fully out of a travel lane to pick up or drop off passengers. See illustrations at Exhibit B. A more recent survey of video has identified fewer than ten stops in which the Cruise AV can be seen to pull slightly toward the curb when dropping off a passenger or to pull slightly away from the curb after picking up a passenger. It is not clear in these cases whether the Cruise AV has reached a location that does not impede the travel of others.

Human drivers obviously make stops in travel lanes to pick up or drop off passengers. In recent years, authorities issued more than 80,000 parking citations to human drivers who made stops like those Cruise appears to depend on for its passenger operations. Tolerating this level of performance will generate a customer base accustomed to practices that, upon expansion, will increase road hazards for vulnerable road users. Cruise has not shared with San Francisco any efforts to improve the performance we have observed in these videos or the results of any such efforts. Instead, Cruise has responded that their technology prioritizes passenger convenience over seeking available curbside space. San Francisco is not aware of any work that Cruise may be doing either to improve the performance of the Cruise AV to prioritize both safety and passenger convenience or to communicate with riders through the Cruise passenger service application to set passenger expectations that Cruise will seek the closest available curb or other space (such as an available driveway or parking lot) to pick or drop off passengers in proximity to their requested pick up or drop off location.[9]

San Francisco has not identified a method to use routinely reported data to determine if pick-up and drop-off stops are safe and consistent with state and local traffic codes. San Francisco cannot identify a single data field that NHTSA could request to assess this important aspect of driving safety. Video of every stop for passenger pick

[9] Where a vehicle is operated by a human driver, the passenger has the opportunity to influence their preferred pick-up or drop-off location, either by standing near an open curb space, for example, or voicing a preference to the human driver, "You can pull into that space behind the van," Or "I am blind, wearing a red hat, and waiting with a black guide dog." San Francisco has no information about passenger service application features that would give passengers the opportunity to influence stop location in this way for the Cruise AV, the Origin, or the Ford ADS equipped vehicle.

up or drop off would require huge data transfers and staff review time and would require protection of passenger privacy. As a result, while safe and lawful stops at the curb for pick up and drop off are a high priority for San Francisco, we recommend that NHTSA address this concern using auditing and or research methods.

> RECOMMENDATION 1.2: If NHTSA is inclined to approve the GM Petition, San Francisco urges NHTSA to work with the City to develop a research protocol to analyze pick up and drop off driving impacts and to condition approval on General Motors cooperation with research, subject to restrictions that may be necessary and appropriate to protect passenger privacy.

Section 2: Does GM make strong and persuasive arguments that granting the GM Petition furthers the purposes of the Motor Vehicle Safety Act and the other public interests advanced?

After hosting driving on San Francisco streets by the Cruise AV for several years, San Francisco remains optimistic that the GM automated driving system may ultimately contribute to improving safety on San Francisco roads. San Francisco welcomes the possibility that the Cruise Origin may improve road safety and stands ready to collaborate with General Motors, Cruise, NHTSA, and California agencies to assess and maximize this potential.

Nonetheless, it is striking that many of the company's public interest arguments are not in fact strong or persuasive. As a general matter, the purpose of the Motor Vehicle Safety Act is to reduce traffic collisions and injuries and deaths resulting from traffic accidents. Congress sought to protect the public against unreasonable risk of injury and fatal crashes arising from the design, construction, or performance of a motor vehicle. Strikingly, the GM Petition focuses on the design, approach and intent of the Origin's features but provides minimal, incomplete, or no documentation at all about the critical issue of actual performance. This is true for both the safety case and for many other arguments the Petition advances to support NHTSA's public interest finding. Thus, should NHTSA be inclined to approve the petition, approval conditions and reporting requirements should be crafted to build a record that both effectively documents the performance and effects of the Origin and that identifies any safety-

related or other negative unintended consequences of the Origin's operations that Cruise, NHTSA, or other federal, state, or local agencies should address.

2.1 San Francisco agrees with the GM that approval will enable GM to share substantive ADS information with NHTSA.

San Francisco agrees with GM that approving the petition could provide data to support future agency rulemaking. GM and Cruise expect that this sharing of information would be generally consistent with the terms of the Nuro petition grant. We reject this assumption because the vehicles at issue in the GM and Ford petitions are entirely different from Nuro's AVs. Nuro sought approval for an unusually small, light, low-weight, and low-speed vehicle that would carry no human passengers. In contrast, GM seeks approval for an unusually large vehicle with characteristics that have the potential to cause great injury to other road users. Further, while testing to date in the Cruise AV has involved speeds only up to 30 mph, the Petition's description of the Origin Operational Design Domain ("ODD") states that it has a maximum speed of 80 mph, greatly increasing the potential for injury to both passengers and other road users.

Under these circumstances, the Nuro data collection standards should be only NHTSA's starting point. Further, while the law appropriately protects disclosure of confidential business information and passenger privacy, San Francisco urges NHTSA to create a mechanism to share with affected road owners ADS crash, near miss, and road failure data reported by GM and Ford. The recently issued National Roadway Safety Strategy puts the Safe System Approach—which focuses on "safer people, safer roads, safer vehicles, safer speeds, and post-crash care" at its core and notes that "safer roadways mean incorporating design elements that offer layers of protection to prevent crashes from occurring and mitigate harm when they do occur." In order to be proactive in building safe roads for the future, cities that host automated driving need access to data and information that documents where automated driving is facing challenges.

> RECOMMENDATION 2.1: If NHTSA is inclined to approve the Petitions, San Francisco recommends that NHTSA expand city access to safety critical incident information (such as crash, near miss, and travel-lane ADS road failures)

submitted by GM and Ford to enable road managers to evaluate factors that may affect the safety of automated driving systems operating on their streets.

2.2 GM asserts that approval of the Petition will promote the safety of the transportation system.

First, San Francisco applauds GM's choice to design the Origin with sliding doors on either side of the vehicle to permit entry and exit without a door protruding into (or further into) adjacent lanes of travel. Assuming it is operated to maximize loading and unloading at the curb, San Francisco expects this door design to reduce the risk of "dooring" collisions, which are a frequent source of injuries to cyclists on San Francisco roads. We are confident that the Origin reflects numerous other design and engineering achievements that support passenger safety and the safety of other road users.

Yet, San Francisco remains disappointed by the GM Petition. NHTSA has posed the question whether GM has made a strong and persuasive case that approving the Petition is in the public interest. It is logical to hope that automated driving systems will be excellent drivers because they will avoid speeding and other driving violations that are highly associated with serious injury and fatality crashes. But the GM Petition generally assumes, rather than making a strong and persuasive case, that GM's autonomous technology will improve the safety of the transportation system.

GM describes the Cruise AV as the "foundational platform for testing and iterating the functionality and safety of the ADS" and the states that the Origin will use the same ADS currently operating the Cruise AV on San Francisco Streets.[10] GM and Cruise state that they have fine-tuned the ADS technology that drives the current Cruise AV "efficiently, effectively, and proficiently." But GM identifies no key performance indicators (KPIs) that GM uses to evaluate the effectiveness of the Origin's crucial perception tools, its prediction algorithms or its driving decision choices. GM identifies no metrics that it uses to evaluate the overall safety performance of the ADS, and offers no analysis of the safety performance of the existing Cruise AV. GM presents no data or analysis of crashes, near misses, or on-road failures by the Cruise AV and includes no analysis of the differences between the Cruise AV and the Origin, such as the shape, size,

[10] GM Petition, pages 3 and E-1.

and weight of the vehicle, that may be associated with different safety outcomes—particularly to vulnerable road users.[11] GM offers no evidence about why the ADS that has been tested only at speeds up to 30 mph is capable of driving safely at the 80 mph identified in the description of the Origin's Operational Design Domain.

We can affirm what all informed readers already know: the Cruise AV has not been involved in any fatal crashes in San Francisco. As a Vision Zero City, San Francisco is grateful for this safety accomplishment. But even minor crashes can signal a systemic problem, and the City does not have the technical expertise to conclude that the absence of fatal crashes from the testing to date of the Cruise AV signals superior driving. Most human drivers have also not been involved in a fatal crash, but this does not necessarily mean that most of us are excellent drivers. Most human drivers do not in fact stop in travel lanes to pick up and drop off passengers, and no human driver would be satisfied owning or operating a vehicle that becomes immobilized at the apparent rates occurring on San Francisco streets.

San Francisco is troubled by the June 3, 2022 crash on Geary Boulevard at Spruce Street that resulted from a Cruise AV's unprotected left turn in front of a speeding oncoming vehicle. This is precisely the kind of crash that San Francisco has understood would be avoided by the superior perception and prediction capabilities of an automated driving system. San Francisco appreciates that Cruise acknowledged the ADS error that contributed to this crash by issuing a defect notice, but we find the explanation of the error unsatisfying.[12] The recall report states that the Cruise AV

[11] NHTSA does not have a safety standard for pedestrian crash protection like UNECE Regulation No. 127: Pedestrian Safety Performance or the EuroNCAP Vulnerable Road User (VRU) Protection scores for head impact, upper leg impact, and lower leg impact. NHTSA conducted crash test research to assess the pedestrian crash protection performance of US fleet vehicles using EuroNCAP test procedures. The pickups and SUVs tested (2016 Chevrolet Tahoe, 2016 Ford Edge, 2016 Ford F-150, and 2015 Toyota Sienna) scored lower than the passenger vehicles. The average pickup and SUV score was 15.72 of 36 maximum points (or 44% of max). The average passenger vehicle score was 25.62 of 36 maximum points (or 71% of max). (Source: NHTSA, "Overview of NHTSA Pedestrian Crashworthiness Research" presentation to SAE Government Industry Meeting, January 24-26, 2018.) GM and Cruise have not provided crash test data to support their claim that the Origin has an overall safety level at least equal to the overall safety level of nonexempt vehicles. The Origin may be more similar to the lower scoring SUVS than to the higher scoring passenger vehicles.

12 See Part 573 Safety Recall Report submitted August 29, 2022, NHTSA Recall Number 22E-072 affecting 80 ADS units. https://static.nhtsa.gov/odi/rcl/2022/RCLRPT-22E072-8020.PDF

reasonably assumed the vehicle would take a right turn because it was at one point traveling in a right hand turn lane. We note that many drivers do not comply with markings that restrict travel to certain vehicles or driving maneuvers. A Cruise AV or Origin that perceives an oncoming speeding vehicle should assume non-compliance with such limitations and should drive defensively to prevent any contact. Further, we question why the Cruise AV stopped in the middle of the attempted left turn, where an unimpaired human driver having mis-judged the gap and started a turn erroneously may have accelerated to avoid a crash.

San Francisco remains optimistic that Cruise will at some point be able to document a high level of safety performance; however, the absence of any analysis of the Cruise AV safety record, combined with the hazardous driving practices addressed in these comments and this surprising recent crash, leaves San Francisco with great uncertainty as to whether that point has in fact already been reached. Going forward, if NHTSA is inclined to approve the Petition, we urge NHTSA to strengthen data collection for leading indicators such as sudden acceleration or 'near-miss' events, as we address in further detail in Section 4.

2.3. GM asserts that approval will take an important step towards unlocking potentially significant environmental benefits and will help advance environmental justice.

General Motors describes its vision for Cruise as producing a future with "Zero crashes, Zero emissions, and Zero congestion.[13] As to Zero Emissions, San Francisco applauds the GM decision to build the Origin on the low emission vehicle base that will be used for other GM electric vehicles. As to Zero Congestion, San Francisco turns to the recent history of Uber and Lyft—each of which claimed that their businesses would reduce congestion and offer cities a climate solution. Research findings now fully refute those claims.

It is estimated that about 50% of the increase in congestion in San Francisco between 2010 and 2016 was due to the use of ridehailing services such as Uber and

[13] See General Motors Voluntary Safety Self-Assessment, https://www.gm.com/content/dam/company/docs/us/en/gmcom/gmsafetyreport.pdf, filed with NHTSA at https://www.nhtsa.gov/automated-driving-systems/voluntary-safety-self-assessment

Lyft.[14] The California Air Resources Board (CARB) found that ridehail vehicles are less efficient the private vehicles that are not used for ridehail. Ridehail vehicles provide only 1.16 passenger miles of travel per vehicle mile traveled, compared to 1.68 passenger miles of travel per vehicle mile traveled in other private vehicles.[15] Three key factors determine this outcome: occupancy, deadheading and mode shift. CARB found no greater average occupancy in passenger cars used for ride-hail service than in cars not used for ride hail service. Though Uber and Lyft began offering shared rides eight years ago, a forthcoming report from the SFCTA analyzing data submitted to the California Public Utilities Commission indicates that in the months preceding the 2020 pandemic only 9.6% of all Uber trip requests were ultimately shared.[16] Second, approximately 40% of TNC driving in cities consisted of deadheading with no passenger in the vehicle.[17] TNC trips previously used more energy and space efficient modes, including transit, walking and biking.[18]Survey data from the San Francisco Bay Area revealed that 47% of ridehail trips were either induced trips, or trips that otherwise would have been made by walking, biking and using transit.[19]

Could the Origin achieve better results? Possibly. However, the GM Petition includes no information about how Cruise will achieve high rates of occupancy and low rates of deadheading in the Origin or how Cruise will avoid shifting travelers from more space and energy efficient modes of travel. As the seventh-largest transit provider in

[14] Erhardt, G. D., S. Roy, D. Cooper, B. Sana, M. Chen, and J. Castiglione. 2019. *Do transportation network companies decrease or increase congestion?* Science Advances 5, 11 pp. https://www.science.org/doi/epdf/10.1126/sciadv.aau2670

[15] California Air Resources Board (CARB). 2019. *SB 1014 – 2018 Base-year Emissions Inventory Report: Technical Documentation.* Sacramento. https://ww2.arb.ca.gov/sites/default/files/2019-12/SB%201014%20-%20Base%20year%20Emissions%20Inventory_December_2019.pdf

[16] SFCTA, TNCs 2020, forthcoming.

[17]SFCTA. TNCs Today. (2017). https://www.sfcta.org/projects/tncs-today; Fehr & Peers. Estimated TNC Share of VMT in Six US Metropolitan Regions (Revision 1). (2019). https://www.fehrandpeers.com/what-are-tncs-share-of-vmt/

[18] Research has revealed that compared to a San Francisco ridehail passenger's previous mode for a trip, ridehail trips resulted in 118% more vehicle miles traveled per trip, after accounting for the potential for multiple passengers per ride, modal shifts, and deadheading. Schaller, B. 2021. *Can sharing a ride make for less traffic? Evidence from Uber and Lyft and implications for cities*. Transport Policy 102, 10 pp. https://doi.org/10.1016/j.tranpol.2020.12.015.

[19] Bradley, M., E. Greene, B. Sana, D. Cooper, J. Castiglione, S. Israel, and C. Coy. 2022. Results of the First Large-Scale Survey of Transportation Network Companies Use in the Bay Area.

the nation in a city known for its hills that make biking and walking very challenging for some people, San Francisco welcomes the opportunity to collaborate with Cruise in achieving this goal. However, the GM Petition includes no plan or even suggestion for how it will achieve significant environmental benefits and we thus do not find the Petition strong or persuasive on this point.

The GM Petition is no more persuasive as to the environmental justice effects of the Origin. The greenhouse gases that will be directly avoided because the Origin is an electric vehicle are important – but not geographically focused in the way that particulate matter is localized around transportation and other sources. Even electric vehicles produce particulate pollutants, and to the extent the Origin increases congestion – a likely outcome -- the additional congestion will increase secondary pollution emitted by other vehicles. Again, as stewards of San Francisco's transportation network, the SFMTA and SFCTA welcomes the opportunity to collaborate with Cruise and other automated vehicle developers to achieve environmental justice outcomes; however, these will come from great effort – the GM Petition offers no plan, analysis, or logic by which these outcomes will naturally follow from the Origin's deployment.

2.4 GM asserts that approval will help advance "greater transportation accessibility for all users."

The GM Petition asserts that the Origin will help advance greater transportation accessibility for all users. The Petition describes how and why transportation plays a critical role in enhancing opportunity for many people with disabilities—through access to basic independence, health, happiness, employment and financial security. As with other arguments, the Petition is disappointing because it provides limited details on disability access features of the Origin, the smartphone application that is essential to accessing the Origin, and the customer support services that may also be essential to using the Origin.[20] San Francisco is excited and delighted that Cruise announced a wheelchair accessible version of the Origin to investors almost a year ago and, as

[20] GM Petition, pages 60-61. GM reports user experience research on accessibility for blind and low vision passengers and 'collaboration to make the Origin accessible to wheelchair users, but the primary specific detail is that Cruise has made its customer service application compatible with ios Voiceover software to support hailing by blind and low vision passengers.

reported in the GM Petition, announced this to the general public more recently.[21] This announcement is extremely important and holds tremendous promise for people with travel-limiting disabilities.

Yet, if Cruise does not timely fulfill this promise, deploying a non-wheelchairi accessible version of the Origin could instead have the effect of amplifying barriers to travelers with disabilities. In San Francisco and many other markets, many of the benefits that attracted riders to Uber and Lyft, such as ease of payment, cheaper fares, and shorter wait times, were not afforded equally to many disabled persons and older adults. The rapid expansion of Uber and Lyft services—outcompeting taxi providers—compromised the availability of accessible taxis under the San Francisco Paratransit Taxi and Paratransit Plus programs.[22] Because Uber and Lyft were not explicitly required to, and did not, provide wheelchair accessible vehicles, ramp taxi riders experienced an overall decrease in mobility opportunity. It took almost a decade of advocacy and litigation before California adopted legislation compelling Uber and Lyft to provide non-discriminatory service to people who use nonfolding mobility devices such as motorized wheelchairs.[23] As of today, Uber and Lyft services remain inaccessible to people who use wheelchairs in most U.S. markets.[24] We anticipate that the Cruise Origin could offer serious competition to the existing sources of wheelchair accessible point to point service in San Francisco. Having designed a vehicle from the ground up specifically for the purpose of providing passenger services to the general public, NHTSA should ensure that the Origin does not trigger another cycle in which a new *inaccessible vehicle* enters the market and drives down the availability of legacy vehicles that are accessible

[21] GM Petition, p. 60; Sam Abuelsamid, Cruise CEO Shows Off Locker Module And Wheelchair Accessible Origin Robotaxi, Forbes (Oct. 6, 2021), https://www.forbes.com/sites/samabuelsamid/2021/10/06/cruise-ceo-shows-off-locker-module-and-wheelchairaccessible-origin-robotaxi/?sh=101016a01c78;

[22] PFM Group Consulting and Schaller Consulting. *Evaluation and Recommendations to Improve the Health of the Taxi Industry in San Francisco. Report*. May 1, 2018. https://www.sfmta.com/sites/default/files/reports-anddocuments/2018/05/final_pfm_schaller_taxi_industry_report_5.1.18.pdf

[23] In the first quarter of 2022, Uber and Lyft reported providing a total of 10,633 trips to customers who requested wheelchair accessible vehicles in California (in response to 21,328 requests for such service); See SFMTA dashboard on TNC Access for All Reporting: https://www.sfmta.com/transportation-network-company-tnc-access-all-reporting.

[24] Chicago, New York and some California counties, including San Francisco, are among few places where wheelchair users can use Uber and Lyft services.

to wheelchair users. San Francisco agrees with disability advocates who call for equal access to the Origin for people who use wheelchairs.

RECOMMENDATION 2.4: If NHTSA is inclined to approve the petitions, San Francisco agrees with disability advocates who recommend that fully accessible model versions should be available when ADS-operated passenger service vehicles without human driving controls are launched in order to prevent discrimination and ensure safety for people with disabilities.

Section 3: Comments on Specific FMVSS Exemptions

As discussed in Section 2 above, the FMVSSs specifically at issue in the General Motors and Ford petitions and the standard for review of Part 555 exemption requests were all developed for conventional vehicles and do not address the safety-critical capabilities of an automated driving system to ensure an equivalent overall level of safety as compared to an FMVSS-compliant vehicle is driven by an attentive human driver. General Motors seeks Part 555 of the Origin under two standards—the "equivalent overall safety" standard found at 49 U.S.C. Section 30113(b)(3)(iv) and the "evaluation of a low emission vehicle" standard found at 49 U.S.C. Section 30113(b)(3)(iii).

While the City applauds General Motors' decision to build the Origin on its low emission vehicle platform, NHTSA should dismiss the argument that FMVSS exemptions are warranted simply because the Origin is a low emission vehicle. The Safety Act authorizes the Secretary to approve an exemption only where a temporary exemption "would make the development or field evaluation of a low-emission motor vehicle easier and would not unreasonably lower the safety level of that vehicle."[25] Congress enacted this basis for exemption in 1994 only to encourage auto makers to develop low emission vehicles— not to encourage the development of purpose-built vehicles operated by an automated driving system. Nothing in the GM Petition suggests that a driving automation system makes it easier to develop or field test a low emission vehicle. GM has already developed its Ultium electric vehicle battery platform without the need for Part 555 exemptions.[26] NHTSA should reject GM's 49 CFR Part 555.6(c) exemption request on the basis that "the exemption would make the development or field evaluation of a low-emission easier and would not unreasonably lower the safety level of that vehicle".

With respect to evaluation under the Overall Safety Level basis for exemption, San Francisco rejects the notion that NHTSA should limit its review to the overall level of safety provided by the specific features from which exemption is sought. We offer these specific comments to the extent NHTSA entertains the GM and Ford Petitions as to the specific features from which exemption is sought.

[25] 49 USC 30113(b)(3)(B)(iii); 49 CFR 555.6
[26] GM, "Electrification" webpage. https://www.gm.com/commitments/electrification

FMVSS 101, Controls and Displays

San Francisco applauds the apparent General Motors decision to provide Origin passengers with telltale information about vehicle hazard status that FMVSS 101 and FMVSS 126, 135 and 138 require to be displayed to the drivers of conventional vehicles. We note that Ford seeks exemption from these requirements, and we address this because we believe NHTSA should use this opportunity to affirm General Motors' choice and require this practice for other manufacturers.[27] While FMVSS 101 was created to inform human drivers about hazardous operational states such as brake and anti-lock brake-system malfunctions, brake pressure, fluid and lining hazards, low tire pressure and tire pressure monitoring system malfunctions,[28] this information is also relevant to passengers. We urge NHTSA to reject Ford's request for these exemptions and empower AV passengers to decline rides in vehicles showing the required hazard notices.

> RECOMMENDATION 3.1: San Francisco urges NHTSA to require GM, Ford and other manufacturers to display system malfunction telltales so they are visible to passengers in vehicles operating in an ADS-driven mode. NHTSA should not allow ADS-operated vehicles to deprive passengers of safety-critical vehicle status information that may inform their decision to travel in such a vehicle.

FMVSS 102, Gear Selection Display

The GM and Ford petitions both seek exemption from the portion of FMVSS 102 that requires that the transmission shift positions must be displayed to a driver whenever the ignition is in a position where the transmission can be shifted or where the transmission is not in park.[29] San Francisco understands the purpose of displaying the transmission shift position under FMVSS 102 is to reduce driver confusion over which gear the vehicle is in and thus reduce shifting errors. Shifting gears will not be a responsibility of passengers in a vehicle operated by an ADS. However, the shift position and the engaged/disengaged status of the driving system is of acute concern to first responders who encounter and must interact with vehicles like the Origin that are not equipped with

[27] Ford Petition, page 5
[28] 49 CFR Part 571.101.S2. Purpose.
[29] 49 C.F.R. Section 571.102,S3.1.4.1. GM Petition, page 30; Ford Petition page 16.

standard FMVSS compliant human driving controls. In San Francisco, firefighters provide emergency medical services and are often the first emergency responders to arrive at the scene of a crash. In response to the question, "Once a Cruise AV stops, how does a first responder know that it won't drive away?" Cruise guidance calls on first responders to call the Cruise Critical Response Line to seek information about whether the vehicle is safely stopped and whether it is in autonomous or manual mode.[30] Most San Francisco firefighters, like those in many jurisdictions, do not carry cell phones and cannot make phone calls to the Cruise Critical Response Line directly. Rather, they would have to first contact dispatchers by radio who can then make telephone contact with the Critical Response Line and relay vehicle status information back to emergency responders on an incident scene. Particularly in light of the incident San Francisco has already had in which the Cruise Critical Response Line was not answered, this process of relaying information does not meet the standard of providing equivalent level of safety to passengers or other road users involved in crashes with conventional vehicles. FIrst responders can usually directly view the ignition and transmission status from the exterior of most conventional vehicles. For their own protection and to speed their ability to effectively support affected passengers or other road users, first responders should have the ability to immediately confirm from the exterior of the Origin or other vehicles without compliant human driving controls whether the ADS is engaged, and, if so, in what gear it is engaged, without making phone calls and conducting further investigation.

> RECOMMENDATION 3.2: San Francisco urges NHTSA, as a condition of approval, to require GM and Ford to ensure that the transmission and operational status of the vehicle (powered on or off) can be easily observed from the exterior of the vehicle to support the safety of passengers, first responders and other road users.

FMVSS 108, Hazard Lights (9.6.2)

The GM Petition seeks exemption from two parts of FMVSS 108. First, the standard requires that hazard lights be operated independently from the ignition or equivalent switch and have an independent power source so that they can be operated

[30] See "Interacting with a Cruise Autonomous Vehicle: A Guide for First Responders", posted November, 2021 and accessed on September 19, 2022: https://www.youtube.com/watch?v=ZM3kfauMgZY

when the vehicle is off. Second, the standard requires that the dashboard contain a vehicular hazard warning signal operating unit (hazard light switch) to power on the hazard lights. GM argues that the Origin will always be powered on when on public streets except where there is a severe incident that causes unintentional loss of power and in such a case asserts that the Origin will automatically command the hazard lights to activate before loss of power (using a required backup power supply). GM further argues that it has intentionally eliminated the in-vehicle activation switch in order to prevent tampering by passengers.[31]

San Francisco is not aware of the vehicle power status of all Cruise AV failure incidents that have been reported to 9-1-1 or otherwise occurred on San Francisco streets. However, it does not seem reasonable to assume that the Origin's power and backup power or hazard light ignition programming will never fail. Cruise has not demonstrated that there is "no reasonably foreseeable situation where the Origin will ever operate on public roads and be stopped without power."[32] It is precisely unexpected circumstances that provide the purpose for FMVSS 108. While we appreciate the concern for passenger tampering, it is not obvious that an equivalent level of safety is established in a circumstance in which neither passengers nor first responders can directly activate hazard lights or depower the Origin. We urge NHTSA to investigate these assumptions thoroughly.

> RECOMMENDATION 3.3: San Francisco urges NHTSA, as a condition for any approval, to consider requiring that the GM/Cruise Origin and the Ford ADS-equipped vehicle ensure passengers and first responders have the capacity to activate hazard lights manually when the vehicle is powered or depowered.
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> RECOMMENDATION 3.4: San Francisco urges NHTSA, as a condition for any approval, to consider requiring that first responders have the capacity to depower the GM/Cruise Origin and the Ford ADS-equipped vehicle manually.

[31] GM Petition, pages 35-36.
[32] GM Petition, page 36.

FMVSS 111, Rearview Mirror

FMVSS 111 requires mirrors (interior or exterior) or a rearview camera display for the purpose of providing the driver with a rear field of view. The GM Petition surveys the various Origin sensors that provide the ADS with equivalent or superior rear visibility to support its driving decisions. San Francisco assumes the rear visibility provided by the Origin's sensor suite is at least equivalent to the rear visibility required for human driven vehicles under FMVSS 11, if not superior. However, as NHTSA and GM note, passengers sometimes use rearview mirrors or images to support their safe exit from a vehicle, and this is a highly beneficial practice. As to this purpose, GM claims that "eliminating the physical rearview mirrors does not reduce the level of safety afforded passengers exiting the Origin." Instead, the Petition notes that "the Origin will provide a visual and audible warning to passengers reminding them to use caution and look for oncoming traffic when exiting the vehicle."[33, 34]

GM cites the Nuro exemption decision to support its assertion that no rearview image display screen is required.[35] But the Nuro decision is hardly relevant given that the Nuro vehicle carries only cargo and does not address what is necessary to best provide passengers with situational awareness before they leave a vehicle so that their exit does not create a hazard for themselves or for other road users. GM states "A passenger exiting an Origin without exterior rearview mirrors is no different than a passenger exiting the rear seat of a traditional motor vehicle where rearview mirrors are not available. In each case, the passenger will need to be aware of their surroundings and use caution and common sense before exiting the vehicle."[36]

San Francisco questions whether generalized visual and audible warnings to passengers provide an equivalent level of safety to that offered by a rear-view mirror visible to a human driver and communication between a driver and passenger – especially since the Origin's carriage seating may be unfamiliar to most riders in a vehicle of this size. The method for providing situational awareness to passengers leaving the Origin — is of great concern to San Francisco because, as discussed in Section 1 above, the Cruise

[33] GM Petition, footnote 24, page 8.
[34] GM Petition, Page 46.
[35] GM Petition, Page 43.
[36] GM Petition. Page 46.

AV has consistently failed to approach the curb to load and unload passengers, even where curb space is readily available.

> RECOMMENDATION 3.5: San Francisco urges NHTSA, as a condition for any approval to consider requiring that the GM/Cruise Origin and Ford ADS-equipped vehicle ensure that passengers, including passengers with vision disabilities, are given specific information about oncoming traffic from the time the trip is stopped until all passengers requesting the stop have exited the vehicle.

Section 4: Responses to NHTSA Notice Section VI. "Statement on Terms"

This section offers in-line responses to conditions, reporting requirements and questions reflected in Section VI of the Notice. San Francisco responses are *in italics.* Where a condition or reporting item is not reproduced below, San Francisco supports the condition or reporting requirement as reflected in the notice.

Please comment on whether NHTSA should apply the following terms and conditions to a potential grant of GM's exemption request:

1. Reporting within 24 hours of an exempt vehicle being involved in any crash, to include:

b. If the ADS was in control of the vehicle during the event, a detailed timeline of the 30 seconds leading up to the crash, including a detailed read-out and interpretation of all sensors in operation during that time period, the ADS's object detection and classification output, and the vehicle actions taken (*i.e.,* commands for braking, throttle, steering, etc.).

The first phrase of subsection b creates ambiguity in the context of the Origin – which can only be controlled by the ADS. We interpret the reporting requirement to apply to all crashes involving an Origin vehicle – including, for example, a crash in which the Origin is stopped and is hit by another vehicle. We suggest that NHTSA clarify this interpretation. In addition, we recommend that NHTSA delete the phrase "in operation during that time period" so that GM is required to submit data from ALL vehicle sensors to support evaluation of the role that sensor failure or unavailability may play in a crash. It is not clear whether the term "all sensors" includes cameras and resulting video recordings. If this is not intended, we recommend that NHTSA at least require the grantees to retain video recordings relevant to incidents reported under 1b, 1,c, 2c, 2d, 2e so that they are accessible if later requested for a relevant investigation.

c. If a human operator took over control of the vehicle prior to the event, a detailed timeline of the 30 seconds leading up to the human operator taking over control, including a detailed read-out and interpretation of all ADS sensors in operation during that time period, the ADS's object detection and classification output, and the vehicle actions taken(i.e., commands for braking, throttle, steering, etc.).

The first phrase of subsection c also creates ambiguity in the context of the Origin. Is this intended to address a situation in which a remote advisor disengages a vehicle from automated driving? Does it contemplate teleoperation? We are not aware of the latter being considered as

part of the GM operational model for the Origin, and this is not suggested in the petition. Taking requirements b and c together, it is not clear whether they call for reporting when an ADS itself triggers a minimum risk condition before or during a crash. We recommend that NHTSA eliminate ambiguity about the intended coverage in a way that calls for the maximum possible reporting. As with subsection b, we also recommend that NHTSA delete the phrase "in operation during that time period" so that GM is required to submit data from ALL vehicle sensors to support evaluation of the role that sensor failure or unavailability may play in a crash.

d. If a human operator was in control of the vehicle at any point during or up to 30 seconds before the event, a detailed timeline of any actions the human operator took that affected the crash event, as well as any technical problems that could have contributed to the crash(signal latency, poor field of view, etc.).

We question why technical problems such as signal latency, poor field of view, etc. should be reported only for crashes when a human operator may have been in control of a vehicle. We recommend that NHTSA seek information about the role played by signal latency or communications failures (for example, between a vehicle and a remote advisor) for all crashes involving ADS operated vehicles.

2. Beginning 90 days after the date of the exemption grant, and at an interval of every 90 days thereafter, a report detailing the operation of each exempted vehicle in operation during that time period. This report may provide this information either in aggregate or on a per-vehicle basis, but it must include the following:

a. A calculation of the total miles the vehicle has traveled using the ADS during the report period, and heat maps of the geofenced area in which the vehicle operates to illustrate travel density.

Because vehicle miles traveled is an essential denominator for many safety and other key performance indicators, we urge NHTSA to require both per-vehicle and aggregate reporting of total vehicle miles traveled by market area.

c. Detailed descriptions of any incidents in which any exempted vehicle violated any local or State traffic law, whether operating using the ADS or under human control.

NHTSA should clarify that it seeks reporting of all incidents of violation of local or State traffic laws, regardless of whether a vehicle is cited by civil or criminal enforcement officers. Further, data should be reported in a structured tabular form that includes date, time, GIS coordinates, and local or State laws violated.

d. Detailed descriptions of any incidents in which the exempt vehicles experienced a sustained acceleration of at least 0.7g on any axis for at least 150 ms, or of any incidents in which the vehicle had an unexpected interaction with humans or other objects (other than crashes that require immediate reporting).

NHTSA should clarify that for all incidents meeting the requested criteria, require reporting of date and time, GPS coordinates, a detailed timeline, a read out and interpretation of sensor data, the ADS's object detection and classification output, and the vehicle actions taken (i.e., commands for braking, throttle, steering, etc.), as well as speed at start of acceleration and at end of acceleration.

e. Detailed descriptions of all instances in which a public safety official, including law enforcement, attempted to interact with an exempted vehicle, such as to pull it over, or contacted GM regarding an attempted interaction with an exempted vehicle

NHTSA should require incident-level reports that contain, at a minimum, the VIN, date, time, GPS coordinates, duration of incident, the office or agency the public safety official represents, and the nature of the interaction, and type of citation issued, if any.

f. Detailed descriptions of any "minimal risk condition fallback" events that occurred, even if no crash has occurred. If the event has occurred because the vehicle self-diagnosed a malfunction of a vehicle system, the report must include a detailed description of the cause and nature of the malfunction, and what remedial steps were taken. If the event was caused by the vehicle encountering a complex or unexpected driving situation, the report must include a detailed timeline of the ADS's decision-making process that led to the event, including any difficulties the ADS had in detecting and classifying objects.

As addressed in San Francisco Recommendation 1.1.1, to support analysis of the impact of the Origin on the overall transportation network, these reports should identify the GPS coordinates of the event, the number of travel lanes blocked by the event, the duration of the event, and how the involved ADS-equipped vehicle(s) were cleared from the scene.

4. GM must be capable of issuing a "stop order" that causes all deployed exempted vehicles to, as quickly as possible, cease operations in a safe manner, in the event that NHTSA or GM determines that the exempted vehicles present an unreasonable or unforeseen risk to safety.

San Francisco supports this requirement and recommends that NHTSA consider minimum standards for fleet towing resources in relation to the size of the Origin fleet in any given market. See also San Francisco recommendation 1.1.2.

5. GM must coordinate any planned deployment of the exempted vehicles or change to the ADS/ODD with State and local authorities with jurisdiction over the operation of the vehicle as required by the laws or regulations of that jurisdiction.

San Francisco supports this requirement and recommends that NHTSA clarify that jurisdictions that have the power to issue civil or criminal traffic citations are included among those that have 'jurisdiction over the operation of the vehicle.'

8. GM must create and maintain a hotline or other method of communication for the public and GM employees to directly communicate feedback or potential safety concerns about the *exempted vehicles to the company.*

San Francisco recommends that NHTSA consider requiring a grantee to make a phone number or other communication method available to the public on the exterior of the vehicle. San Francisco also recommends that NHTSA modify its defect reporting systems to facilitate their use by people who do not own an ADS-operated vehicle and do not know the VIN number of the ADS-operated vehicle.

10. If the agency were to require the reporting of data, for what period should the agency require it to be reported--the two-year exemption period or the vehicles' entire normal service life?

NHTSA should in the first instance require all data reporting requirements to extend for the vehicle's entire normal service life; however, we note that some of the data reporting requirements suggested above may become unnecessary over the passage of time, or may be incorporated into motor vehicle safety standards or other requirements of general application, such as the Standing General Order.

13. With regard to environmental impacts, how should NHTSA use the part 555 exemptions to learn about the interplay between fuel efficiency and ADS technologies? Should the agency adopt reporting requirements that would allow the agency to better understand the energy use of the vehicles throughout their service life and possibly better assess, and quantify, the environmental impacts of ADS- equipped vehicles? Should NHTSA require an entity whose petition has been granted to provide data about, for example, how often and how far its vehicles are driving around unoccupied v. occupied? Is there other information related to the environmental consequences and effects of the vehicles covered by the petition that NHTSA should require from entities granted an exemption?

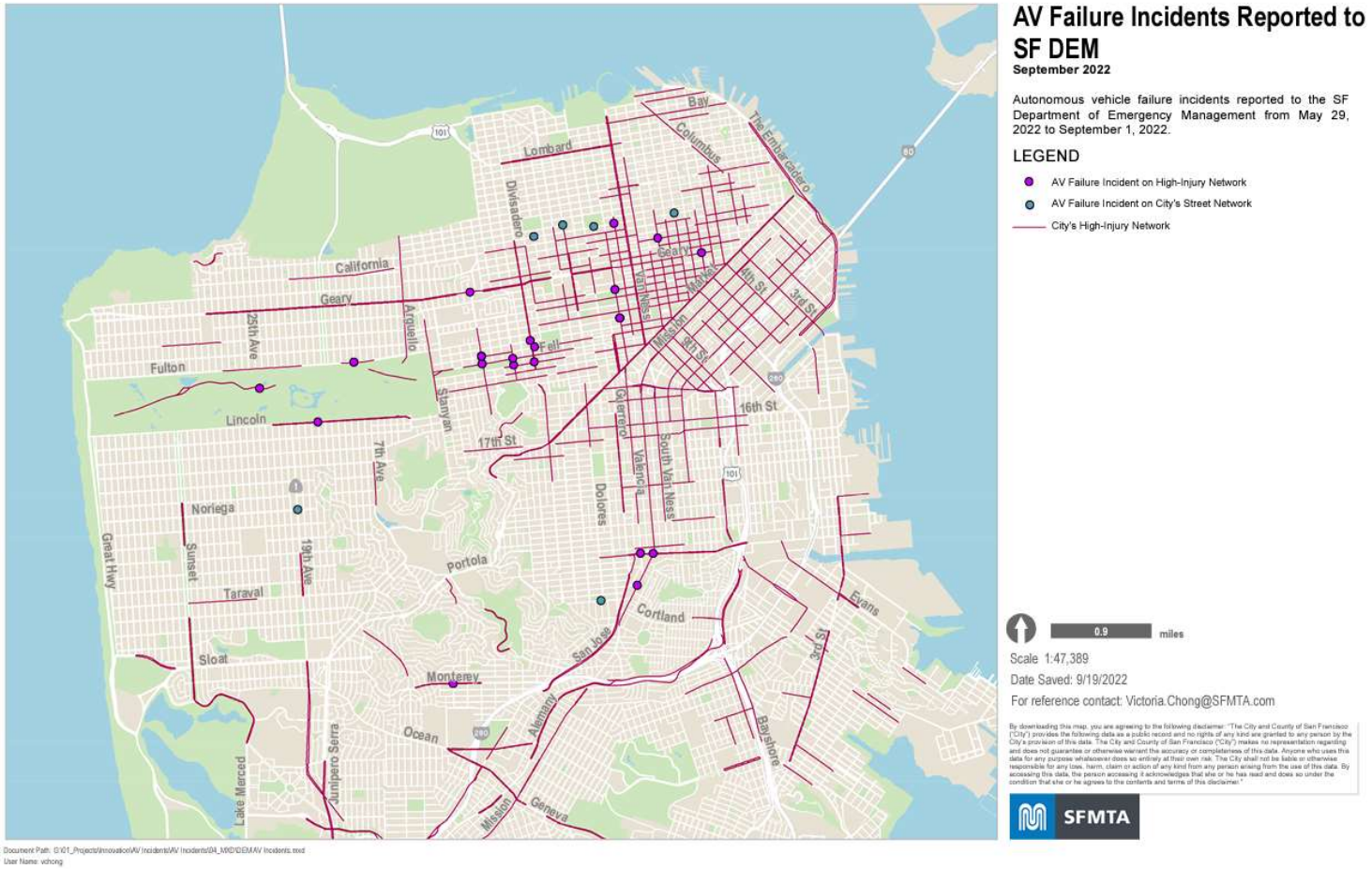
Yes, in light of research findings about energy efficiency and GHG arising from ride-hail services in cities throughout the nation, NHTSA should adopt reporting requirements for both GM and Ford that support analysis of energy use and lifecycle GHG. In addition, yes, NHTSA should adopt quarterly reporting requirements for each exempted vehicle to report total vehicle miles traveled (VMT) driven with no passengers, the total VMT driven with passengers, and the total PMT (person-miles traveled) by passengers, segmented by vehicle, ODD, day of week, and hour of day.

14. How should NHTSA consider accessibility in applying appropriate conditions to an exemption if it were granted? As noted above, many proponents of ADS technology often claim that ADS-equipped vehicles could help advance greater transportation accessibility for persons with disabilities. Should NHTSA impose conditions on grants of part 555 exemptions to learn more about specific actions that manufacturers and operators of ADS-equipped exempted vehicles are planning, or have taken, to further the attainment of accessibility and equity goals? Should NHTSA seek information from manufacturers granted an exemption as to how they ensure that their ride-hailing services comply with any applicable Americans with Disabilities Act (ADA) requirements, how many vehicles would be wheelchair accessible, how they reach people with disabilities to offer access to ride sharing services, or whether the exempt vehicles provide other accommodations for individuals with disabilities, such as communication and/or human-machine interface (HMI) features designed for individuals with sensory disabilities (such as sight or hearing) or cognitive disabilities? Should NHTSA require grantees to report on efforts, such as research or community outreach, that the manufacturer is planning, or has taken, to increase the likelihood that accessibility goals will be met? Comments are requested on whether there is other information related to accessibility that NHTSA should require from an entity when granting its petition.

Yes, NHTSA should impose conditions on grants of Part 555 exemptions to further the attainment of accessibility and equity goals and to seek information about how grantees comply with requirements of the Americans with Disabilities Act. In addition to Recommendation 2.4, San Francisco recommends that NHTSA require GM and Ford to submit quarterly reports on:

- *the number of wheelchair accessible vehicles that are available in each market area of operation (geographic ODD);*
- *all measures taken to ensure that the ADS software is equally proficient at identifying and appropriately responding to persons with disabilities who are other road users, notwithstanding any mobility devices they may be using or carrying;*
- *all measures taken to ensure that passengers using wheelchairs, walkers, canes or other mobility devices, can safely transition from the Origin to the sidewalk and vice versa;*
- *any people with disabilities identifiable in relation to crashes, near misses, or roadway failures;*
- *measures taken to ensure that all components of an ADS-operated vehicle without human driving controls, including the smartphone user application and all passenger communication and support services, are accessible to passengers with disabilities;*
- *the scope and frequency of disability access training for all field and remote support staff who perform passenger supporting functions;*
- *how the owner/operator will collect feedback to identify any barriers to full access that may be identified by people with disabilities;*
- *research or community outreach undertaken to address any barriers to full access identified for people with disabilities and plans and timelines for remediation of barriers*

Exhibit A: Reported Cruise AV Travel Lane Failures on San Francisco streets

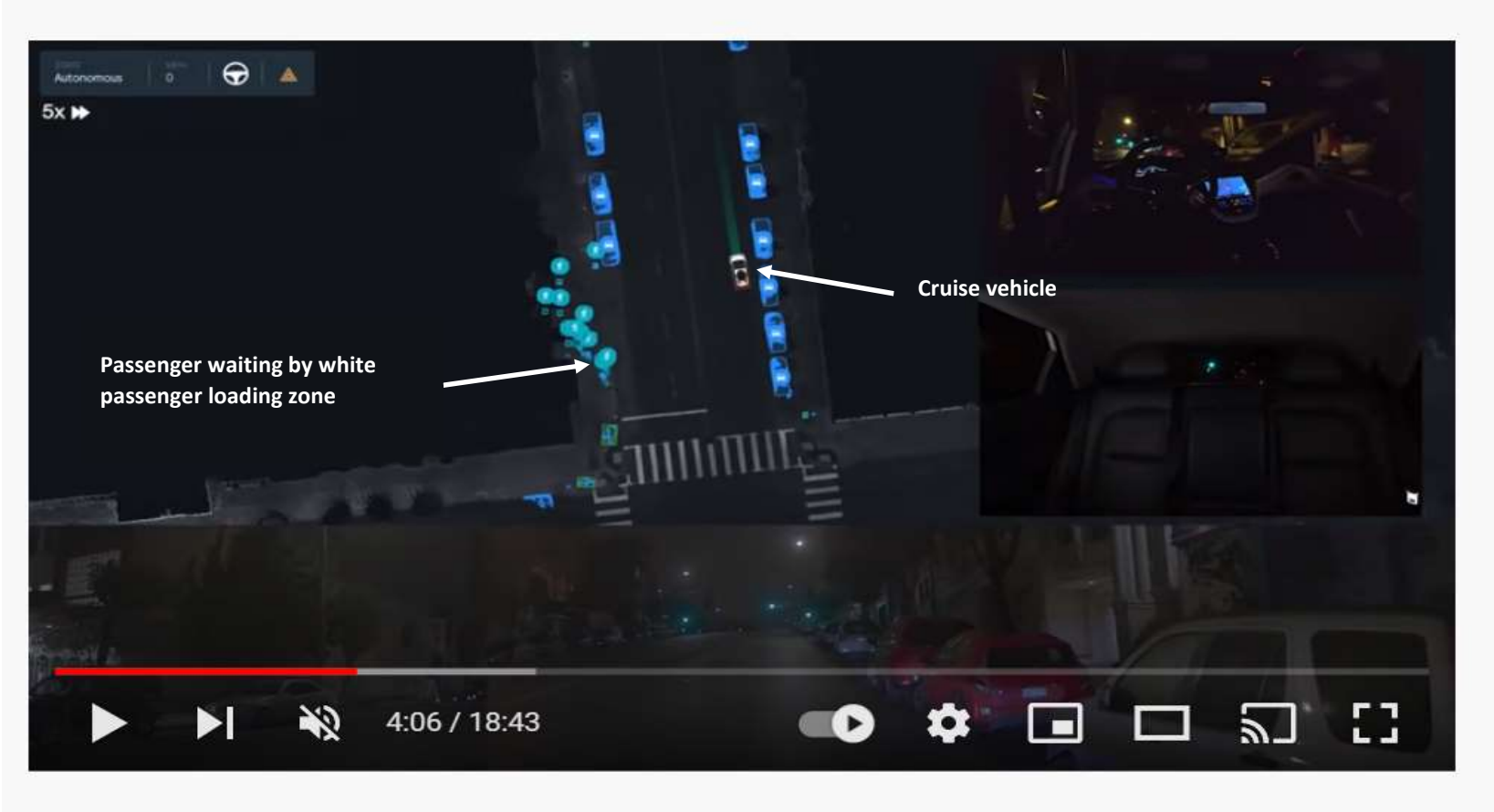


Note: Two separate incidents were reported at Gough and Fulton (June 29, 2022 and August 31, 2022). Two separate incidents were also reported at Masonic and Hayes (June 14, 2022 and July 9, 2022).

Exhibit B

Screenshot from video posted by Cruise LLC on November 3, 2021 (https://www.youtube.com/watch?v=svebS-uR7wc)

In the image below the passenger can be seen waiting in front of an unoccupied white passenger loading zone, but the Cruise vehicle stops in a travel lane across the street to pick up the passenger.



Below is an example where the Cruise vehicle stops in the travel lane to drop off the passenger. Curb space is available both immediately in advance of and immediately beyond the location where the vehicle stops in the travel lane to unload a passenger.

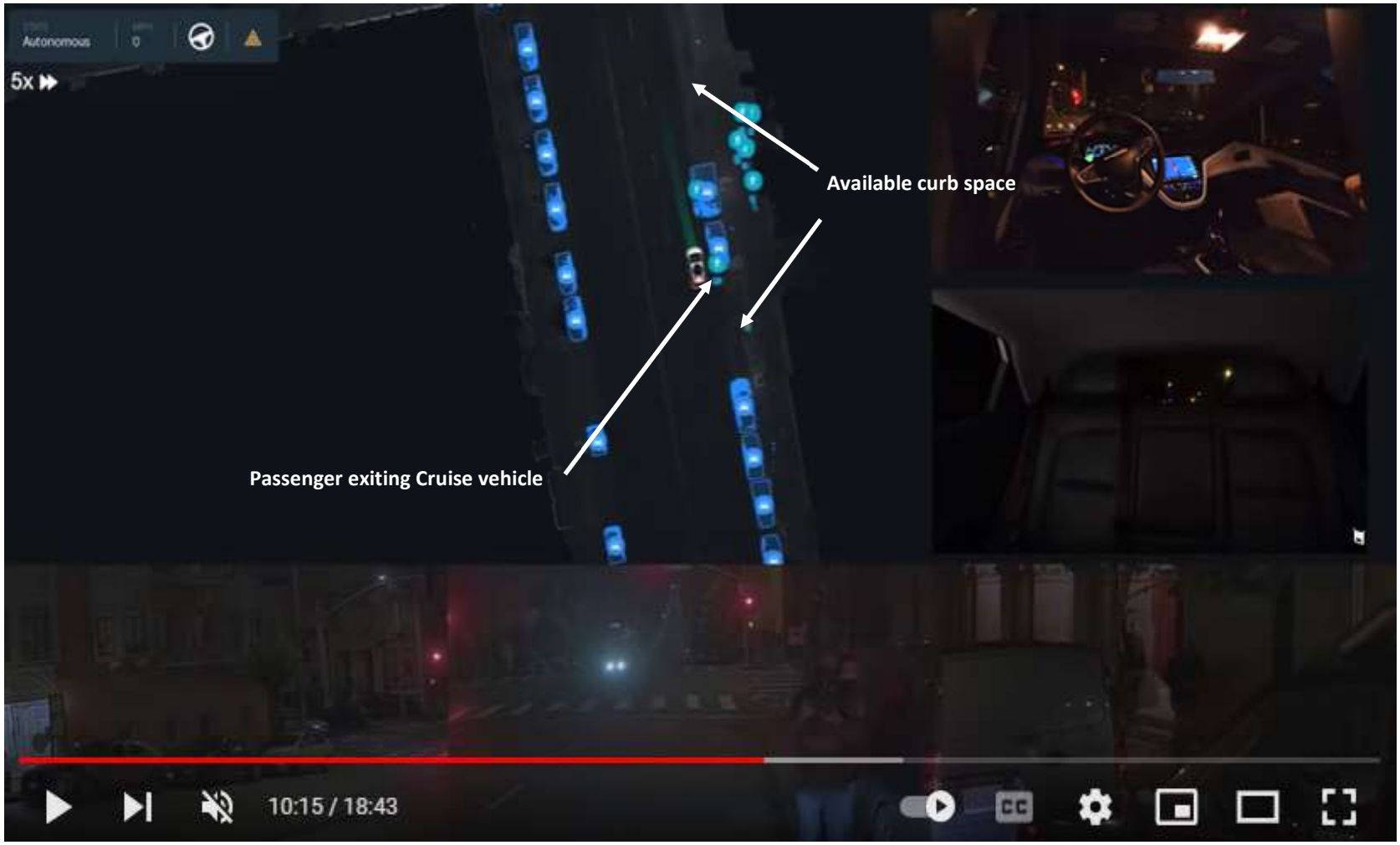


Exhibit C: Summary of San Francisco Recommendations

RECOMMENDATION 1.1.1 If NHTSA is inclined to approve the GM Petition, San Francisco recommends that NHTSA require General Motors to submit quarterly data on Cruise AV and Origin requests for remote advisor assistance as they operate on public roads and in-lane failures that affect a travel lane on a public road, including bike lanes and lanes designated for transit or other vehicles. Incidents should be reported in relation to the vehicle model, date, time, location and in relation to the vehicle miles traveled both on an individual vehicle and aggregate fleet basis by market area.

RECOMMENDATION 1.1.2: If NHTSA is inclined to approve the GM and Ford Petitions, San Francisco recommends that in addition to informing NHTSA, in the event of any cybersecurity incident that warrants issue of a "stop order" because it presents an unreasonable or unforeseen risk to the safety of vehicles on the road, NHTSA should require General Motors and Ford to immediately report to all relevant Public Safety Answering Points the existence of the risk and what actions will be taken to cease operations in a safe manner.

RECOMMENDATION 1.1.3: If NHTSA is inclined to approve the Petitions, NHTSA should use data reported by GM and Ford to develop key performance indicators for human advisor response to AV requests for assistance, in-lane failures on public roads, Critical Response Line pickup time, road clearance time and other measures of safety performance and road impact.

RECOMMENDATION 1.1.4: If NHTSA is inclined to approve the requested exemptions, NHTSA should initially approve the GM petition in a way that limits the geographic deployment in the San Francisco market by number of vehicles and time of day and expands authorization only after GM or Ford demonstrate reasonable performance based on key performance indicators.

RECOMMENDATION 1.2: If NHTSA is inclined to approve the GM Petition, San Francisco urges NHTSA to work with the City to develop a research protocol to analyze pick up and drop off driving impacts and to condition approval on General Motors cooperation with research, subject to restrictions that may be necessary and appropriate to protect passenger privacy.

RECOMMENDATION 2.1: If NHTSA is inclined to approve the Petitions, San Francisco recommends that NHTSA expand city access to safety critical incident information (such as crash, near miss and travel-lane ADS road failures) submitted by GM and Ford to enable road managers to evaluate factors that may affect the safety of automated driving systems operating on their streets.

RECOMMENDATION 2.4: If NHTSA is inclined to approve the petitions, San Francisco agrees with disability advocates who recommend that fully accessible model versions should be available when ADS-operated passenger service vehicles without human driving controls are launched in order to prevent discrimination and ensure safety for people with disabilities.

RECOMMENDATION 3.1: San Francisco urges NHTSA to require GM, Ford and other manufacturers to display system malfunction telltales so they are visible to passengers in vehicles operating in an ADS-driven mode. NHTSA should not allow ADS-operated vehicles to deprive passengers of safety-critical vehicle status information that may inform their decision to travel in such a vehicle.

RECOMMENDATION 3.2: San Francisco urges NHTSA, as a condition of approval, to require GM and Ford to ensure that the transmission and operational status of the vehicle (powered on or off) can be easily observed from within and from the exterior of the vehicle to support the safety of passengers, first responders and other road users.

RECOMMENDATION 3.3: San Francisco urges NHTSA, as a condition for any approval, to consider requiring that the GM/Cruise Origin and the Ford ADS-equipped vehicle ensure passengers and first responders have the capacity to activate hazard lights manually when the vehicle is powered or depowered.

RECOMMENDATION 3.4: San Francisco urges NHTSA, as a condition for any approval, to consider requiring that first responders have the capacity to depower the GM/Cruise Origin and the Ford ADS-equipped vehicle manually.

RECOMMENDATION 3.5: San Francisco urges NHTSA, as a condition for any approval to consider requiring that GM and Ford ensure that passengers, including passengers with vision disabilities, are given specific information about oncoming traffic from the time the trip is stopped until all passengers requesting the stop have exited the vehicle.

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TNCs Today

A Profile of San Francisco Transportation Network Company Activity

FINAL REPORT | JUNE, 2017

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We wish to thank the following individuals who contributed to the development of this report:

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Contents

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Executive Summary

Transportation network companies (TNCs) such as Uber and Lyft are an increasingly visible presence on San Francisco streets, but there has been no comprehensive data source to help the public and decision-makers understand how many TNC trips occur in San Francisco, how much vehicle travel they generate, and their potential effects on congestion, transit ridership, and other measures of system performance. The California Public Utilities Commission (CPUC) regulates TNCs and requires data reporting by TNCs, but will not share these data with local jurisdictions and the public.

The purpose of this report is to provide information on TNC activity in San Francisco, in order to help the San Francisco County Transportation Authority (Transportation Authority) fulfill its role as the Congestion Management Agency for San Francisco County. The report is also intended to inform the Transportation Authority board which is comprised of the members of the San Francisco Board of Supervisors, as well as state and local policy-makers in other arenas, and the general public, on the size, location and time-of-day characteristics of the TNC market in San Francisco.

The information presented is a profile of estimated local TNC usage (trips made entirely within San Francisco) from mid-November to mid-December of 2016. The TNC data was originally gathered by researchers at Northeastern University from the Application Programming Interfaces (APIs) of Uber and Lyft and then shared with the Transportation Authority. The Transportation Authority's data team cleaned and analyzed the data for presentation here.

While this document provides a broad range of descriptive information about TNC trips, it does not evaluate the effects of these TNC trips on the performance of the San Francisco transportation system, nor does it explain TNC customer trip purposes, demographic characteristics, or longer term effects on vehicle ownership and residential and employment location. This report does not identify the extent to which TNCs affect congestion. Many factors contribute to increased congestion—population and employment growth, construction activity, increased delivery and other transportation services, and TNCs.

Subsequent reports and studies by the Transportation Authority and others will address these important analytic and policy topics in depth, including the effects of TNCs on roadway congestion, public transit operations and ridership, disabled access, and equity.

The report is structured around six primary questions:

HOW MANY TNCS OPERATE IN SAN FRANCISCO TODAY?

- The San Francisco Treasurer's Office estimates that 45,000 Uber and Lyft drivers may operate in San Francisco, and in 2016 sent notices requiring them to register their business with the city.
- Almost 21,000 drivers are estimated to have complied with the requirements to register their business with the city. Of that number, only 29% are San Francisco residents.
- On a typical weekday, over 5,700 TNC vehicles operate on San Francisco streets at peak times, with the peak period occurring between 6:30pm and 7:00pm. On Fridays, over 6,500 TNC vehicles are on the street during the peak of 7:30pm to 8:00pm. This is over 15 times the number of taxis on the street at these times of day.

HOW MANY TNC TRIPS ARE OCCURRING IN SAN FRANCISCO?

- On a typical weekday, TNCs make over 170,000 vehicle trips within San Francisco, which is approximately 12 times the number of taxi trips, and 15% of all intra-San Francisco vehicle trips. This represents a conservative estimate of total TNC trips in San Francisco because the study's dataset does not include trips with a regional origin or destination.
- Assuming TNC occupancy rates are similar to taxi occupancy rates, it is estimated that at least 9% of all San Francisco person trips use TNCs.

WHEN ARE TNC TRIPS OCCURRING IN SAN FRANCISCO?

- Significant numbers of TNC vehicle trips occur on both weekdays and weekends, with the highest number on Fridays with over 222,500 trips, and the lowest number on Sundays with approximately 129,000 trips.
- On weekdays, TNC usage is concentrated during the AM and PM peak periods when congestion is greatest, and extends into the evenings on Friday. Saturday and Sunday TNC trips occur primarily in the afternoon and evening.

WHERE ARE TNC TRIPS OCCURRING IN SAN FRANCISCO?

- TNC trips are concentrated in the densest and most congested parts of San Francisco including the downtown and northeastern core of the city. At peak periods, TNCs are estimated to comprise 25% of vehicle trips in South of Market.
- TNC trips are concentrated on the busiest arterials, yet also operate extensively on neighborhood streets, including along major public transit lines.

HOW MANY VEHICLE MILES TRAVELED (VMT) DO TNCS GENERATE WITHIN SAN FRANCISCO?

- Intra-SF TNC trips generate approximately 570,000 vehicle miles of travel (VMT) on a typical weekday, comprising as much as 20% of intra-SF-only VMT, at least 6.5% of average total weekday VMT citywide, and may account for more than 10% of weekend VMT, primarily during the AM peak, PM peak, and early evening time periods. These estimates include both in-service and out-of-service vehicle miles.
- Approximately 20% of total TNC VMT are out-of-service miles. This is significantly lower than the more than 40% of taxi VMT that are out-of-service miles. The greater efficiency of TNCs is likely due to the higher number of TNC vehicles and more efficient technology.

DO TNCS PROVIDE A HIGH DEGREE OF GEOGRAPHIC COVERAGE THROUGHOUT THE ENTIRE CITY?

- TNCs provide broader service across the city than taxis, particularly in the western neighborhoods.
- TNCs provide fewer trips per population and employment in southern and southeastern areas of the city, which may reflect the presence of fewer TNC vehicles, or neighborhood preferences or demographics.

For more information, or to obtain a downloadable file of Transportation Authority processed data, visit the TNCs Today website at www.sfcta.org/tncstoday.

Introduction

Transportation network companies (TNCs) such as Uber and Lyft are visible presences on San Francisco's streets, in both the downtown core as well as in the city's neighborhoods. These companies allow people to use a smartphone app to request and pay for rides sourced from a pool of available drivers. These services are taxi-like in that they provide point-to-point transportation primarily in private vehicles. The success of TNCs in attracting rides in San Francisco and other cities reflects the high unmet demand for premium services and the extensive benefits they provide to users who can afford their services. Initially TNCs offered some distinct advantages over taxis including the ability to easily reserve a ride, the ability for both driver and passenger to contact each other and to know the location of the other using GPS, ease of payment, cheaper fares, shorter wait times, and more availability at all times of day due to a larger supply of vehicles. Taxis now offer some of these features, although the supply of taxis is still significantly smaller than TNCs, and taxi fares are higher.

The advantages of TNCs over taxis and other transportation modes are in part a result of the technological innovation of directly connecting travelers and drivers, but are also in part an outcome and reflection of the relatively light regulatory requirements under which TNCs operate, relative to taxis and other for-hire vehicles. The biggest difference between TNCs and other modes is the significantly lower barrier for drivers to enter the market. California state law grants municipalities the ability to regulate taxis, and in San Francisco, the taxi medallion system limits the number of taxi vehicles that can serve the city. In addition, taxis are subject to price controls, must provide access to all areas of the city, must provide service to people with disabilities, have greater insurance requirements, and are subject to driver background checks and vehicle inspections. In contrast, there is no limit on the number of TNCs that may operate on San Francisco streets, no price controls, no geographic service area requirements, minimal disabled access requirements, limited driver background checks and few vehicle inspection or driver training requirements (TRB 2015).

There is a perception that TNC vehicles now comprise a significant number of the vehicles on San Francisco streets, having increased rapidly since TNCs started operating in the city seven years ago. However, there has been little data to either confirm or refute this perception. The California Public Utilities Commission (CPUC), which regulates TNCs due to the inter-city, non-hail nature of the service they provide, requires TNCs to report to the CPUC an extensive set of information on service provision including where and when trips are starting and ending, the availability of disabled-accessible vehicles, traffic incidents, and hours and miles logged by drivers. However, the CPUC has refused to share these TNC data with San Francisco, stating that it is authorized to withhold official information if disclosure of the information is against the public interest (CPUC Letter to the Transportation Authority, 2017). However, recent SFMTA Travel Decisions Survey results indicate that TNCs are growing in significance as a share of overall San Francisco travel, doubling in mode share served between 2014 and 2015 (SFMTA 2014, SFMTA 2015). In addition, it has been noted that Uber reported an annual tripling of trips in San Francisco (TRB 2015). However, these data sources provide no reliable estimates of the true number of TNC trips occurring in San Francisco, where TNC trips are occurring, or when TNC trips are occurring.

Purpose

The purpose of this report is to provide information on TNC activity in San Francisco, in order to help the San Francisco County Transportation Authority (Transportation Authority) fulfill its role as the Congestion Management Agency for San Francisco County. The report is also intended to inform the Transportation Authority board which is comprised of the members of the San Francisco Board of Supervisors, as well as state and local policymakers in other arenas, and the general public, on the size, location and time-of-day characteristics of the TNC market in San Francisco.

This document provides estimates of how many TNCs are operating in San Francisco during all times of day and days of week, imputes the number, location, and timing of intra-San Francisco TNC trips based on TNC driver trip acceptance information (referred to in this report as pick-ups) and TNC driver drop off information (referred to as drop-offs). The report estimates the amount of daily vehicle miles travelled (VMT) generated by TNCs, and contextualizes these relative to the other travel modes operating in San Francisco, including private vehicles, public transit, walking and biking. TNC trips between San Francisco and other counties (regional TNC trips) are not included in these estimates, and as a result these numbers represent a lower-bound estimate of the number of actual TNC vehicles and trips operating in San Francisco. Note that the data on which this report is based does not include any information on TNC trip purposes, travel party size, fares paid, traveler attributes such as gender, income, disability, mode choice shifts, or induced travel.

The information presented is a profile of local TNC usage in San Francisco from mid-November to mid-December of 2016, excluding dates around the Thanksgiving 2016 holiday. The TNC data was originally gathered by researchers at Northeastern University from the Application Programming Interfaces (APIs) of Uber and Lyft which show the locations of available vehicles to mobile apps, and then was shared with the Transportation Authority through a research collaboration over the past year. The other data referenced in the report come from a variety of sources including Caltrans, the San Francisco Municipal Transportation Agency (SFMTA), and the Transportation Authority's SF-CHAMP travel demand model.

This document does not evaluate the near-term impacts of TNCs on the performance of the San Francisco transportation system, nor does it explain potential longer-term effects of TNC provision on vehicle ownership or residential and employment location.

This report does not identify the extent to which TNCs affect congestion. Many factors contribute to increased congestion—population and employment growth, construction activity, increased delivery and other transportation services, and TNCs. Subsequent reports by the Transportation Authority through this project and the larger Emerging Mobility Services and Technology (EMST) policy framework and the Connect SF long-range planning process, both being undertaken in coordination with other City agencies, will address these important analytic and policy questions in depth.

Methodology

This research team developed and applied multiple procedures to estimate TNC trips within San Francisco. First, the team acquired data on TNC vehicle locations that was gathered from the Uber and Lyft APIs. The research team then cleaned this location data, removing unnecessary, anomalous, or redundant information. Finally, the team identified trips and imputed missing attributes.

DATA COLLECTION

In order to provide real-time information to drivers and passengers, Lyft and Uber expose certain data through public-facing APIs. This information includes nearby vehicle locations, estimated times-to-pickup, and sometimes, estimated costs. The data exposed through the APIs also includes, among other things, a vehicle identifier associated with a sequence of time-stamped coordinates, and the service types associated with that vehicle, such as UberX or UberPOOL. Sending a request to the API returns a text file response containing this information for the nearest available vehicles. When a vehicle becomes unavailable, either because the driver has turned off their app or they have accepted a ride request, the vehicle disappears from the datastream. Similarly, when the vehicle becomes available, either because the driver has turned on their app or they have completed a ride request, it reappears in the datastream. Researchers at Northeastern University implemented a systematic method for collecting this datastream such that it geographically covers all of San Francisco. The Northeastern University researchers collected information on vehicle locations every five seconds for approximately six weeks. The data collection methodology has no impacts on either drivers or riders.

DATA CLEANING

The research team collected data by sampling available TNC vehicles using a geographic grid that covers all of San Francisco. This sampling procedure means that any available Uber or Lyft vehicle may be detected by multiple sampling locations. Furthermore, because data is being collected almost continuously in time for each sampling location, the same vehicle will often appear repeatedly in the datastream for each individual sampling location. The first step in the data preparation process involved cleaning the information in the datastream. In addition, the raw data may at times contain anomalous data, which was also screened out to ensure the reasonableness of the GPS traces. The result was a set of unique GPS traces for each TNC vehicle.

TRIP IDENTIFICATION, TRIP MATCHING AND ATTRIBUTE IMPUTATION

Cleaning resulted in a set of unique "pre-trip" vehicle trajectories that reflect when a vehicle became available (due to the driver dropping off a passenger or starting a shift) and when the vehicle became unavailable (due to the driver accepting a passenger or ending a shift). Once pre-trips and pickup and drop-off locations were defined, "trips" were imputed by linking the pickup and trip drop-off locations. Lyft trips were created first because the Lyft API reveals a persistent vehicle identifier, with which it is possible to build an aggregate matrix of Lyft flows from pickup locations to dropoff locations by detailed time-of-day. This matrix of flows is used to estimate the vehicle miles traveled generated by TNCs. Uber's API does not have persistent identifiers that are necessary to connect pickup and dropoff locations, so the research team used the Lyft matrix of pickup and dropoff flows by travel analysis zone (TAZ) and time-of-day as a starting point, and then proportionally fitted the matrix to match Uber trip pickup locations and drop-off locations by time-of-day.

A unique aspect of the Uber and Lyft driver labor market is that drivers may drive for both services simultaneously. As a result, these driver vehicles may appear in both the Uber and Lyft datastreams. It is necessary to identify these "matched pre-trips" in order to avoid double-counting of TNC pre-trips and trips. Matched pre-trips were identified by comparing the start and end times of the pre-trips and selecting only those pre-trips whose start and end times both occurred within a limited time window, as well as selecting only pre-trips that traversed the same set of network links in the same sequence. The pre-trip (and associated trip) were then assigned to either Lyft or Uber, based on which pre-trip ended first, representing the first platform on which a driver accepted the trip.

For pre-trips, out of service travel times and distances could be calculated directly from the cleaned and processed datastream. For Lyft trips, trip travel times could be derived from the datastream. Because the datastream does not contain the information on the actual paths used by TNCs on trips, it was necessary to impute distances between observed pickup and dropoff locations using information from the Transportation Authority's SF-CHAMP model. For Uber trips, both travel times and distances were imputed from the model system.

DATA LIMITATIONS

It must be emphasized that the TNC information documented in this report does not represent direct observa-

tion of TNC trips. Trips and pre-trips are imputed based on the changes in the supply of Uber and Lyft vehicles as revealed by each company's API. Requests to the CPUC and to Uber and Lyft for data that could be used to validate these findings were declined.

However, as documented in subsequent sections of this report, the summaries of how the time and location of imputed TNC trips vary across time and space are generally consistent with overall travel patterns within the city.

There are a number of other limitations to the data as revealed by the APIs. Pickup locations and drop-off locations are not true trip origins and trip destinations. Instead, they represent where drivers accept rides (which are assumed to be a few minutes from true trip origins) and where drivers are available again (which are assumed to be near true trip destinations). In addition, no information on the specific TNC products used (such as UberX or LyftLine) can be derived from the datastream. Pooled services like UberPOOL and LyftLine which are designed to encourage users to share rides may not show up in the datastream. No information on TNC vehicle occupancy or traveler demographics is available, nor is consistent information on costs. Finally, these estimates are a lower bound on TNC trips in San Francisco, as all trips with one or more end outside the city (regional and through trips) are excluded from the analysis.

Research Questions

HOW MANY TNCs OPERATE IN SAN FRANCISCO TODAY?

Two measures of TNC supply are the number of TNC drivers who regularly drive in the city and the number of TNC vehicles that operate in the city at peak times.

There are no definitive observed data of the number of TNC drivers who regularly drive in San Francisco. It has been estimated that as many as 45,000 TNC drivers may operate in San Francisco, based on the number of letters sent by the San Francisco Treasurer's office to potential TNC drivers, notifying them of the requirement to register their businesses with the City. (SF Examiner, 2016). The City's business location database (https://data.sfgov.org/Economy-and-Community/Registered-Business-Locations-San-Francisco/g8m3-pdis) provides industrial sector detail and business addresses of individuals who have registered businesses in San Francisco. Based on information from this database, the research team estimates that approximately 21,000 drivers complied with the City's business registration requirements. In contrast, there are only approximately 1,800 San Francisco taxi vehicle medallions (SFMTA 2016). Table 1 shows the distribution of registered drivers' locations, by county. It appears that only 29% of TNC drivers who work in San Francisco are based in the city, indicating that vast majority of TNC drivers are coming in the city from other Bay Area counties and beyond.

Table 1. Estimated SF-Registered TNC Businesses by County

COUNTY	PERCENTAGE
Alameda	21%
Contra Costa	12%
Marin	2%
Napa	0%
San Francisco	29%
San Mateo	16%
Santa Clara	6%
Solano	2%
Sonoma	1%
Outside Bay Area	10%
TOTAL	**100%**

Source: San Francisco Registered Business Location Database, accessed 2017 May 12

Figure 1 shows the estimated number of TNC vehicles that are on San Francisco streets on a typical weekday, by time-of-day, while Figure 2 (next page) shows the number of TNC vehicles on a typical Friday. These data show that on weekdays, the peak number of TNC vehicles occurs between 6:30pm and 7:00pm, when approximately 5,700 TNC vehicles are on San Francisco streets. On Fridays, the peak occurs between 7:30pm and 8:00pm, when an estimated 6,500 TNC vehicles are on the street.

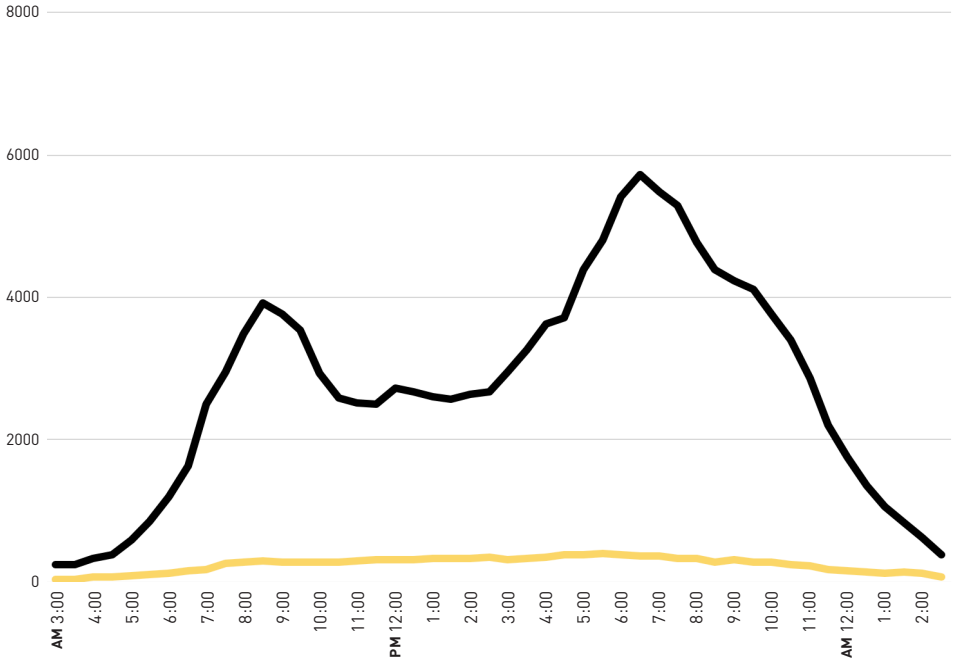


Figure 1. Intra-SF TNC and Taxi Vehicles On Street on Average Wednesday by Time-of-Day

SOURCE: TNC data; SFMTA

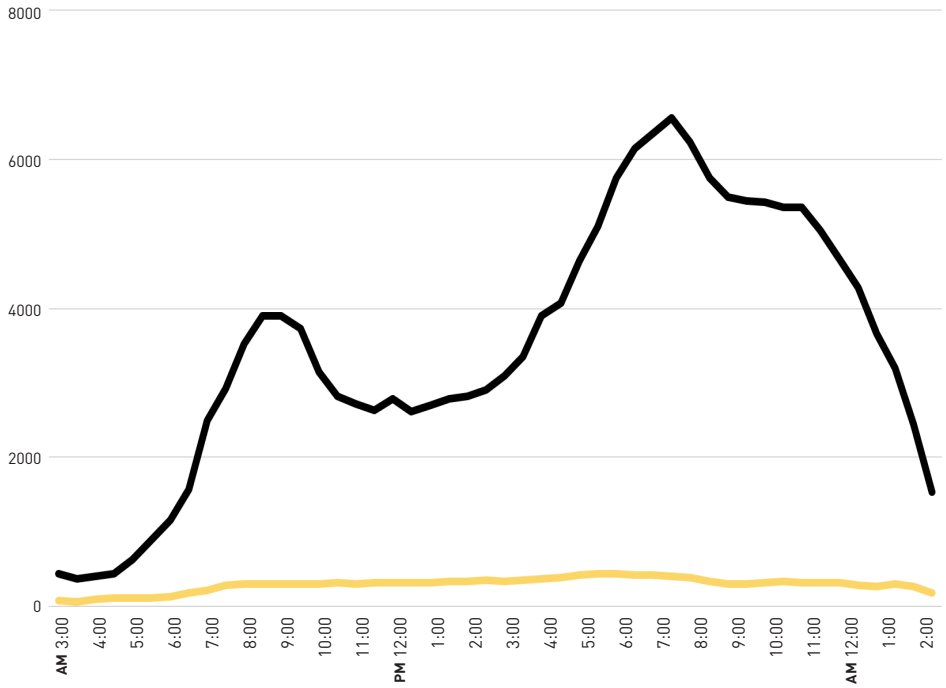


Figure 2. Intra-SF TNC and Taxi Vehicles On Street on Average Friday by Time-of-Day

TNC Vehicles
Taxi Vehicles

SOURCE: TNC data; SFMTA

HOW MANY TNC TRIPS ARE OCCURRING IN SAN FRANCISCO?

Two types of TNC trips were estimated: vehicle trips and person trips. The number of TNC vehicle trips is important because more vehicle trips generally leads to increased congestion and conflicts with other street users, while more person trips may indicate enhanced mobility. Again, only those trips with both pickup and drop-off location within San Francisco are considered in the following summaries.

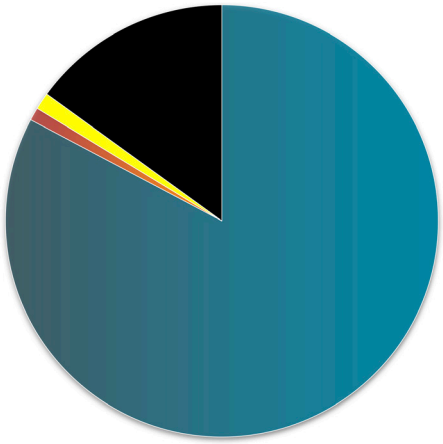
"Vehicle trips" in Table 2 refers to movements by motor vehicles with origins and destinations entirely within San Francisco. Vehicles may carry different numbers of people, or may be public transit vehicles or taxis. Trucks are excluded. Approximately 170,000 TNC vehicle trips are estimated to occur within San Francisco during a typical weekday. This represents approximately 15% of all weekday vehicle trips that both start and end within the city, as shown in Table 2. There are approximately 12 times as many TNC trips as taxi trips during a typical weekday.

Table 2. Weekday Intra-SF Vehicle Trips by Mode

MODE	VEHICLE TRIPS	%
Private Auto	940,000	83%
Public Transit Vehicle	11,000	1%
Taxi	14,000	1%
TNC	170,000	15%
TOTAL	**1,135,000**	**100%**

Source: TNC data; SF-CHAMP travel model, SFMTA

Figure 3. Average Wednesday Intra-SF Vehicle Trips by Mode



SOURCE: TNC data; SF-CHAMP.

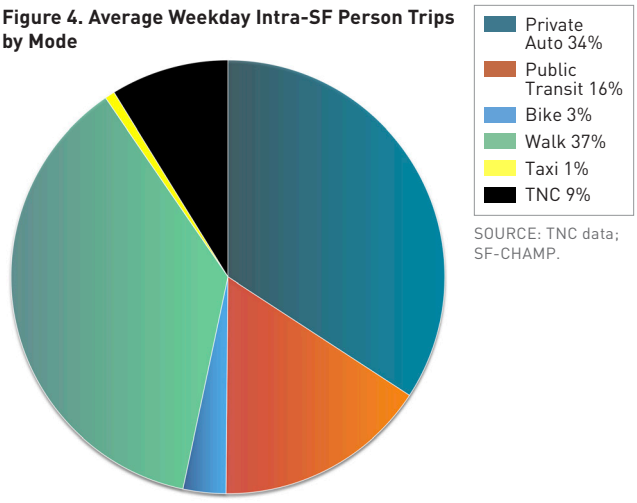
Person trips refers to movements by people with origins and destinations in San Francisco. Person trips are different than vehicle trips because person trips include walking and biking trips (which don't require motor vehicles), and also because private vehicles, public transit vehicles and taxis may carry more than one person. For TNCs and taxis, vehicle trips were converted to person trips using an assumed occupancy rate of 1.66, based on observed taxi data (Schaller, 2017). This assumed occupancy rate affects the TNC share of overall travel. Use of a lower occupancy rate would result in lower TNC person trip mode shares. Approximately 290,000 TNC person trips are estimated to occur within San Francisco during a typical weekday. This represents approximately 9% of all weekday person trips within the city, as shown in Table 3.

Table 3. Weekday Intra-SF Person Trips by Mode

MODE	PERSON TRIPS	%
Drive	1,099,000	34%
Public Transit	512,000	16%
Bike	103,000	3%
Walk	1,193,000	37%
Taxi	24,000	1%
TNC	283,000	9%
TOTAL	**3,214,000**	**100%**

Source: TNC data; SF-CHAMP travel model, SFMTA

Figure 4. Average Weekday Intra-SF Person Trips by Mode



SOURCE: TNC data; SF-CHAMP.

WHEN ARE TNC TRIPS OCCURRING IN SAN FRANCISCO?

The timing of TNC trips is important because trips that occur during peak periods and weekdays are more likely to exacerbate congestion and delay on roads, affecting both general traffic, surface public transit as well as conflicts with bicycles and pedestrians.

Figure 5 shows the total number of estimated TNC vehicle trips and taxi trips by day-of-week. It shows that TNC trips increase as the week progresses, reaching their peak volume on Friday and hitting their lowest volume on Sunday. This indicates that TNCs are serving both the weekday and

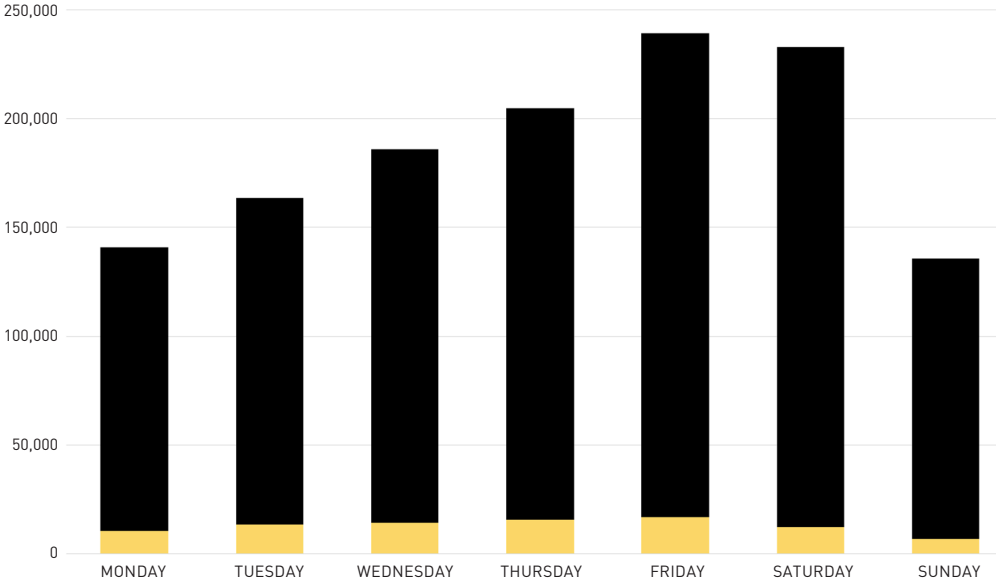


Figure 5. TNC and Taxi Intra-SF Trips by Day-of-Week

SOURCE: TNC data; SFMTA

weekend travel markets, and that TNCs have strong discretionary trip market demand.

Figure 6 provides additional detail on the timing of TNC trips by showing the estimated number of trips by half-hour and by day of week. This figure indicates that during the weekdays, TNCs have a clear pattern of peak usage that coincides with the existing AM and PM peak periods. Peak periods typically have the highest availability of other forms of transportation, and are also the times when added traffic has the highest negative effect on other transportation system users. Figure 6 also shows that on Fridays and Saturdays usage of TNCs extends later into the evening, suggesting that TNCs may also provide additional options for travelers at times when other modes such as public transit, biking or walking may be less attractive due to reduced service or safety concerns.

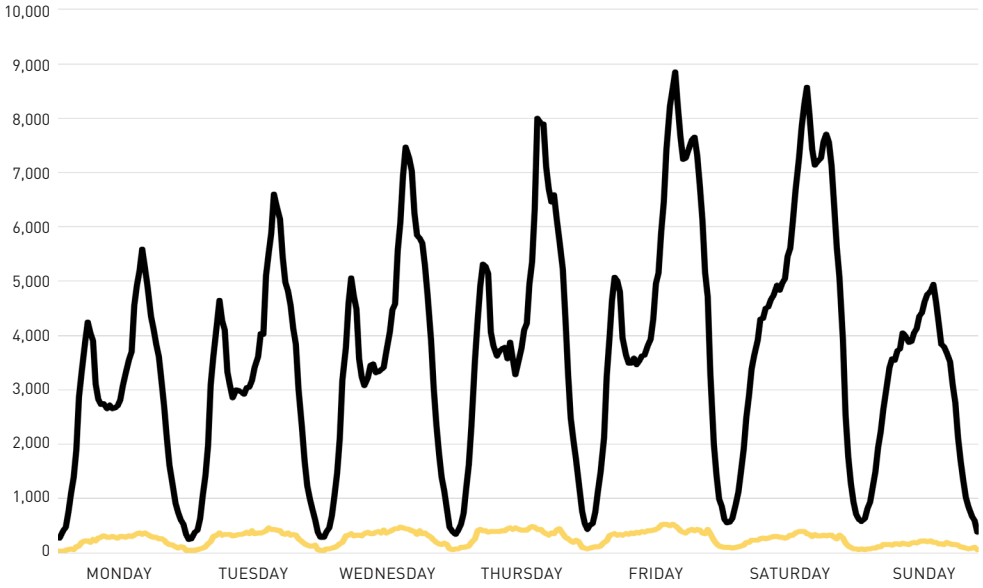


Figure 6. TNC and Taxi Intra-SF Trips by Day-of-Week and Time-of-Day

SOURCE: TNC data; SFMTA

WHERE ARE TNC TRIPS OCCURRING IN SAN FRANCISCO?

The location of TNC trips is important because trips that occur where there is already significant traffic are more likely to exacerbate congestion and conflicts with other road users, while trips that occur in less congested areas may reflect lower transportation impacts.

Figures 7 through 9 provide geographic detail on the locations of TNC pickups on weekdays, Saturdays and Sundays. In these figures, TNC trip pickups have been aggregated to travel analysis zones (TAZs), which are a basic spatial unit used by the Transportation Authority for transportation analyses (dark colors indicate more daily TNC trips, and light colors indicate fewer daily TNC trips). TAZs are approximately the size of US Census block groups in most of the city, and the size of Census blocks in the core downtown area. Figure 7 illustrates clearly that the vast majority of TNC trips are occurring in San Francisco's northeast quadrant, which is the most congested area of the city, as well as the area that is most well served by public transit, bicycling and walking facilities. South of Market, the Mission Street corridor, the Van Ness Avenue corridor, Pacific Heights and the Marina all show relatively higher intensities of TNC usage.

To a lesser extent, TNC usage is also high along the Geary Street corridor, Panhandle, and Inner Sunset, and Stonestown/San Francisco State University area.

Figure 8 illustrates that the even greater levels of TNC trip-making that occurs on Saturday is also highly concentrated in these same areas, along with more trips from Golden Gate Park and along the Geary Avenue corridor. Figure 9 shows the significantly lower level of TNC trip-making on Sundays, particularly in the northern neighborhoods.

Figures 10–12 (next page) provide an alternative detailed visualization of the locations of TNC drop-off locations. Rather than aggregate the drop-off locations to TAZs, the drop-off point locations are used to directly map the intensity of drop-offs on the roadway network. This provides insights into which specific streets and transit corridors are likely being affected most by TNC activity. The patterns are broadly similar across weekdays, Saturdays and Sunday. The Market Street spine, and areas north and south of Market show high levels of TNC drop-off activities at all times of day. Many other streets clearly stand out as well, including nearly all downtown and SoMa streets, Columbus Ave, Geary Blvd, Mission and Valencia Streets, 19th Avenue, 3rd Street, and San Bruno Avenue.

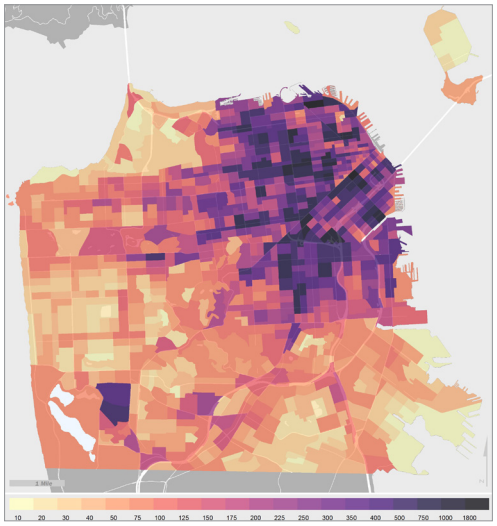


Figure 7. Average Weekday Intra-SF TNC Pickups by Travel Analysis Zone

SOURCE: TNC data

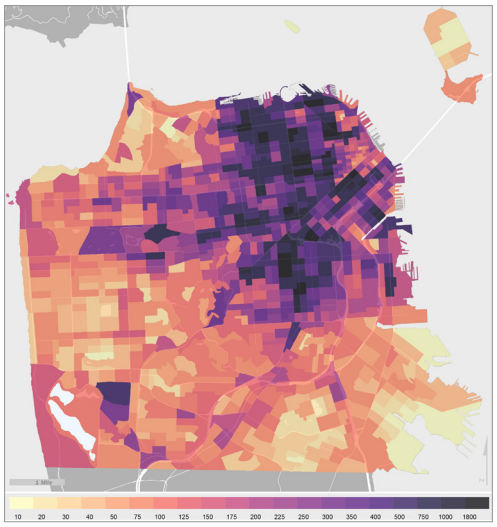


Figure 8. Average Saturday Pickups by Travel Analysis Zone

SOURCE: TNC data

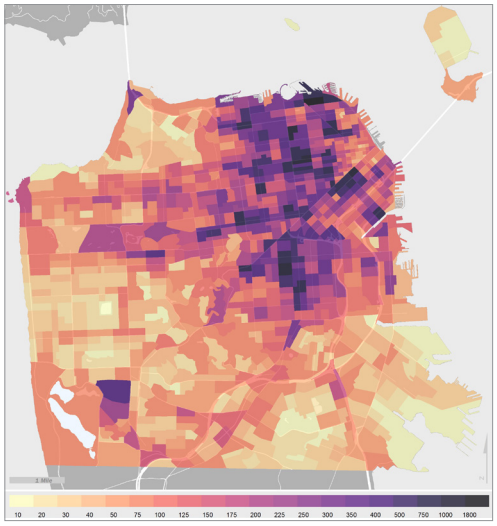


Figure 9. Average Sunday Pickups by Travel Analysis Zone

SOURCE: TNC data

The locations with the highest levels of TNC pickups and drop-offs include:

- Union Square
- Market/Van Ness
- Caltrain (4th and King)
- Transbay Terminal (2nd and Market to Harrison/Beale)
- Chinatown
- Marina
- 9th/Brannan
- Fell/Oak/Divisadero
- Embarcadero Center (Clay/Front)
- Clay/Van Ness

Figure 13 summarizes the percentage of all vehicle trips starting in each of the supervisorial district that are TNC vehicle trips. This provides information on how the overall share of 15% of daily vehicle trips as TNC trips varies by time of day and location. In District 6, the research team estimates that more than 25% of AM peak and PM peak period vehicle trips are by TNC.

Figures 14–16 (next page) show the average number of TNC pickups and drop-offs by San Francisco supervisorial district by day-of-week. Figure 14 shows that, as noted above, District 6 absorbs the greatest number of weekday TNC trips, followed closely by District 3 and more distantly by Districts 2 and 5. This likely reflects the significant employment and public transit hubs found in Districts 3 and 6, combined with higher parking supply restrictions and parking costs. Interestingly, Figure 15 indicates that the greatest number of Saturday TNC trips occur in District 3 instead, followed by District 6, possibly reflecting a greater concentration of entertainment and dining opportunities in District 3. Finally, Figure 16 shows the overall lower number of TNC trips occurring across all districts on Sunday, while the relative distribution by district is very similar to that observed on weekdays and Saturdays.

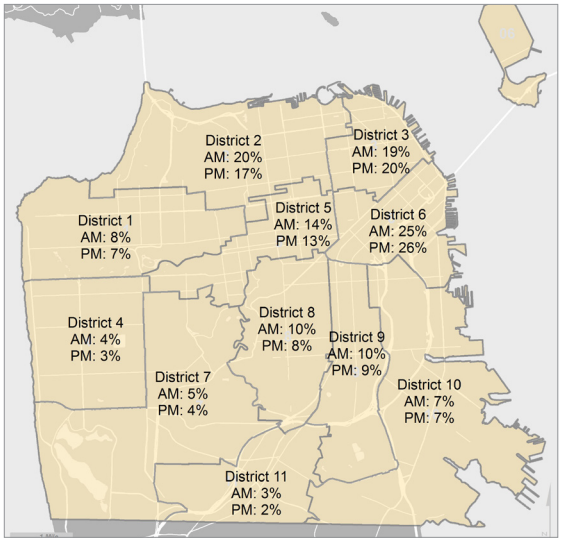


Figure 13. TNC AM and PM Vehicle Shares by Supervisorial District

SOURCE: TNC data

Figure 10. Weekday Pickup Hotspots

SOURCE: TNC data

Figure 11. Saturday Pickup Hotspots

SOURCE: TNC data

Figure 12. Sunday Pickup Hotspots

SOURCE: TNC data

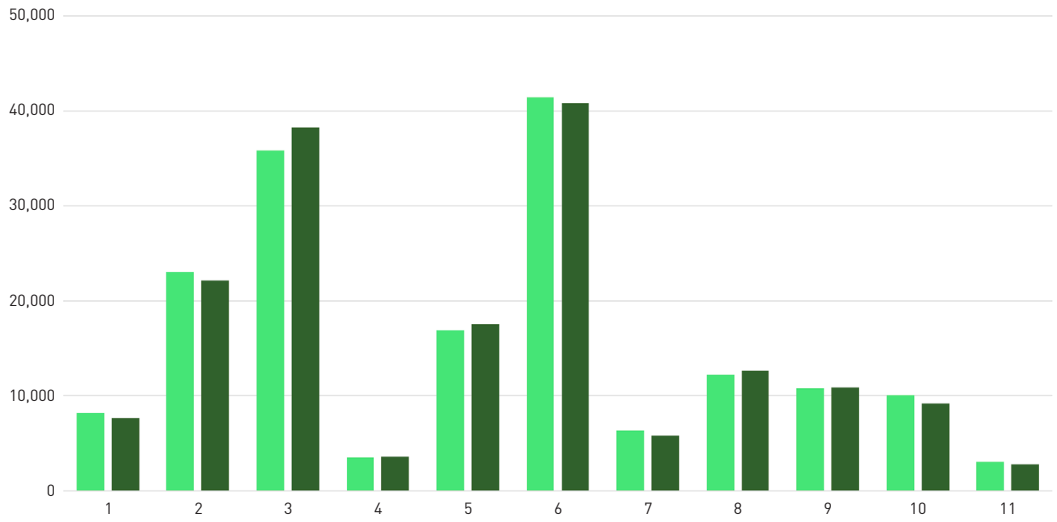


Figure 14. Weekday Pickups and Dropoffs by Supervisorial District

SOURCE: TNC data

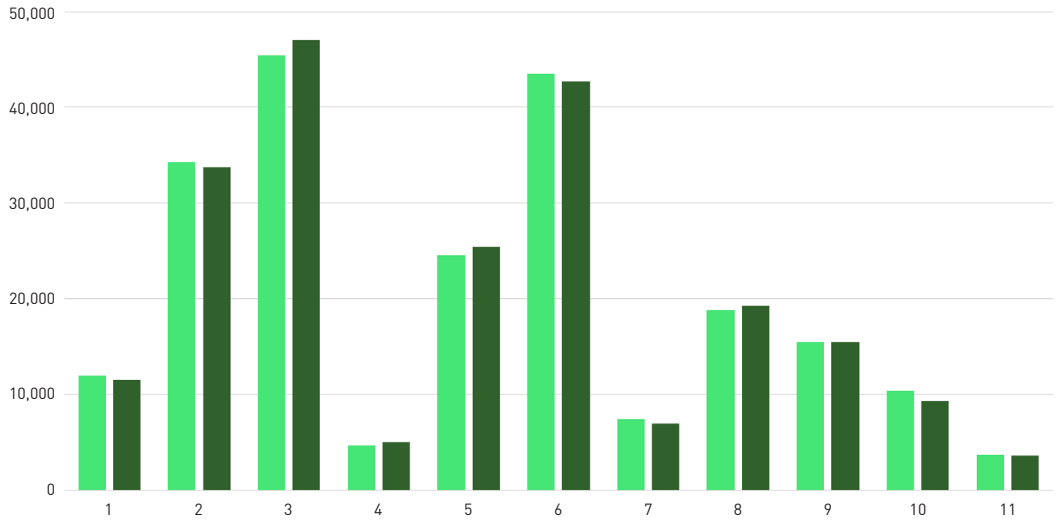


Figure 15. Saturday Pickups and Dropoffs by Supervisorial District

SOURCE: TNC data

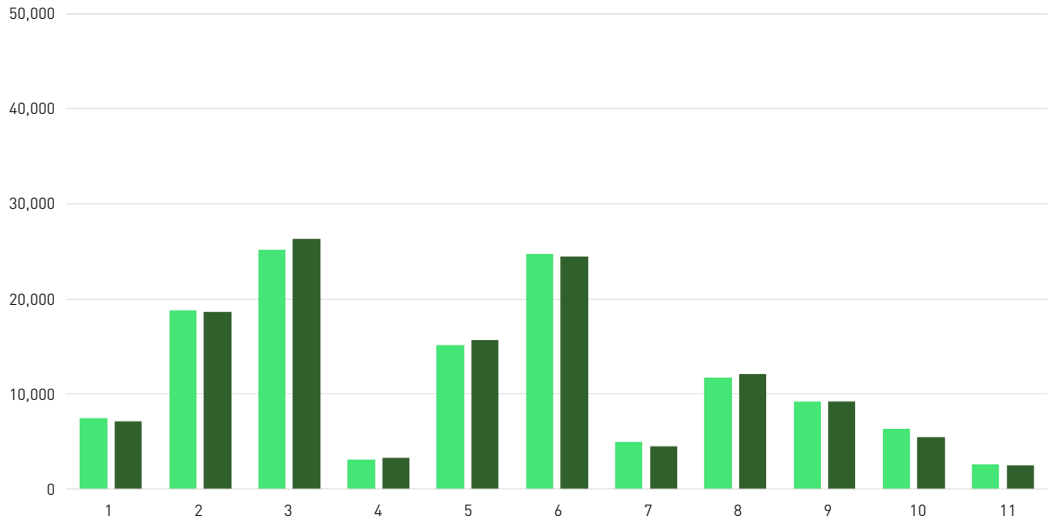


Figure 16. Sunday Pickups and Dropoffs by Supervisorial District

SOURCE: TNC data

Figures 17–19 further illustrate the total number of TNC and non-TNC vehicle trips by supervisorial district and time of day. These show overall higher levels of TNC vehicle trips in the PM peak than in the AM peak, and that District 3 and District 6 have the greatest levels and the greatest shares of TNC vehicle trip-making.

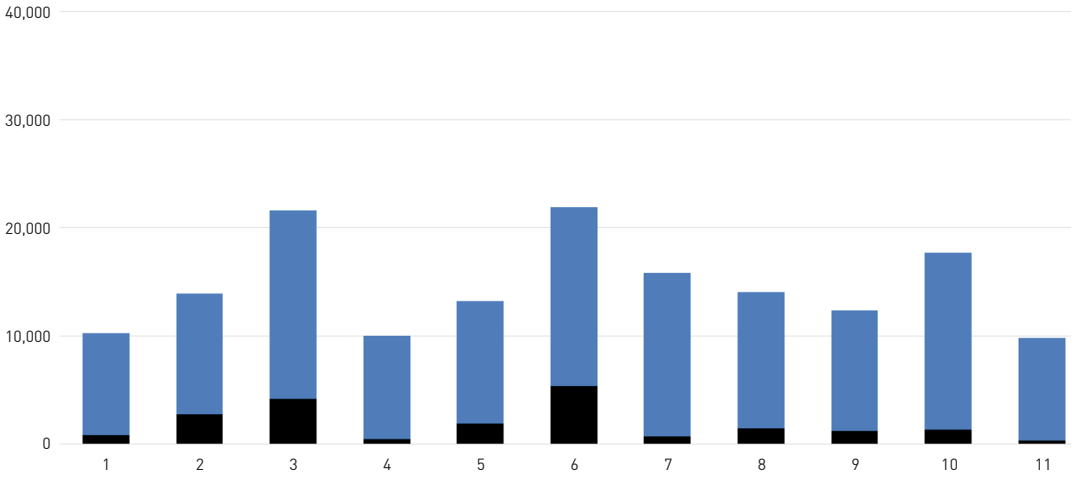


Figure 17. Intra-SF AM TNC and Vehicle Trips by Supervisorial District

SOURCE: TNC data; SF-CHAMP

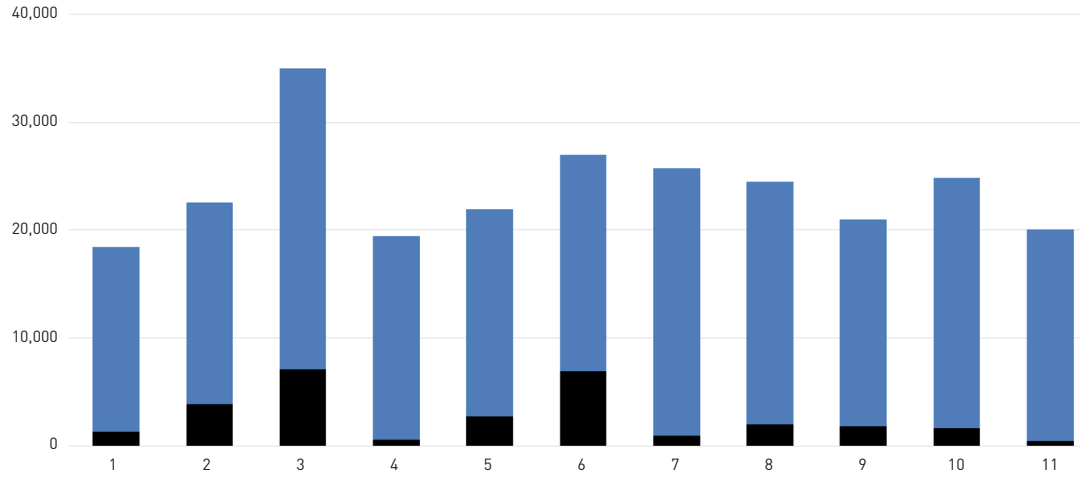


Figure 18. Intra-SF PM TNC and Vehicle Trips by Supervisorial District

SOURCE: TNC data; SF-CHAMP

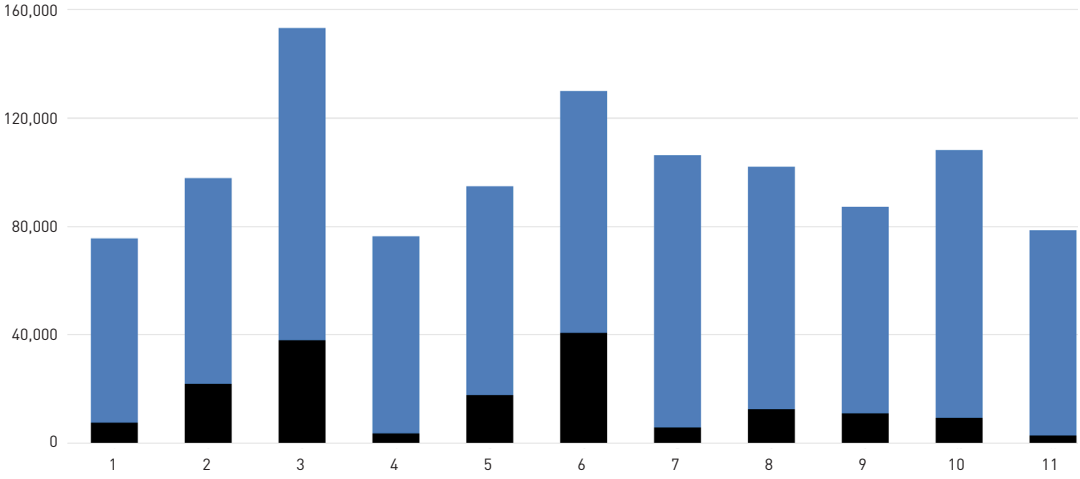


Figure 19. Intra-SF Daily TNC and Vehicle Trips by Supervisor District

SOURCE: TNC data; SF-CHAMP

HOW MUCH VMT DO TNCs GENERATE WITHIN SAN FRANCISCO?

The amount of VMT, or vehicle miles travelled, that is generated by TNCs is important because VMT is a fundamental measure of transportation system performance. Higher levels of VMT are associated with greater levels of emissions of greenhouse gases such as CO_2 as well as other pollutants. In addition, higher levels of VMT are also associated with greater roadway congestion and conflicts. For TNCs and taxis, two types of VMT are important, in-service VMT and out-of-service VMT. In-service VMT refers to the vehicle miles traveled when transporting a passenger. Out-of-service VMT refers to the vehicle miles traveled while circulating to pickup a passenger.

Tables 4–6 show the total trips, total VMT, average total trip length, in-service trip length, out-of-service trip length, and percent out-of-service trip length by day-of-week for local TNCs and taxis. These tables indicate that TNCs and taxis are generally similar in terms of average in-service trip length. However, a notably smaller share of TNCs' total trip lengths are out-of-service miles, while a significant share of total taxi trip length (over 40%) are out-of-service miles. The greater efficiencies of TNCs, as reflected in a lower share of out-of-service miles, are likely primarily a reflection of the larger fleets of TNC drivers operating on the road at any given time, enabling shorter distances to pickup locations. In addition, TNCs' routing software may be more efficient than the taxi dispatch systems. Most critically, Table 4 indicates that the estimated TNC total VMT on a typical weekday is approximately 570,000 VMT, and this estimate is clearly conservative given that it:

- Includes only intra-SF TNC trips (such as trips to and from San Francisco International Airport).
- Underestimates out-of-service VMT because it excludes the additional distance from acceptance location to where the passenger is actually picked up.
- Excludes VMT associated with TNC drivers commuting to SF from non-SF home origins.

This TNC VMT estimate indicates that intra-SF TNCs generate as much as 20% on weekday VMT for intra-SF vehicle trips and at least 6.5% of total weekday VMT in San Francisco, given Caltrans' most recent estimate of weekday VMT traveled on San Francisco streets and highways (Caltrans 2014). Saturday roadway volumes are lower than weekday volumes, yet Saturday TNC VMT is even greater than average weekday TNC VMT. It is possible that TNCs may account for approximately 10% of VMT on Saturdays.

Table 4. Average Weekday Intra-SF Trip Lengths

	TNCS	TAXIS
Trips	170,400	14,400
VMT	569,700	65,900
Average Total Trip Length	3.3	4.6
Average In-service Trip Length	2.6	2.6
Average Out-of-service Trip Length	0.7	2.0
% Out-of-service Trip Length	21.0%	43.6%

Table 5. Average Saturday Intra-SF Trip Lengths

	TNCS	TAXIS
Trips	220,700	12,300
VMT	703,600	53,600
Average Total Trip Length	3.2	4.4
Average In-service Trip Length	2.6	2.4
Average Out-of-service Trip Length	0.6	1.9
% Out-of-service Trip Length	18.6%	44.1%

Table 6. Average Sunday Intra-SF Trip Lengths

	TNCS	TAXIS
Trips	129,100	6,700
VMT	471,200	31,900
Average Total Trip Length	3.7	4.8
Average In-service Trip Length	2.9	2.6
Average Out-of-service Trip Length	0.8	2.2
% Out-of-service Trip Length	20.7%	45.5%

Figure 20 (next page) illustrates the amount of estimated in-service and out-of-service VMT generated by local TNCs and taxis for typical weekdays, Saturdays and Sundays. TNCs generate more than 10 times as many VMT as taxis on a typical weekday, while generating 12 times as many trips.

Figure 21 (next page) shows the distribution of weekday VMT by time-of-day for TNCs and taxis. It indicates that most of the VMT generated by TNCs occurs during the AM peak and PM peak hours, with significant VMT also occurring during the evening hours, following the PM peak. VMT generated during periods of peak demand likely exacerbates existing peak period congestion.

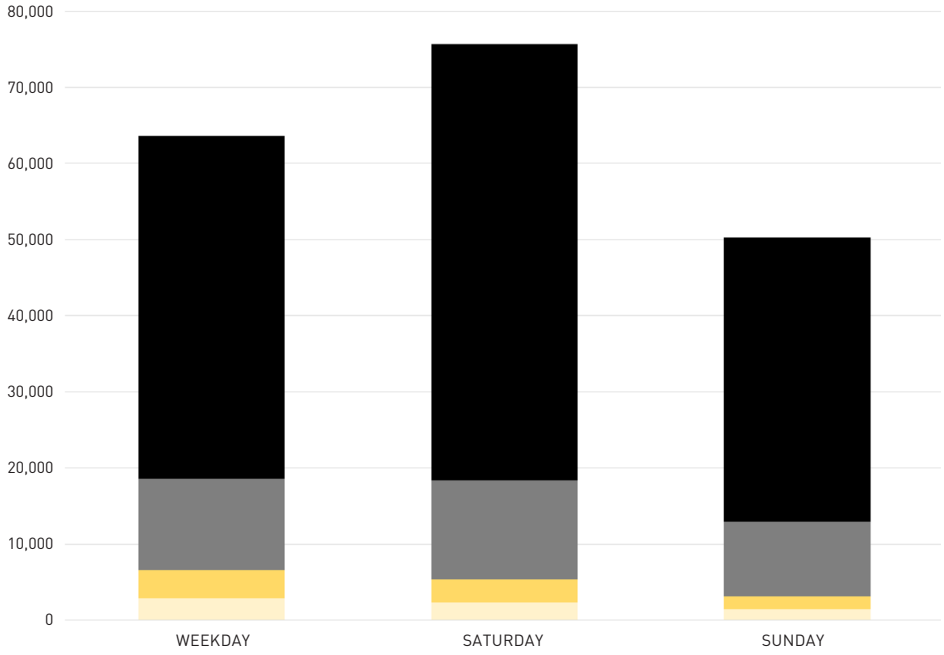


Figure 20. Intra-SF TNC and Taxi Vehicle Miles Traveled (VMT)

SOURCE: TNC data

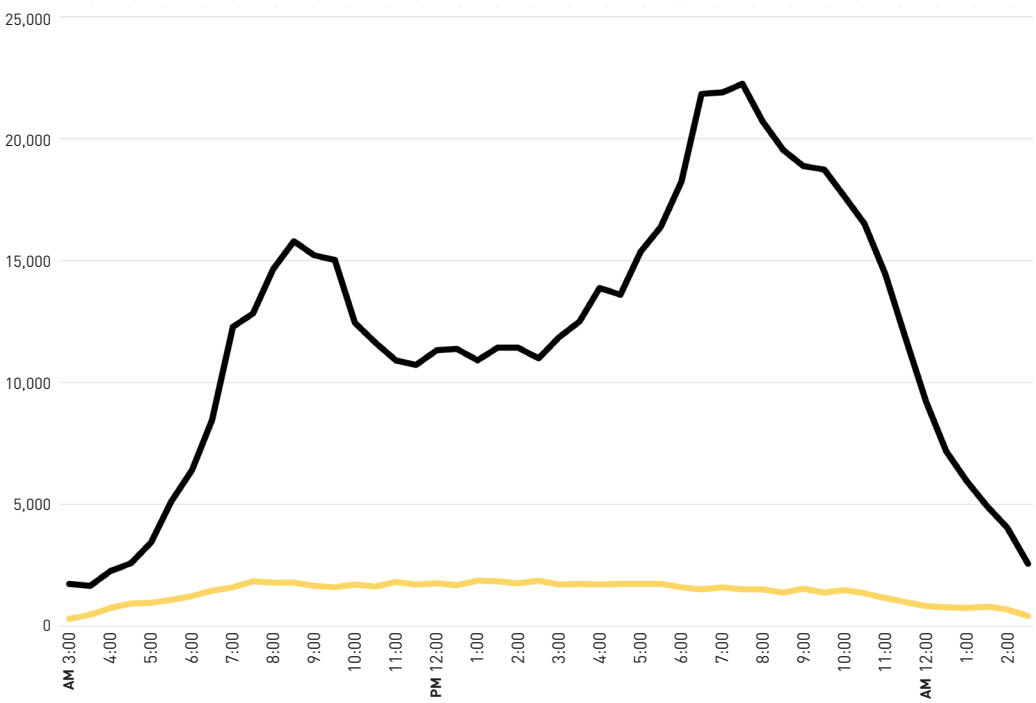


Figure 21. Intra-SF Weekday TNC and Taxi VMT by Time-of-Day

SOURCE: TNC data

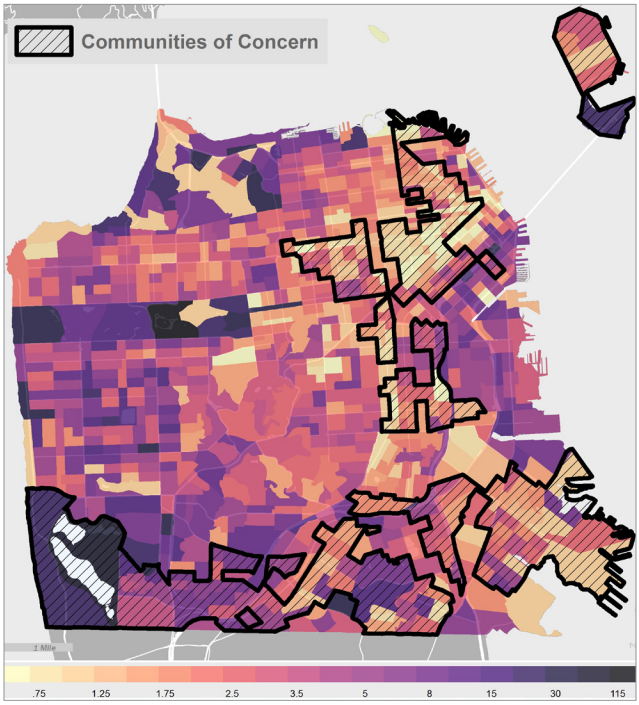
DO TNCs PROVIDE GOOD GEOGRAPHIC COVERAGE THROUGHOUT THE ENTIRE CITY?

It is important to ensure that all areas of the city have access to transportation alternatives, while also acknowledging that different communities may have different needs and abilities to pay for mobility services. Due to their flexibility, TNCs should be able to provide reasonable geographic coverage to all areas of the city. In order to assess whether TNCs are serving all neighborhoods, two metrics are used: the number of TNC pickups per taxi pickup in each TAZ and the number of TNC pickups per combined population and employment in each TAZ.

Figure 22 shows the number of TNC pickups per taxi pickup. Areas defined as "communities of concern" are also identified. Darker areas indicate where TNCs are providing broader service than taxis. However, the figure also suggests that southeastern neighborhoods may not be well served by TNCs.

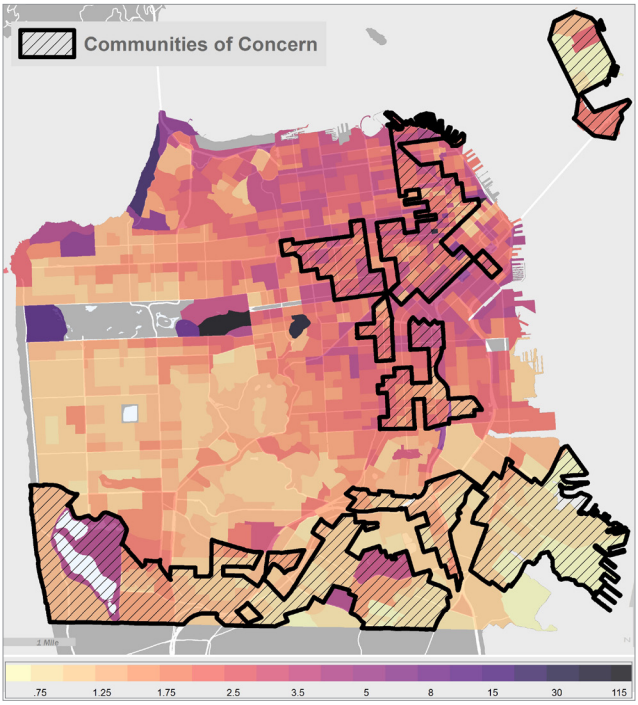
Figure 23 shows the number of TNC pickups per combined population and employment by TAZ. This shows that the northeastern core and northern parts of the city are generally well served by TNCs. Southeastern and southern neighborhoods do not appear to be as well served. This may reflect either a lack of vehicles available in this area, or may reflect inability of residents of these areas to use TNCs, or some combination of these or other factors. Additional data is required to better understand this pattern.

Figure 22. Weekday TNC Pickups per Taxi Pickup



SOURCE: TNC data

Figure 23. TNC Pickups per Population and Employment



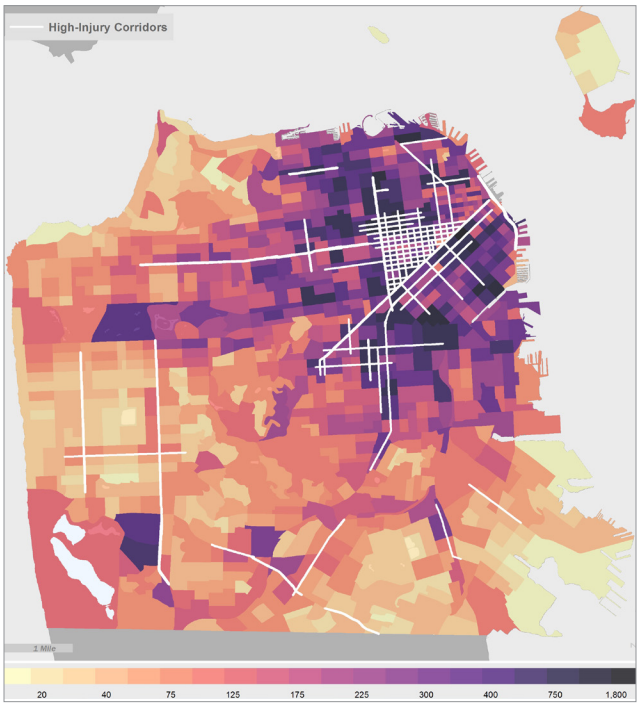
SOURCE: TNC data

Future Research

The report provides a profile of estimated TNC usage from mid-November to mid-December of 2016. This document does not evaluate the impacts of TNCs on the performance of the San Francisco transportation system, nor does it recommend any policy responses. Subsequent reports by the Transportation Authority and others will address important analytic and policy questions in depth, including:

- **TNC POLICIES.** What is the role of government in regulating TNCs? What TNC regulatory frameworks exist in other US cities or internationally?
- **TNC BEST PRACTICES.** What potential impacts of TNCs have other agencies identified, and what policies have they enacted in response? How have agencies partnered with TNCs?
- **TNCS AND STREET SAFETY.** How do TNCs affect the safety of people who use the roads, including public transit riders, bicyclists and pedestrians? How can TNCs help San Francisco achieve its VisionZero goals?
- **TNCS AND TRANSIT DEMAND.** How do TNCs complement, compete with, or otherwise affect public transit ridership and mode share?
- **TNCS AND PUBLIC TRANSIT OPERATIONS** How do TNCs affect public transit service operations?

Figure 24. High Injury Corridors with Average Weekday Intra-SF TNC Pickups by Travel Analysis Zone



SOURCE: TNC data

- **TNCS AND CONGESTION.** How do TNCs affect roadway congestion, delay and travel time unreliability? How do TNCs affect air quality?
- **TNCS AND DISABLED ACCESS.** To what extent do TNCs serve people with disabilities?
- **TNCS AND EQUITY.** Can TNCs be accessed by all San Francisco residents including communities of concern and those without smartphones or credit cards? Are all neighborhoods served equitably?
- **TNCS, LAND USE AND CURB MANAGEMENT.** What are the best practices for loading/curbside/roadway space allocation? How do TNCs affect parking demand? Is TNC demand associated with certain land uses? What are the effects of TNCs on location choices and auto ownership?

Additional data collection will be necessary in order to help answer these questions. We are seeking/open to research collaborations to obtain further information, including data to validate or enhance these findings, TNC vehicle occupancy information, traveler demographics and travel purposes, travel costs, TNC fleet composition data, and a range of other data items.

For More Information

The Transportation Authority makes available aggregate travel analysis zone (TAZ) level summaries of TNC pickups and drop-offs by hour of day, which can be downloaded at the Transportation Authority website (www.sfcta.org/tncstoday). In addition, an interactive visualization of the TAZ-level TNC data can be found at http://tncstoday.sfcta.org. The Transportation Authority will not provide detailed telemetry data or processed pre-trip and trip information due to the potential to contain personally identifiable information. Parties interested in the detailed telemetry data may contact the Northeastern University researchers to request access. Further information on on-going emerging mobility services and technology work being performed by the Transportation Authority can be found on the Transportation Authority website at: www.sfcta.org/emst.

Bibliography

California Department of Transportation. "2014 California Public Road Data: Statistical Information Derived from the Highway Performance Monitoring System." http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/prd/2014prd/2014PublicRoadData.pdf

California Public Utilities Commission, Letter to San Francisco County Transportation Authority, May, 2017.

Corey, Canapary & Galanis Research. "Travel Decisions Survey 2014—Summary Report." Prepared for San Francisco Municipal Transportation Agency. https://www.sfmta.com/sites/default/files/reports/2015/Travel%20Decision%20Survey%202014%20Summary%20Report.pdf

Corey, Canapary & Galanis Research. "Travel Decisions Survey 2015—Summary Report." Prepared for San Francisco Municipal Transportation Agency. https://www.sfmta.com/sites/default/files/reports/2016/Travel%20Decision%20Survey%202015%20Report_Accessible.pdf

Hara Associates. "Best Practices Studies of Taxi Regulation: Managing Taxi Supply." Prepared for San Francisco Municipal Transportation Agency, 2013.

Rayle L, Dai D, Chan N, Cervero R and Shaheen S. "Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco." *Transport Policy 45*, 2016.

Schaller, B. "Entry Controls in Taxi Regulation: Implications of US and Canadian experience for taxi regulation and deregulation." *Transport Policy 14*, September 2007.

Transportation Research Board. "TRB Special Report 319: Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services." National Academies Press, Transportation Research Board, 2015.

Glossary

APPLICATION PROGRAMMING INTERFACE (API): Programming code that allows interaction with software, or between software components. It is a tool that a developer of an app uses to communicate with data from a central server.

IMPUTE: Refers to any method to estimate an unknown or missing value in a dataset based on known values or information.

PERSON TRIPS: A trip by one or more people in any mode of transportation.

TELEMETRY: A remotely collected continuous series of GPS points with associated time and other information that forms a path.

TRANSPORTATION NETWORK COMPANY: Uses an online-enabled platform to connect passengers with drivers using their personal, non-commercial, vehicles.

TRAVEL ANALYSIS ZONE (TAZ): A geographic unit used for transportation analysis. The Transportation Authority uses a roughly 1000-zone system with average sizes of 1 block in the downtown area and several blocks for outer areas.

Print Form

Introduction Form

By a Member of the Board of Supervisors or Mayor

Time stamp
or meeting date

I hereby submit the following item for introduction (select only one):

- ☐ 1. For reference to Committee. (An Ordinance, Resolution, Motion or Charter Amendment).
- ☑ 2. Request for next printed agenda Without Reference to Committee.
- ☐ 3. Request for hearing on a subject matter at Committee.
- ☐ 4. Request for letter beginning :"Supervisor [ ] inquiries"
- ☐ 5. City Attorney Request.
- ☐ 6. Call File No. [ ] from Committee.
- ☐ 7. Budget Analyst request (attached written motion).
- ☐ 8. Substitute Legislation File No. [ ]
- ☐ 9. Reactivate File No. [ ]
- ☐ 10. Topic submitted for Mayoral Appearance before the BOS on [ ]

Please check the appropriate boxes. The proposed legislation should be forwarded to the following:

☐ Small Business Commission ☐ Youth Commission ☐ Ethics Commission

☐ Planning Commission ☐ Building Inspection Commission

Note: For the Imperative Agenda (a resolution not on the printed agenda), use the Imperative Form.

Sponsor(s):

Supervisor Peskin

Subject:

[City Policy – AV Compliance With Federal, State And Local Street Safety Standards]

The text is listed:

Resolution making it the official policy of the City and County of San Francisco not to grant any fleet charging, fleet deployment or other city support resources, approvals or incentives to Autonomous Vehicle (AV) programs until or unless all safety concerns and transit first priorities have been addressed as outlined by the National Highway Traffic Safety Administration (NHTSA), State transportation agencies and the San Francisco Municipal Transportation Agency (SFMTA) and San Francisco County Transportation Authority (SFCTA).

Signature of Sponsoring Supervisor: //AP//

For Clerk's Use Only