Comprehensive Plan Element
Land Use and Regulatory Principles for Autonomous and Connected Vehicles

Background:

The District of Columbia has been at the forefront of United States transportation innovation for the last decade and more. The city pioneered bikesharing in the U.S., demonstrating the potential for bikesharing to act as a new mode of public transit in such a compelling way that by 2016 more than 55 systems followed DC's example in cities throughout the country.[1] Carsharing (e.g., Zipcar, Car2Go), electronic hailing, then ridesharing (e.g., Uber, Lyft), and sophisticated wayfinding and multimodal transportation choice apps (e.g., Ridescout) debuted in DC and were quickly adopted by the city's transportation-savvy residents.

DC area travelers already enjoyed access to heavy rail Metro transit and the other transportation choices that became popular in this past decade (including the return of streetcars after a 50-year hiatus), permitted DC travelers to make more than half of all work trips by walking, biking or transit, rather than via private vehicles.[2] As a result, household rates of car ownership in DC are much less than the national average, with nearly 80% of households with 1 or fewer cars and 34 % with zero cars, according to the U.S. Census Bureau data.[3]

While UCLA Professor Emeritus Don Shoup estimates that in the U.S., private automobiles are used 5% of the time and parked 95% of the time[4], in cities like DC, that utilization rate is even lower. Many residents find that a mix of transportation options that might include transit, bicycling, walking, shared vehicles, and electronically hailed cars is a much better value proposition than a privately owned vehicle.

Personal travel is only one area of transformation – deliveries and logistics are a large and growing part of e-commerce. Beginning this year, DC is a leading test bed for automated logistics. Estonia-based Starship Technologies began testing its rovers on city sidewalks in January 2017 with e-commerce partner Postmates. Automated delivery tests under the city's Personal Delivery Device Pilot Program are restricted to no more

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[1] "Bike Share in the US: 2010-2016," National Association of City Transportation Officials, 2016

[2] American Community Survey 2014 1-year estimates, U.S. Census Bureau

[3] ibid

[4] The High Cost of Free Parking; Donald Shoup; American Planning Association; 2005

than five vehicles per vendor, a 50-pound vehicle weight cap, and a 10 mph speed limit. [5]

Expected Impacts and Timing:

According to McKinsey & Company[6], urban mobility is continuing to quickly evolve.

From…	**Toward…**
Individual car ownership as dominant form of transport	Individual car ownership as one form of multimodal, on-demand, and shared transport
Limited consumer choice and few service levels	More consumer choice and many service levels
Government-funded public transit	Public and private transit operate in parallel
Unconnected, suboptimal, transportation systems	On-demand, connected systems that use data to unlock efficiencies

The combination of shared mobility, electrification, and autonomous vehicles could be transformative. According to a recent study, by encouraging a large increase in trip sharing, transit use, and active transport through policies that support compact, mixed use development, cities worldwide could save an estimated $5 trillion annually by 2050 while improving livability and increasing the likelihood of meeting climate change targets.[7]

Perhaps the most impactful and disruptive single technological innovation in urban mobility innovation is now on the horizon. ***Autonomous Vehicles (AVs)***[8], which are likely to also be ***connected*** to each other[9] and powered

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[5] Taming the Autonomous Vehicle: A Primer for Cities; Bloomberg Philanthropies and the Aspen Institute; 2017; p. 4

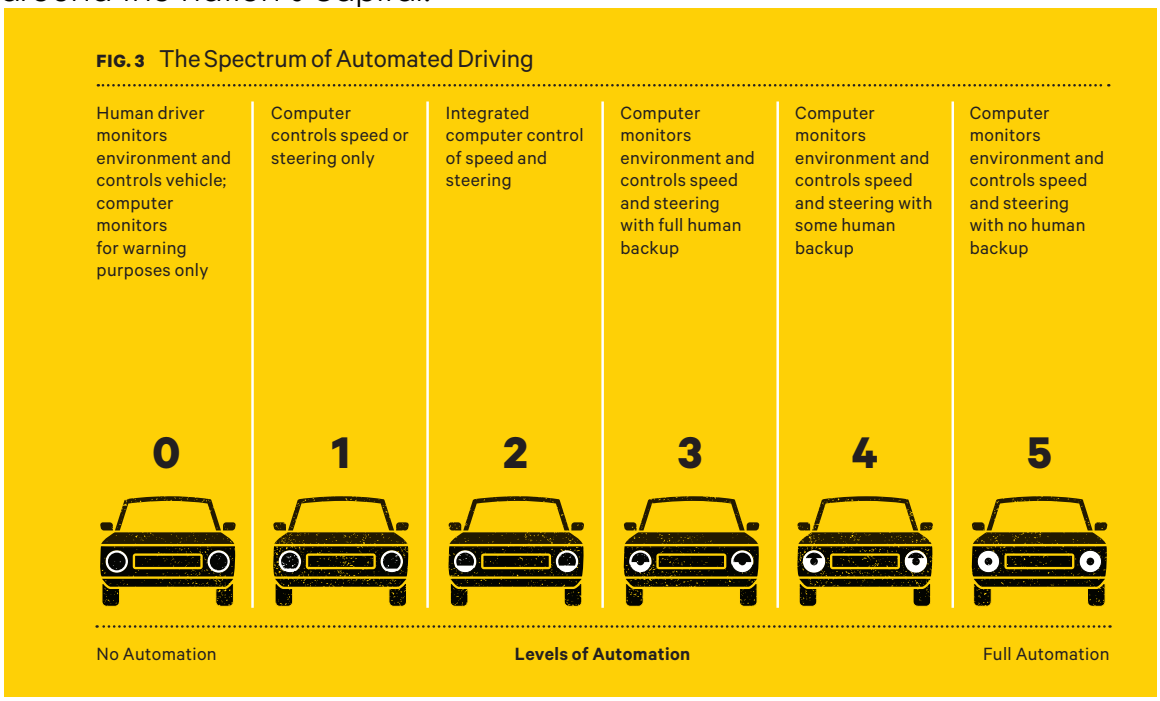
[6] Urban Mobility at the Tipping Point; Bouton, Shannon; Knupfer, Stefan; Mihov, Ivan; and Swartz, Steven; McKinsey & Company; 2016; p.

[7] Three Revolutions in Urban Transportation: *How to achieve the full potential of vehicle electrification, automation and shared mobility in urban transportation systems around the world by 2050; Lew Fulton,* University of California Davis Institute of Transportation Studies*; Jacob Mason,* Institute for Transportation and Development Policy*; Dominique Meroux, UC Davis; June 2017; pp 19-28*

[8] Autonomous Vehicle - The U.S. Department of Transportation recommends defining autonomous vehicle technology levels using the SAE J3016 standard:

[9] **Connected Vehicle** -A vehicle that communicates with the Internet, other vehicles, wayside systems and/or passengers.

by electricity, have the potential to transform how people travel in and around the nation's capital.



From Taming the Autonomous Vehicle: A Primer for Cities; Bloomberg Philanthropies and the Aspen Institute; 2017.

AVs could reduce crashes, improve first and last mile connections for transit users, and reduce the high cost of owning a private vehicle. AVs could vastly reduce the need for parking, allow existing roadways to be used at much higher capacity, and permit some amount of publically-owned right-of-way to be repurposed for other needed uses, like wider sidewalks, transitways, stormwater management facilities, even housing. Planners and designers around the world have already begun to plan and conceive how spaces designed for large numbers of conventional vehicles can be transformed. The transition to AVs offers enormous potential for higher value and community-enhancing land uses along additional homes and jobs, if key steps are taken to lock in the anticipated place-making and land-use benefits.[10]

AVs, combined with shared mobility, have the ability to serve key segments of the population in ways that could be transformative. By 2030, more than 1.4 billion of the world's population will be age 60 or older. This group is expected to have a large impact on the market for

[10] Making Better Places: Autonomous Vehicles and Future Opportunities, WSP | Parsons Brinckerhoff, in association with Farrells, UK, 2016

AVs. In cities, AVs will allow people to pursue their preferences to age in place and to do so with less reliance on city-funded services.[11]

Many studies estimate that AVs could dramatically reduce the number of passenger vehicles in communities. As AV technology gets more fully adopted, the distinctions between large buses, minibuses, shared cars and private vehicles might simply be a function of price per trip. According to a recent UC Davis- ITDP study, with just a 30-40% increase in average vehicle occupancy, from 1.3 to 1.8 passengers per vehicle, the number of autonomous, connected vehicles needed would drop by about 75%. By 2050, widespread use of shared and autonomous vehicles would reduce the number of urban light duty vehicles in the world from 2.1 billion projected, to about 500 million. That kind of shift would have enormous and salutary effects on traffic congestion and the demand for overall car storage.[12]

However, there are also scenarios that show that electrification, and continued efficiencies and price decreases with lithium Ion batteries, will cause the cost per mile of automobility to plummet – with estimates of 8-35 cents per mile (compared to a cost of about 57 cents per mile today),[13] leading to more driving and a shift of modes from bike, walk and transit, to autos, as well as increasing the distances traveled. Other negative impacts of AVs include causing even short term parking revenues to dwindle– why ever park if it is cheaper for empty electric vehicles to circle the area until called by a passenger? – while the resulting churn of empty, circling vehicles could snarl traffic well beyond the worst rush hour congestion we currently experience. Negative impacts include more road wear, more total vehicle miles traveled, and higher carbon emissions.

Moreover, in the District of Columbia alone, there are thousands of jobs that involve driving – taxis, commuter and public transit, school buses, private transit vans, delivery trucks, electronically hailed rides – that could be impacted by AV technology. Taxi fleets are on a relatively fast track to full automation, and this will have an immediate impact on employment and city streets. Analysts at Barclays estimate that by eliminating the cost of taxi drivers' labor, full automation could slash uberPOOL's current fares for shared rides ($1.00 to $1.50 per mile) to as low as eight cents per mile. If

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[11] Taming the Autonomous Vehicle; ibid; p. 7

[12] Three Revolutions in Urban Transportation; ibid; p. 24.

[13] Ibid; p 16

even a small portion of these fare reductions is achieved in practice, use of shared AV taxis could grow rapidly.[14]

Public transit has a long history of automation, where it has been pursued to improve safety and capacity, but also with costs in mind. Future investments, however, are more likely to focus on controlling labor costs a. According to a 2015 survey of 23 metro systems worldwide, fully automated trains and fare gates can achieve a 70 percent reduction in staffing needs. For buses, where one driver is needed to transport only a few dozen passengers, driverless vehicles could reap enormous savings.[15] Where our regional Metro system lacks a dedicated funding source, there are a whole range of AV considerations to ponder, from cost saving to potentially managing a fleet of AVs to solve first and last mile connectivity to the rail system and to provide flexibility on less traveled bus routes that might be better managed as an on-demand service.

Any analysis of impacts should also consider what jobs might be created to lessen the impact of those possible job losses and how that might effect the District's economy, and the opportunities for our residents.

The protections, incentives/disincentives, land use policies and rules of the road adopted by state/local governments will be dispositive in determining how much benefit and how much harm we will experience. DC is in the unique position of having both local and state-level responsibilities when it comes to AVs and thus the ability to play a leadership role in setting the most formative policies at both levels.

Autonomous vehicle technology is already here and is advancing rapidly: AVs are being tested on both test tracks and on public streets around the country including in Pittsburgh, Boston, Texas, Aberdeen (MD), Willow Run (MI), Contra Costa (CA), Iowa City (IA), San Diego (CA), Madison (WI), Central Florida, North Carolina, Texas, and Arizona.[16] We may have vehicles that are largely autonomous operating in DC before 2020. Most studies suggest that the technology will be fully implemented before 2050. The shift from human-driven to driverless vehicles will be most intense between 2025 and 2035, with human drivers in the clear minority by the end of that period. In less than ten years, more than a million driverless cars are expected to be in use worldwide. And given the uptake of

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[14] Taming the Autonomous Vehicle, ibid; page 42

[15] Taming the Autonomous Vehicle; ibid; pp. 42-43

[16] Korosec, Kirsten; "Here's Where the 10 Federal Self-Driving Car Test Sites Are;" Fortune, Jan 20, 2017

transportation innovation in the District, we should expect to be among the earliest adopters.[17]

Yet DC does not yet have an autonomous vehicles policy. In order to maximize potential benefits and minimize potential threats, the 2017 Comp Plan Update should include a policy to ensure that AVs advance our adopted comprehensive plan's vision and principles, originally stemming from the City's "Vision for Growing an Inclusive City" and the 36 principles laid out in the 2006 Comprehensive Plan. These principles express the crosscutting goals for the District's future that risk being undermined without a deliberate and sensible connected and autonomous vehicle policy and are organized around the following relevant themes:

- Managing Growth and Change
- Creating Successful Neighborhoods
- Increasing Access to Education and Employment
- Connecting the City
- Building Green and Healthy Communities

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In 2014, the District of Columbia released its long range transportation plan, moveDC, which laid out a long term vision: ***The District of Columbia will have a world-class transportation system serving the people who live, work, and visit the city. The transportation system will make the city more livable, sustainable, prosperous, and attractive. It will offer everyone in the District exceptional travel choices. As the transportation system evolves over time,*** the District will:

- Be more competitive and attractive locally, regionally, nationally, and internationally
- Have safer and more vibrant streets and neighborhoods
- Have cleaner air, streams, and rivers, and be more responsive to climate change
- Accommodate the travel needs of all residents, workers, and visitors regardless of age or ability
- Integrate the District's transportation system with the region's transportation network

That plan also organized its more specific goals around 7 broad themes:

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[17]Taming the Autonomous Vehicle; ibid; pp. 8-9

- **Sustainability and Health**: Achieve 75% of all commute trips in the District by non-auto modes
- **Citywide Accessibility and Mobility**: Maximize system reliability and capacity for moving people and goods
- **Accessibility and Connectivity**: Support neighborhood vitality and economic development

- **Safety and Security**: Achieve zero fatalities and serious injuries on the District transportation network
- **Public Space:** Reinforce Washington, D.C.'s historic landscapes and quality of neighborhood public space
- **Preservation**: Maximize reliability for all District transportation infrastructure by investing in maintenance and asset management
- **Funding and Financing**: invest in transportation to achieve outcomes within the plan horizon

The Policies and Actions below are designed to provide guidance to the Office of Planning, the District Department of Transportation and other implementing agencies, public sector organizations, private sector entities and our residents and businesses regarding the District's Connected and Autonomous Vehicles Policy. Future policies should provide clear guidance for evaluating autonomous vehicle tests, pilots, and eventual deployment.

This submittal is proposed to amend Comprehensive Plan District Elements, Chapter 4, Transportation Element. While many of the new policies and proposed actions relate directly to other parts of Chapter 4, it is both helpful and appropriate to consider Connected and Autonomous Vehicles as whole, given their potentially enormous impact on mobility, congestion, employment, cost of travel, land use, allocation of public rights-of-way; safety, privacy, and city revenue. Scattering actions and policies throughout Chapter 4 as well as parts of other chapters related to housing, public realm, economic development, environment and sustainability, climate change, and equity/inclusiveness would detract from the urgency and the synergy of addressing this emerging and disruptive technology comprehensively. Across all the proposed policies, there is a consistent effort to reflect a priority for AVs that are fleet (rather than privately owned), electric (rather than internal combustion engine fueled), and shared by multiple passengers (rather than single occupancy). This combination is likely to produce the greatest benefits with the least risk.

With clear policy direction and coordination and consultation with other cities, use of autonomous vehicles in the District of Columbia could boost

the likelihood of achieving our Vision Zero, economic, housing, environmental, employment and equity goals, without many of the negative impacts that we would otherwise experience.

Connected and Autonomous Vehicles Policy

Policy T-5 Connected and Autonomous Vehicles Policy. Ensure that connected and autonomous vehicles advance District of Columbia's Comprehensive Plan multiple goals and policies, as well as those of moveDC, including Vision Zero; and the specific goals around climate pollution reduction and cleaner air, housing affordability, equity, physical activity, economic opportunity, great places, mode share, and reducing vehicle miles traveled.

Like Portland, Seattle, Boston and other cities, continue to refine and implement a *prioritization of modes* for people movement by making transportation system decisions according the following precedence:

1. Walking
2. Bicycling
3. Transit
4. Fleets of electric, fully automated, multiple passenger vehicles
5. Other shared vehicles
6. Taxi/commercial transit/shared vehicles
7. Low or no occupancy vehicles, fossil-fueled non-transit vehicles
8. Zero emission vehicles
9. Other single-occupant vehicles

Within that precedence, prioritize connected and autonomous vehicles that are (1) fleet/shared ownership; (2) electric; (3) fully automated; and, (4) for passenger vehicles, shared by multiple passengers. Develop and implement strategies as described in the following policies and actions:

Policy T-5.1 Develop the District's Approach to Connected and Autonomous Vehicles Collaboratively. Because the timing, market actors, state of federal, state and local regulation, pace and scale of adoption and impacts are all uncertain and influenced by so many factors, policies, approaches and pilot projects should be developed through broad District-based, national and international partnerships and collaborations.

Action T-5.1 A Form a working group of District agencies, including representatives from the Offices of the Deputy Mayor for Planning and Economic Development; the City Administrator; the Office of Planning; the District Department of Transportation; the Department of Energy and

Environment; Department of Employment Services; and other agencies as appropriate to further flesh out and develop the District's AV policies, with a focus on data, protocols, land use strategies, and the other policies outlined in Policy T-5, working with the Autonomous Vehicle Task Force described below.

Action T-5.1 B. Create an Autonomous Vehicle Task Force, co-led by the DC Surface Transportation (DCST), that draws representation from the private sector, DDOT and other DC government agencies, WMATA, MWCOG, NCPC, GSA, DOT, BIDs, members of the development community, neighborhood organizations, technologists, and transportation providers to inform stakeholders, and develop a broad AV Strategy for the District, with a focus on funding infrastructure, replacing parking revenue, models for new right-of-way configuration, and proposals for AV pilots.

Action T-5.1 C. Form or join alliances with leading local governments, thoughtful state agencies, and international leaders on AV policy and technology implementation to lead and keep up with those other organizations laying the groundwork for the best possible AV outcomes for cities.

Action T-5.1 D. Partnerships: Wherever possible, collaborate with federal, state, regional, local, and private sector partners, with the transparency and advocacy for the public interest and citizens of the District. Utilize existing forums or create new ones to share what is being learned from our efforts and those of others so that our collective learning can accelerate. Participate in state-level convenings on regulatory approaches to connected and autonomous vehicles, automated safety technology; and advocate for approaches that explicitly recognize city oversight of autonomous vehicles on city streets;

Policy T-5.2. Information: Ensure that when connected and autonomous vehicles use District rights-of-way or when vehicles connect with smart infrastructure within the District they share information including vehicle type, occupancy, speed, travel routes, and travel times, with appropriate privacy controls.

Action T-5.2 A. Work with other cities to develop common standards for data gathering and sharing. Eliminate barriers to the flow of data between AV operator(s) and public sector. Establish data protocols for the public good, including disaggregated data by race, income, other demographics to ensure access and fairness.

Action T-5.2.B. Maintain District authority to identify and develop appropriate data sharing requirements to inform and support safe, effective, and equitable management of the transportation system.

***Policy T-5.3. Learning, Assessing and Adapting*:** Given the uncertainty around the specific timing and speed of adoption of connected and autonomous vehicle technology, develop regulatory, investment, land use, and zoning approaches to adapt to the technology in 5-year increments, with metrics to use as milestones to trigger implementation of the next increment. Regularly publish data and reports that help make the changes and opportunities visible across the city.

Action T-5.3.A. Analyze the potential impacts of connected and autonomous vehicles on traffic and travel modeling, development patterns, parking demand analysis and projects, right-of-way needs and allocation, alternatives, real estate and development demand, and parking and vehicle capacity evaluation, management, funding, and other evolving issues; develop the needed metrics and milestones to both assure ultimate success but also those early indicators of adverse impacts to mitigate or benefits that might be able to be amplified in subsequent phases.

Action T-5-3.B**.** Develop policies, incentives, regulations and/or Identify, prevent, identify, and mitigate potential adverse impacts and lock in benefits from connected and autonomous vehicles. Use a full range of tools to ensure that connected and autonomous vehicles contribute to achieving Comprehensive Plan principles and moveDC goals.

Action T-5-3.C. Use the opportunity of AVs to achieve a universal integrated mobility platform with access for all, connecting transit, bikeshare, e-hailing, and other mobility options.

***Policy T-5.4. Equity**:* Make benefits of autonomous mobility available on an equitable basis to all geographies of DC and all segments of the community;

Action T-5-4.A. Develop policies, data collection protocols, regular reports and public access to data (consistent with ensuring individual privacy) focused on ensuring AV and other mobility access to the full range of possible users, including low-income, elderly, disabled, and technology-limited riders.

Policy T-5.5. Climate: Cut vehicle carbon pollution.

Action T-5-5.A. Develop additional policies to incentivize or otherwise encourage electric or other energy-efficient vehicles.

Action T-5-5.B. Develop policies to reduce or eliminate "dead-heading" traveled by passenger vehicles with no passengers.

Action T-5-5.C. Develop policies, including vehicle registration, street access or other pricing policies to encourage multiple passengers per vehicle.

Policy T-5.6. Safety: Ensure that all levels of self-driving vehicles operate safely for all users, especially in the presence of vulnerable road users;

Action T-5-6.A. Support federal requirements that all new passenger vehicles are equipped with dedicated short-range communications (DSRC) radios, which include a number of traffic safety technologies that are consistent with the moveDC Vision Zero goals.

Policy T-5.7. Reliability and Efficiency: Ensure that connected and autonomous vehicles improve travel time reliability and system efficiency.

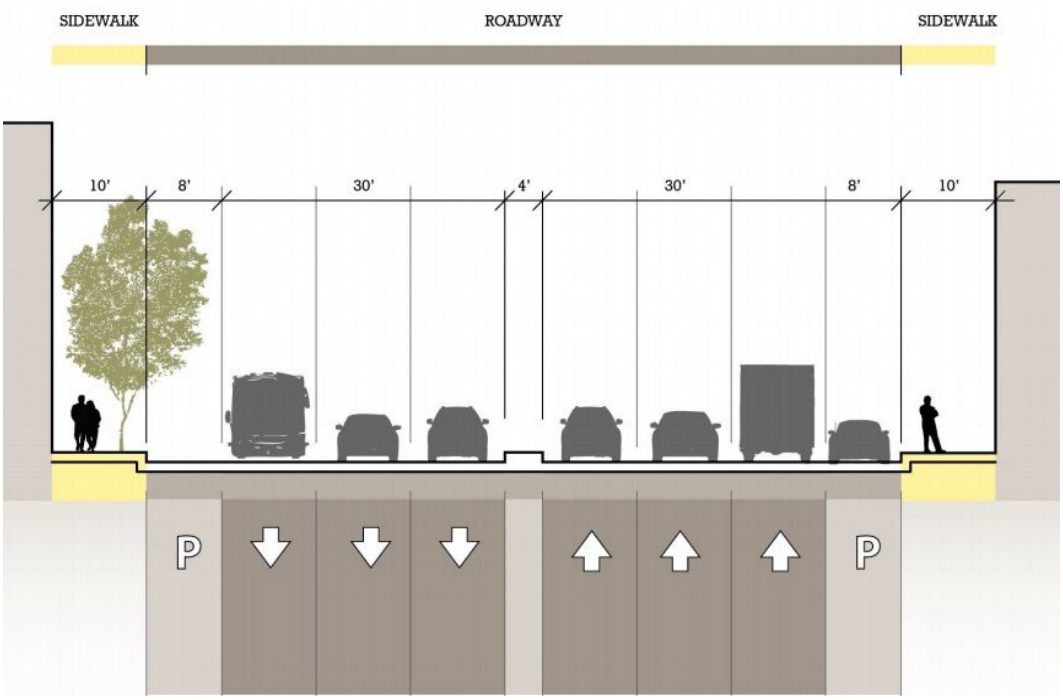
Action T-5-7.A. Reduce the number of vehicle trips during peak congestion periods, with a focus on reducing low occupancy vehicle trips, especially during peak congestion periods; explore policies that include users paying for use of, and impact on, the District's transportation system including factors such as congestion level, vehicle miles traveled, vehicle occupancy, and vehicle energy efficiency;

Action T-5-7.B. Evaluate investments in roadside connectivity and Internet systems to ensure resilient and redundant connectivity for connected and autonomous vehicles. Develop a criteria-driven automated vehicle roadside infrastructure investment plan.

Policy T-5.8. Design and Manage: Design and manage the mobility zone, curb zone, and traffic control devices, e.g. to control excessive speed to increase safety, evaluate future demand for pick-up and drop-off zones, and to prioritize autonomous electric vehicles carrying more passengers in congested times and locations; identify a wide range of opportunities and designs for re-using the current allocation of public rights-of-way, including new non-transportation uses; ensure that autonomous vehicles and vehicles that connect to smart District infrastructure help pay for

infrastructure and service investments, and support system reliability and efficiency

Action T-5-8.A. In coordination with the District Department of Transportation, study and create a schedule of phased implementation of a new hierarchy of streets and new street typologies. These new models may have more mixed travel/use zones and identify re-purposed rights-of-way for new housing, stormwater management, bike, ped or transitways, while also ensuring access, convenient mobility, pick-up and drop-off laybys for e-hailed vehicles, and adjusted street widths appropriate to connected and autonomous vehicles.



A reimagining of 19th Street in San Francisco; with fewer cars on the road due to the efficiency of autonomous driving, more space is left

Image courtesy of Curbed, and Gerry Tierney, Perkins + Will [18]

[18] **How Driverless Cars Can Reshape Our Cities:** A potential shift to a society of riders could reclaim roadways for green space and help reshape the public realm; Sisson, Patrick; blog post on Curbed, Feb 25, 2016

Action T-5-8.B. Broaden and increase District efforts to price parking for availability. Expand the elimination of parking minimums. Establish maximums for parking.

Action T-5-8.C. Develop policies to encourage the shared use of parking. Promote and encourage the adaptive reuse of parking structures, or spaces in structured parking facilities where demand for parking is diminished.

Action T-5-8.D. Consider implications of designating public streets as public utilities to manage use, access and fee structure. Evaluate options for tiered and dynamic pricing that reflects vehicle impacts on public streets and the transportation system, including factors such as vehicle occupancy, energy efficiency, carbon emissions, congestion level, and vehicle miles traveled.

Action T-5-8.E. Develop sustainable funding mechanisms to support connected and autonomous vehicle infrastructure and service investments, transportation system maintenance, and efficient system management, considering the potential revenue implications of changes in parking practice, fleet size/parking demand, and incidents of traffic and parking violation.

Action T-5-8.F. Look for opportunities to conduct and carefully evaluate limited pilot projects. Initially prioritize autonomous bus or other high occupancy, multi-passenger autonomous vehicles. Consider options for using mixed HOV/transit lanes that include shared AVs. One or more pilots should be co-developed to test new employment options. Support testing connected and autonomous vehicles in limited initial applications to explore the best methods of advancing adopted goals, policies, and objectives.

Action T-5-8.G. Re-use of Publicly owned Rights-of-Way. Develop policies, metrics/milestones to begin to phase in and gradually repurpose excess capacity (e.g., former on-street parking, surplus travel lanes) consistent with the new Street Hierarchy of Policy T-5-8 and Action T-5-8.A. for new uses, including stormwater management, transit ways, bikeways, pedestrian facilities, housing, parks, and other facilities.

Policy T-5.9 Re-employment Analysis and Pilots. Examine the types of jobs held by District residents or currently offered by District employers and their vulnerability to AV adoption. Consider jobs that might be created by

AVs compared to jobs that might be lost and run pilot efforts to explore new employment options.

Action T-5-9.A. Analyze the overall impacts of job losses to DC and consider the fungibility with jobs emerging in the growth sectors of the economy.

Action T-5-9.B. Work with government and private sector employer partners to do job training and placement for those losing work in the transition to AV technology and adoption.

Action T-5-9.C. Create new pilot projects around new and emerging jobs. Pilots might include: Green infrastructure installation and maintenance; the retrofit of existing buildings for energy efficiency, renewables and disaster resilience (eventually scaling up to 5% of the existing building stock per year); and expansion of "clean and safe" teams from the commercial areas of the city to every Business Improvement District (BID)-adjacent residential neighborhood with BIDs as partners in job training, supervision and management.

Definitions:

Autonomous Vehicle - The U.S. Department of Transportation recommends defining autonomous vehicle technology levels using the SAE J3016 standard:

- Level 0 – No Automation: The full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems.
- Level 1 – Driver Assistance: The driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task.
- Level 2 – Partial Automation: The driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving

environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task.

- Level 3 – Conditional Automation: The driving mode-specific performance by an Automated Driving System of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene.
- Level 4 – High Automation: The driving mode-specific performance by an Automated Driving System of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene.
- Level 5 – Full Automation: The full-time performance by an Automated Driving System of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver.

Connected Vehicle -A vehicle that communicates with the Internet, other vehicles, wayside systems and/or passengers.