CAUSE NO. D-1-GN-20-005550

THE ANTI-DEFAMATION LEAGUE AUSTIN, SOUTHWEST, AND TEXOMA REGIONS; COMMON CAUSE TEXAS; and ROBERT KNETSCH; *Plaintiffs*,	§	**IN THE DISTRICT COURT**
	§	**TRAVIS COUNTY TEXAS**
v.	§	**353rd JUDICIAL DISTRICT**
GREG ABBOTT, in his official capacity as the Governor of Texas, *Defendant*.	§	

DECLARATION OF DR. DANIEL G. CHATMAN

I, Dr. Daniel G. Chatman, respectfully declare as follows:

1. I am an Associate Professor of City and Regional Planning at the University of California, Berkeley. I have taught undergraduate and graduate courses in urban and regional transportation planning, transportation and land use planning, and research methods.
2. I received a B.A. degree from the University of California, Berkeley in 1991, a Master's degree in Public Policy from the Kennedy School of Government at Harvard University in 1997, and a Ph.D. in Urban Planning from the University of California, Los Angeles in 2005. From 2005 to 2009 I was Assistant Professor in the Bloustein School of Planning and Public Policy at Rutgers University, where I also served as Director and Research Director of the Alan M. Voorhees Transportation Center. I was appointed as Assistant Professor at U.C. Berkeley in 2008, and was promoted to Associate Professor with tenure in 2014.

3. I conduct research on travel behavior and the built environment, immigrants and travel in the United States, the relationships between public transportation services and the economy, and other topics related to transportation and land use planning. I have published more than 50 peer-reviewed journal articles, book chapters, research reports, and lay articles, and have given more than 100 invited or refereed talks on these topics. I have been principal investigator on transportation and land use research grants and contracts totaling more than $3.3 million in funding.
4. In 2014, I provided a report and testified as an expert in a voting case in Texas. My analysis and testimony concerned the racial/ethnic and income distribution of transportation burdens associated with newly imposed photo identification requirements for voter eligibility in Texas (United States District Court, Southern District of Texas, Corpus Christi Division, MARC VEASEY, et al., Plaintiffs, v. RICK PERRY, et al., Defendants. Civil Action No. 2:13-cv-193 (NGR)). In September 2020, I provided a report and testified in a voting case in Ohio concerning travel burdens and queuing delays associated with a State of Ohio rule that ballot drop boxes may only be provided at the county board of elections in each county (United States District Court, Northern District of Ohio (Cleveland), A. PHILIP RANDOLPH INSTITUTE OF OHIO et al, Plaintiffs, v. FRANK LAROSE, Secretary of State of Ohio, Defendant. CASE NO. 1:20-cv-01908-DAP).

Questions Addressed

5. I was retained to analyze both the travel burdens and the queuing delays associated with the recent decision by the Governor of the State of Texas that ballot drop boxes may be provided in only one location in each county in the state; and to assess the impact across the major racial/ethnic groups in the state.

Summary of Results: Travel Burdens for Voters to Access a Ballot Drop Box

6. In the first analysis, I investigated the travel burden that would be incurred by citizens of voting age who are eligible to vote via absentee ballot because they are over the age of 65 or disabled, and who wish to drop off their absentee ballots rather than mailing them. I focus on the time required to access a ballot drop box by car, via public transportation, or on foot, and to return home, as time is the most salient and readily quantifiable of the various costs involved in travel. The main output of this first analysis is an estimate of travel time burdens across the population of all citizens of voting age who are eligible to vote via absentee ballot due to age or disability, with a focus on the impact on the largest counties in the state.
7. I find that the Texas prohibition on providing more than one ballot box location per county, rather than permitting multiple drop boxes or allowing absentee ballots to be dropped off at in-person polling locations, will place a substantial travel burden on absentee-eligible citizens of voting age without access to a vehicle who find it necessary to drop off their absentee ballots rather than mail them, particularly when looking at those who lack access to a personal vehicle in their household. I define a "travel burden" in two ways in the declaration, focusing in this introduction on the more restrictive of my two definitions: namely, having to travel more than an hour and a half round trip, which would more than double the average amount of daily household travel for a Texas resident. The share who would have to travel for more than 90 minutes is very low for absentee-eligible citizens of voting age (AECVAs) who live in a household with access to a personal vehicle, but very high for those without access to a car, who make up about 7.5 percent of AECVAs in the state. About 89 percent of absentee-eligible citizens of voting age without access to a car would have to spend more than 90 minutes to deliver their ballot to a county drop box and return home. The *average*

round trip duration for these burdened individuals is more than 6 hours, due to a significant number of those who would be required to travel for long distances on foot; such distances are impossible for most if not all of the elderly and disabled people eligible for an absentee ballot in Texas.

8. The burden is not evenly distributed across the state. The 10 most populous counties in the state account for more than half of all burdened individuals. Several counties have a 90-minute travel burden share that is 30 to 60 percent more than the rest of the counties in the state, while in Harris County, the largest county by population, the share of households with a travel burden exceeding 90 minutes is twice as high as the state average across counties, at about 13 percent of all absentee-eligible citizens of voting age. The share of those with a travel burden of more than 70 minutes is 38 percent in Harris County, about four times as high as the average across counties in the state.
9. This burden is disproportionately borne by African Americans in comparison to Whites, and to a lesser extent by Hispanics, particularly using the more onerous 90-minute travel burden measure. This is largely because of the lower auto ownership and access of eligible African American voters, in addition to their concentration in the more populous counties in the state.
10. The presence of households with a travel burden is also highly correlated with poverty status. Having a round trip of more than 90 minutes to access a ballot drop box is almost entirely associated with individuals not having access to a car. One of the best predictors of whether a person owns a car is their income, and the median income of households without cars in Texas is about half that of households who have a car.
11. My detailed travel burden analysis is set forth below at pp. 7-27 after a summary of the results of the queuing burden analysis. Results of the analysis are presented at pp. 21-27.

Summary of Results: Queueing Burdens to Access a Ballot Drop Box on Election Day

12. In the second analysis, I estimated how the restriction permitting only one location for drop boxes per county is likely to lead, in counties with larger populations, to long queues of vehicles and pedestrians waiting to drop off their ballots. In the general election in November there would appear to be the potential for several million absentee-eligible registered voters desiring to access a drop box, given widespread concerns about unreliability and delays associated with mail delivery of absentee ballots.

13. I carried out a queuing analysis to determine the length and waiting times likely to be associated with ballot drop box locations. Under conservative assumptions detailed below, it is likely that, varying by county, between 1.5 and 6 percent of registered voters could attempt to deliver their absentee ballots to a county drop box location on the day of the election. Based on experiences elsewhere, demand for ballot drop box use will be highest on Election Day.

14. Under one set of baseline assumptions that are relatively conservative, I calculate that with only one drop box location per county, queues would be intolerably long in dozens of the most populous counties, and many voters there would be forced to forgo depositing their ballots. The lines would be particularly burdensome in the top ten counties by population in the state (including Harris, Dallas, Travis, and Fort Bend Counties), with between 10,000 and 64,000 voters in each of those counties waiting for 15 hours or more to drop off their ballots, unless (more likely) they are dissuaded from voting altogether. When using less conservative but still reasonable assumptions based on experiences elsewhere, the projected queues are even longer, affecting more than 625,000 voters in the most populous counties in the state, with many of those likely to be dissuaded from casting their ballots, and with queues so long that they imply huge traffic snarls in the counties affected.

15. My detailed queueing analysis is set forth below, after the detailed description of the travel burden analysis, at pp. 28-39. The detailed statement of my queuing results at pp. 33-39 is preceded by a discussion of my methodology.

Overview of Work

16. I defined and carried out the first analysis of travel burden in four parts. First, I identified a simplified set of home starting points for trips that would be undertaken by those who seek to drop off their absentee ballots at a ballot drop box, consisting of the "centroids," or central geographical coordinates, of the 15,811 Census-defined block groups in the state of Texas. I also identified and mapped the individual locations within each county where ballot drop boxes are located. Second, using both geographical information system software and Google Maps, I estimated the time it would take to travel from home to the designated county ballot drop box, and back, by each of three travel modes: personal automobile, public transportation, and on foot. Third, I compiled and estimated information about the absentee-eligible citizens of voting age (AECVAs) by race/ethnicity located in the 15,811 block groups throughout the state, with a focus on those living in households without access to an auto. Fourth, I estimated the round-trip travel times to drop off a ballot for AECVAs depending on their race/ethnicity and access to a personal vehicle in their household.
17. I carried out the second analysis of queue lengths and delays as follows. First, I estimated the share of registered voters in each county who are likely to attempt to deliver absentee ballots to a county drop box on the day of the election. Second, I applied queuing analysis methods along with a set of parameters regarding the capacity of each box, the share of drop-offs occurring during daily peak travel periods and off-peak, and the operating hours over which voters are likely to drop off ballots on Election Day, to estimate hour-by-hour queue lengths

and time delays waiting in the queue. Third, I estimated the number of voters likely to be dissuaded from voting by using queue length at the end of the day as an approximation.

18. I was assisted in geocoding, mapping, data procurement, data management, and data analysis by five doctoral candidates and four undergraduate research assistants. I also paid Google for the use of their cloud services to procure one set of travel time estimates, in addition to calculating my own set of travel time estimates using Open Trip Planner, an open-source geographical information system software program.

Travel Burden Analysis: Methodology and Results

A. Background

19. As noted above, for purposes of this investigation, I define "travel burden" in terms of time. This is based on a comparison with both national travel survey data and survey data from the State of Texas.

20. The cumulative time that individuals spend traveling every day varies a great deal by household (National Household Travel Survey, 2017). In the State of Texas, among those of income greater than $25,000, the average daily time spent traveling for all trips made for personal and household purposes is 66.4 minutes; for those making less than $25,000, the average is 72.5 minutes per day. These figures are slightly lower than the US averages for the same groups (see Table 1 below). A starting point for any definition of "travel burden" is the current amount of time that an individual already spends traveling each day, because this pattern typically reflects constraints that make it difficult to travel more without having financial impacts or causing time scarcity (Farber and Páez, 2011).

Table 1: Average minutes spent traveling per day, by income

	All persons	
	<$25,000	>$25,000
Texas	72.5	66.4
U.S. Total	75.2	69.1

Source: National Household Transportation Survey, 2017

21. The average duration for a home-based trip for a non-work purpose (excluding trips taken by air or intercity bus)—that is, the time needed for the average trip from home to reach an activity such as grocery shopping, seeing the doctor, or dropping one's child off at school—was 20.3 minutes in the US and 20.6 minutes in Texas in 2017. The duration of an average round trip is higher on both public transportation and walking than in a car, reflecting slower travel speeds than for auto. Across all trip purposes, the average duration of a trip taken via public transportation or on foot was 52.8 and 22.4 minutes respectively in the US, and 63.9 and 22.8 minutes in the State of Texas (Nationwide Household Transportation Survey, 2017). Regardless of trip purpose, almost all trips in both the US and in the State of Texas are taken by personal vehicle, due to the relatively slow speeds and incomplete spatial coverage afforded by public transportation in most parts of the US and of Texas, as well as the long distances between activity locations, and often hazardous or strenuous walking conditions, that often make walking impractical. Just 1.2 percent of all trips in Texas are taken on public transportation, while 6.5 percent of all trips are taken on foot.
22. While some individuals may have time to spare for any of a number of activities, most individuals must make tradeoffs when there is any new demand on time. An increase in the amount of time required to travel can cut into discretionary time for activities like

entertainment, socializing, and shopping, and then into non-discretionary time for activities like work, meals, child care, and buying groceries (Farber and Páez, 2011).

23. There are a number of burdens associated with traveling to a ballot drop box, the largest and most quantifiable of which may be time. The primary burden arises for those who do not have access to a vehicle, as those who do can either drive to the location or get a ride from someone in their household, and the physical effort involved is minimal. For those who do not have access to a vehicle, however, in order to drop off a ballot, they must rely on either a ride from someone else not living in the household, or an alternative travel mode such as public transportation or walking. Since there are only 254 ballot drop box locations in Texas, a state of about 29 million people, and since public transit services are slower and not ubiquitously available throughout the state, travel distances and durations can be quite large. The burden is highest for those without familiarity with public transportation routes, with physical difficulties in walking, and so on.
24. While acknowledging the existence of a subjective aspect of travel burden that goes beyond travel *time*, the primary focus of this analysis is to investigate the number and share of absentee-eligible citizens of voting age ("AECVAs") who would need to undertake trips of long duration in order to drop off their absentee ballots. Calculating the travel burden based on the amount of time required to access a ballot drop box does not account for the relative inconvenience and physical discomfort associated with the walking, waiting, and in-vehicle times associated with long public transportation rides; or the physical effort involved with walking all or some of the distance to the location, along routes that may be largely inhospitable to pedestrians. This method also does not reflect how such trips can be

particularly difficult or nearly impossible for elderly people and people with physical limitations, who are the primary users of absentee ballots and ballot drop boxes in Texas.

25. There is some scientific literature that has translated these qualitative facts about accessing and egressing public transportation on foot into estimates of the valuation of time associated with waiting, walking, and riding on vehicles in transit, by analyzing survey data for the purpose of predicting choices between travel modes. Based on a set of 192 studies of walk time values and 77 of waiting time values, the time that people spend waiting for public transportation or walking to and from public transportation stops is about 1.6 times as burdensome as time spent traveling in a personal vehicle (Abrantes and Wardman, 2011, Table 21). In turn, time spent riding the bus or rail is somewhat more burdensome than time spent in a personal vehicle. One quantitative figure averaging a smaller set of studies puts the value at 1.2 for the disutility of time spent on a bus compared to time spent in a car (Abrantes and Wardman, 2011, Table 19).
26. In addition, people of lower income can be expected to have more difficulty than people of higher income in managing to find additional time to drop off their ballots. Those of lower income usually do not have the option of purchasing services to reduce time requirements in other areas, such as paying for child care, laundry service, home cleaning services, meals out, or prepared food. Travel becomes particularly burdensome when it requires difficult choices such as whether to work fewer hours in the week (and thus to pay in dollar terms, not just in time terms); to require children to stay up later than normal in order to accommodate the lengthened schedule for that day; or to forgo a trip to the doctor that week. Because these kinds of burdens are more likely to be borne by those of lower income, but cannot be

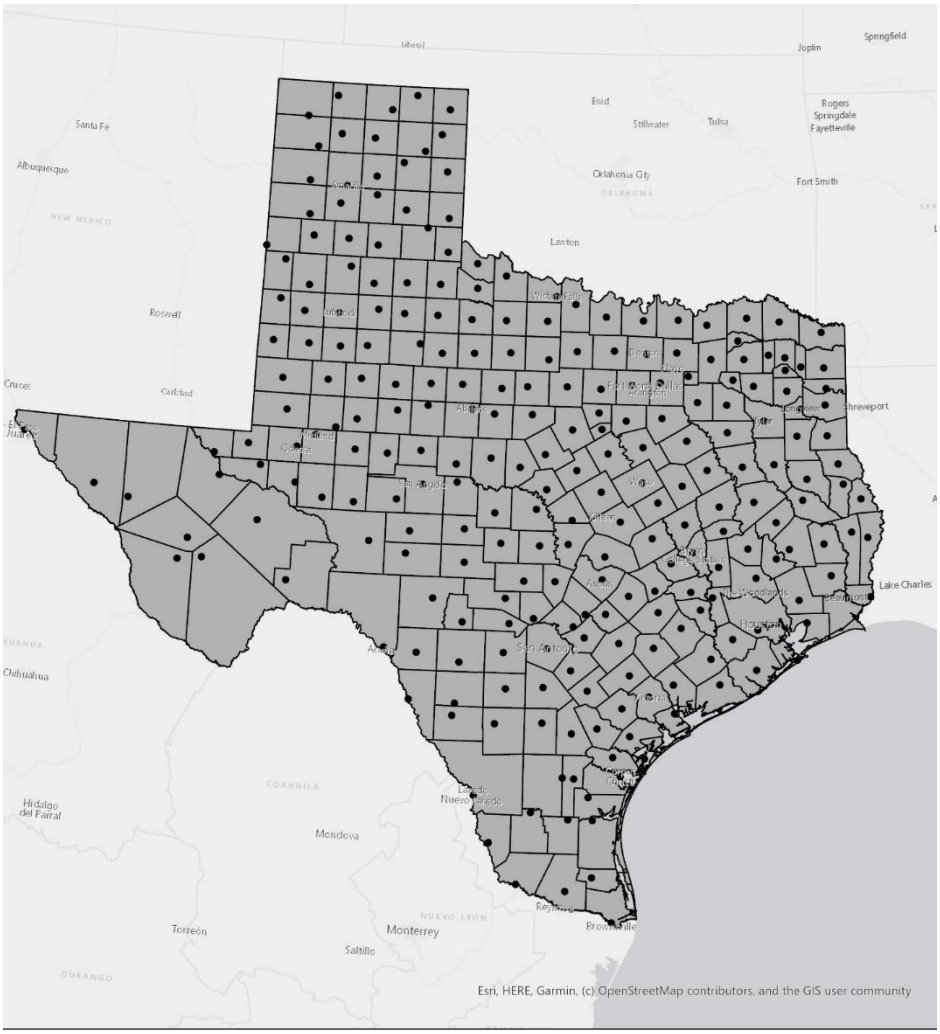
otherwise measured directly with available data, I also investigated whether the travel time burden is associated with poverty status in the State of Texas, as discussed later in the report.

27. For the purpose of this analysis I define a travel burden in two ways: as a round trip that exceeds 90 minutes, or as a round trip that exceeds 70 minutes. The first definition essentially focuses on trips on foot or via public transit, which are more onerous than trips undertaken in a private vehicle, because very few trips to access a ballot drop box in Texas would require a driving trip exceeding 90 minutes. Just 1.0 percent of trips in Texas exceeded 45 minutes one way (90 minutes round trip) on public transportation or on foot, according to the most recent data for Texas from the National Household Travel Survey (2017). The fact that such long trips on foot or via public transportation are so rare suggests that people avoid them whenever possible.

B. Methodology: Travel Starting and Ending Points; Calculation of Travel Times

28. I obtained online listings of the 254 county locations where ballot drop boxes are or will be located, and geocoded these using Google Maps. Figure 1 (below) displays the geocoded ballot drop box locations on a county map of Texas.

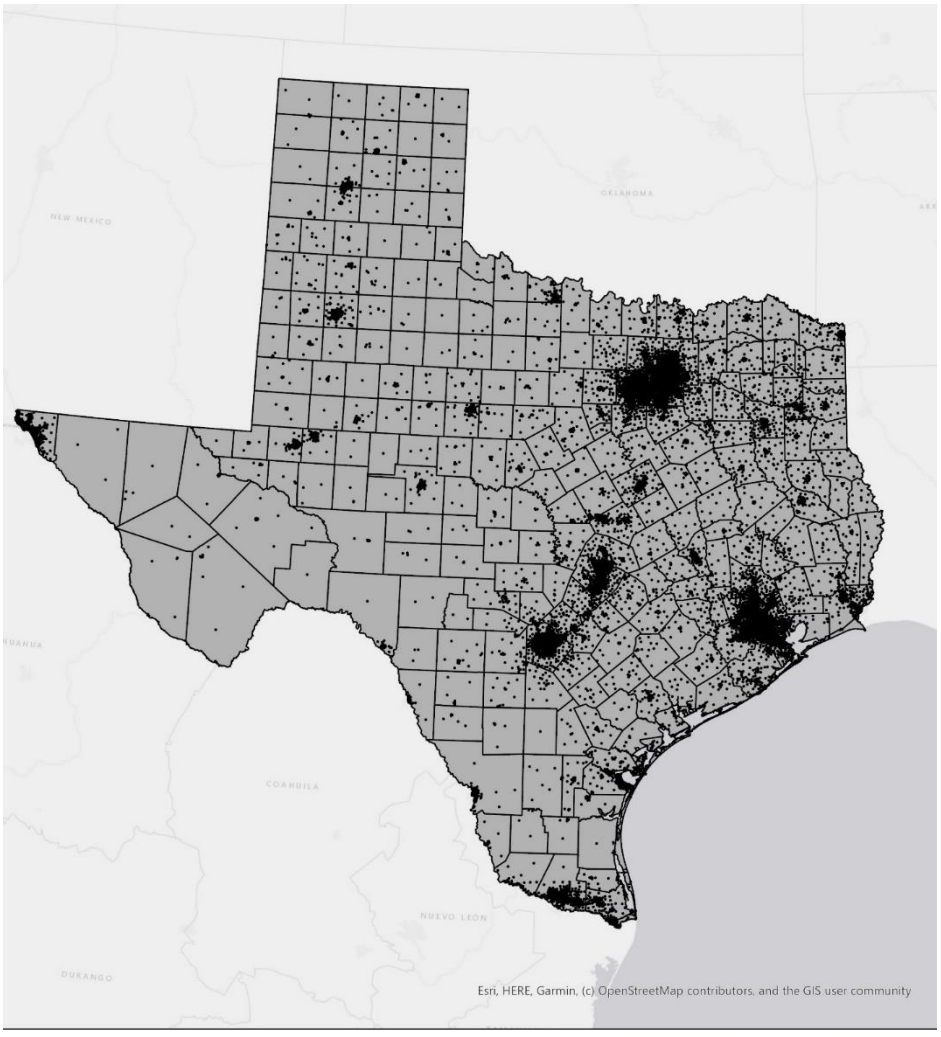
Figure 1: Geocoded ballot drop box locations in the state of Texas



29. There were about 11.3 million occupied housing units in the State of Texas as of 2018 (U.S. Census Bureau, 2020), and therefore I used a set of simplified home locations to estimate the travel times for those eligible voters who may seek to deliver their ballots to a county drop box, consisting of Census block groups, which typically include between 200 and 1,000 housing units. I defined the location for all households in the block group as consisting of the centroid of the block group (the spatial center of gravity of the block group polygon). Figure 2 (below) displays the centroids, and county boundaries are also shown. (Block group boundaries are not shown.)

30. Figure 2 also illustrates the fact that any meaningful spatial error in identifying the locations of specific housing units is likely of most concern in locations in the outlying and less dense parts of the state. In these locations it is more likely that travel time estimates are inaccurate because the block group centroid may be located farther from the average household than in block groups in the most densely populated parts of the state. However, by the same token, this error exists only with regard to a small fraction of the Texas population.

Figure 2: Block group centroids (estimated home locations) for Texas



31. For each block group centroid I estimated the travel time to the ballot drop box location within that county. There are many possibilities to obtain data to estimate travel times, but the best estimates are based on distances along the road network, travel times on public transportation, and distances along the pedestrian network. I used network and schedule-based estimates rather than more commonly calculated "zone to zone" estimates of travel time, which rely on aggregated information about trip destinations and are therefore less accurate.

Public Transportation Times

32. There are eight large public transportation agencies (with at least 2 million one-way trips per year as of 2020) in the state of Texas, serving the metropolitan areas of Austin, Corpus Christi, Dallas-Fort Worth, El Paso, Houston, Laredo, Lubbock, and San Antonio. Of these, three metropolitan regions offer rail systems. Commuter rail systems include the Capital MetroRail (Austin metropolitan area) and Trinity Railway Express (Fort Worth & Dallas commuter rail). Light rail systems in Texas include the Dallas Area Rapid Transit (DART), and Houston's METROrail, other rail includes El Paso's Streetcar line. Outside of the state's major metropolitan areas, there are 31 urbanized transportation agencies, 36 rural transportation agencies, and 58 disabled accessible / enhanced mobility of seniors agencies, according to the Texas Department of Transportation Texas 2019 Transit Statistics Report. Roughly 90 percent of all unlinked passenger trips on public transit in Texas are handled by the metropolitan agencies, which generate 76 percent of all vehicle revenue miles and 91 percent of all transit operating expenses in Texas.

33. Even in counties with some form of public transportation not every individual can use public transportation to access a county ballot drop box location. To provide more granular public

transportation information I have calculated public transportation travel times across the state from the household location to the county designated ballot drop box location.

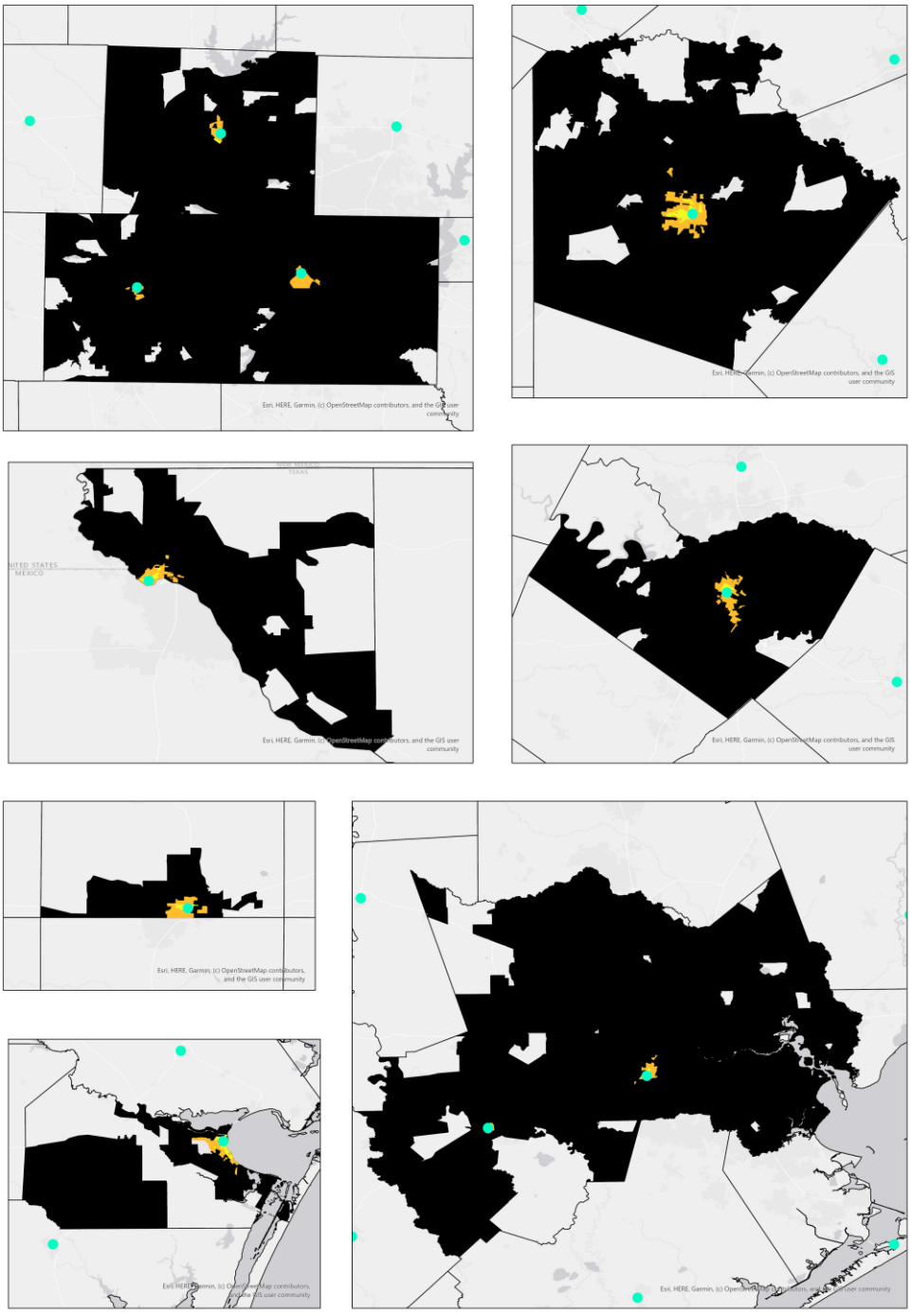
34. I used both Google Maps and Open Trip Planner (OTP) along with Open Street Map software and General Transit Feed Specification (GTFS) data to estimate public transportation times from block group centroids to ballot drop box locations. Having two independent sources for travel times acts as a check to ensure the accuracy of the results, and in some cases a public transportation estimate was available using one method but not the other. The estimates rely on spatially specific information about the routes of public transportation vehicles, location of stops, and schedules in GTFS data. These make it possible to estimate public transportation travel times that take into account actual service frequency, scheduled public transportation times, and waiting times between transit vehicles. The OTP software includes estimation of walking routes to and from public transportation stops and between public transportation lines when transfers are necessary. In the end I relied primarily on OTP estimates for the large urban centers, supplemented by Google Maps estimates for the remainder of the state for which I could not quickly procure GTFS data and Open Street Map data and for which Google Maps had access to GTFS data that it had collected.

35. For every trip on public transportation, travel time includes walking to the nearest bus or rail stop from home, waiting for a bus or train, and walking from the closest available stop to the ballot drop box. These public transportation travel time estimates assume the best-case scenario of highest schedule availability and no travel delay. Specifically, it is assumed that everyone can make their trip to the ballot drop box on Tuesday morning (a weekday morning, typically the highest frequency public transportation schedule) despite the fact that

many people will find it difficult to travel at that time of day due to obligations like work. Those who travel on public transportation to a drop box during the middle of the day, at the end of the work day, or on a weekend, could encounter a much less frequent schedule than what is assumed here, and would almost never encounter a more frequent schedule.

36. For the 10,571 block groups for which public transportation travel was possible, the median total time to travel from home to the nearest ballot drop box, including walking time, was 200 minutes (3 hours and 20 minutes), round trip. There was substantial variance. For example, ten percent of block groups had a one-way trip of almost four hours to arrive at a ballot drop box, or about eight hours round trip.
37. Figure 3 (below) shows the spatial extent of transit access in some of the largest cities in Texas. The black areas are farther than 45 minutes one-way on public transit. It is notable that a relatively small fraction of the urban areas can reach the single drop box location in these locations.

Figure 3: Transit access maps for selected counties in Texas



Travel Times by Auto

38. To estimate the driving time between Census block group centroids and ballot drop boxes, I used an automated batch interface for Google Maps using a cloud services account, which provided a time estimate for a standard, time-efficient route that accounted for any habitual travel delays caused by road congestion and traffic signals. I calculated the driving time from the geographic center of each Census block group to the county ballot drop box location and the return trip as well, under the assumption that the beginning of the trip was at 9 am on a Tuesday. The average road distances from block group centroids to ballot drop boxes ranged from less than a tenth of a mile to 80 miles, with a median one-way distance of 12.4 miles. The round-trip times ranged from less than a minute to as long as four hours, with a median round trip value of 36 minutes when averaged over block groups. More than 95 percent of block group centroids had round trip travel times via auto of less than 70 minutes.

Travel Times on Foot

39. I calculated walking distances and durations using both Google Maps and Open Trip Planner GIS software to identify the shortest route within each county to each county ballot drop box from the geographic center of each Census block group using the road network. Walking distances to the county ballot drop box location were very similar to the road distances (above). Walk times were estimated based on the assumption that travelers walk at 1.9 miles per hour based on a study of walk speeds for older and disabled adults (FHWA, 2006). The walk time figures were estimated using both Google Maps and Open Trip Planner. This resulted in estimated walk times as long as 25 hours and as short as 12 minutes.

C. Methodology: Spatial Distribution of AECVAs by Race/Ethnicity & Auto Ownership

40. The location of ballot drop boxes is relevant to people of voting age who are eligible for absentee ballots due to citizenship status, along with their age and/or disability, and who are registered to vote. There currently are no secondary data available to me to determine the locations of individuals—and therefore the travel times of those individuals—who are also registered to vote and eligible for absentee ballots. Therefore, for the analysis presented here, I focus on estimating the locations and characteristics of citizens of voting age over the age of 65 and/or with disabilities, by race/ethnicity and access to a personal vehicle in their household.

41. Calculating the travel burden associated with dropping off a ballot requires, first, knowing how many citizens of voting age there are in each Census block group. I obtained block group counts of the number of residents in each Census block group who were 18 to 64 years old and 65 years of age or older from the 2014-2018 American Community Survey (ACS). There are 15,811 block groups in the state. These are the most accurate data currently available for a base count of the population by age, even though changes to the population may have occurred in the last two years. Race/ethnicity data are also available at the block group level, and this analysis also relies on disaggregate data in the ACS Public Use Microdata Sample (PUMS) of 2014-2018.

42. The block group level data from the ACS tells us how many people of different ages by race/ethnicity there in each block group, but not whether they are citizens, have a disability, or have access to a personal vehicle in their household. To estimate citizenship and disability down to the Census block group level, I used the 2014-2018 ACS five-year estimates at the Census tract level to obtain the share of voting-age residents who were citizens and the share

of 18-to-64 year-olds with disabilities in each Census tract. There are 5,265 Census tracts in Texas, containing between one and eight block groups, with a median of three block groups. To estimate citizens of voting age in each block group by race/ethnicity, I first calculated the share of adults of voting age by race/ethnicity that are citizens in the five-year sample for each Census tract. I then multiplied this ratio by the number of people in each age category in each block group to estimate the CVAs in each age category in each block group (Chapa et al., 2011). I performed an additional calculation to estimate the share of CVAs who were aged 18 to 64 who also have a disability. I first calculated the share of 18-64 year-olds in the Census tract that reported one or more disabilities on the ACS survey, and then multiplied this ratio by the estimated number of citizens by race/ethnicity aged 18 to 64 in each Census block group to distinguish those AECVAs aged 18-64 with disabilities from those without a disability.

43. To estimate auto availability down to the block group level for citizens over the age of 65, and for citizens aged 18 to 64 with at least one disability, I used data from the American Community Survey Public Use Microdata Sample for Texas, which allows a precise estimate of auto ownership for detailed subgroup definitions, though for a larger spatial area in which those block groups fall. I calculated the share of vehicle access among these two population subsets living in the Public Use Microdata Areas in which the block groups are included. I used these percentage shares to multiply the block group level figures for citizens over the age of 65 and citizens aged 18 to 64 with disabilities to determine the share of each that do and do not have access to a personal vehicle in their household. I followed a similar procedure to estimate auto access for citizens by race/ethnicity in the 65-plus age group and for citizens by race/ethnicity who have a disability and are age 18 to 64.

44. The American Community Survey five-year block group, Census tract, and PUMA estimates are based on a one percent sample conducted every year. Because the ACS is conducted upon a sample of the population, rather than a complete count, its estimates are subject to sampling variability, but the five-year ACS data are the most precise and spatially specific available given that the Decennial Census data are a full decade old.

45. Because there is no generally accepted methodology for aggregating confidence intervals from the Census tract level to higher levels of geography (e.g., to the county or state levels), I report these estimates without confidence intervals. Statewide figures presented in this report are statistically significant at the 0.001 level or better.

D. Results: Travel Times by Race/Ethnicity & Auto Ownership for Counties and the State

46. To assign a round-trip travel time to any given citizen of voting age in any given Census block, I followed the following deterministic algorithm. First, individuals living in a household with an auto available will either drive or be driven by another household member to the county ballot drop box, unless taking public transportation or walking is faster, in which case the faster of those alternative modes will be assigned. Second, individuals living in a household without an automobile will take public transportation if it is faster than walking, and will otherwise walk to the county ballot drop box.

47. As it turns out, the fastest travel time between the home location (block group centroid) and the nearest county ballot drop box was always via driving. Of the 15,811 simplified home locations (block group centroids), in no case was public transportation or walking faster. In turn, walking was the best option in less than half of the block groups in which a vehicle was not available, most obviously in those counties where public transportation is not offered.

48. In order to evaluate the extent to which all Texas citizens seeking to drop off their absentee ballot will encounter a travel burden, I identified all of the absentee-eligible citizens of voting age in the state who I estimate would have to carry out a round trip of more than 90 minutes, or a round trip of more than 70 minutes. As noted above, having to carry out a round trip exceeding 70 minutes more than doubles the average amount of travel carried out per day by an individual in the state of Texas; and having to carry out a round trip of more than 90 minutes means not only a longer trip, but also that it is almost always done via public transportation or on foot, which are more onerous.

49. Of the estimated 4.4 million absentee-eligible citizens of voting age, I calculated that about 4.1 million have access to a vehicle owned by the household (a "car"), and about 321,000 do not (7.3 percent). Of the estimated 4.1 million AECVAs with a car available, only about two percent have a round trip to access a ballot drop box location of more than 90 minutes. But about 89 percent of the 321,000 AECVAs who do not have access to a vehicle in their household would be expected to experience a travel burden in accessing a ballot drop-off location if only one location is made available in each county. This is because transit and walk times are much longer on average than drive times. Approximately 2.4 percent of Texas voting-age citizens younger than 65 and without a disability lack access to a personal vehicle. AECVAs are much more likely to lack vehicle access. About 6.7 percent of citizens aged 65 or more lack a vehicle in the household (2.8 times as high as non-disabled citizens aged 18 to 64) while about 9 percent of those with a reported disability aged 18 to 64 lack vehicle access (3.75 times as high). Furthermore, a travel burden of 90 minutes or more to access a ballot drop box is even more likely to be the case for African American AECVAs, who lack vehicle access at more than twice the rate of White AECVAs.

50. In total this analysis finds that 7.7 percent of the state's population of AECVAs would experience a travel burden exceeding 90 minutes if they wish to deliver their ballots to a drop box, almost all of them lacking auto access and having to use public transportation or walk. The share of the population experiencing a travel burden is higher when using the 70-minute threshold definition. Under this definition, about 13.5 percent of AECVAs in the state would experience a travel burden to access a ballot drop box; more than half via public transportation or walking, and less than half via auto.
51. The majority of AECVAs with a travel burden to reach a ballot drop box lives in ten of the 254 counties in the state. Harris County has a particularly large share of AECVAs, and they have travel burdens at a much higher rate than other counties. Its share of those with an expected travel time exceeding 90 minutes is about 13 percent, or about twice as high as the Texas county average of 6.4 percent. And in Harris County, using the less restrictive travel burden definition, 38 percent of absentee-eligible households are expected to have travel time exceeding 70 minutes, a share almost four times as high as the Texas county average of 9.7 percent. Dallas and Travis Counties are also substantially higher than the average across state counties, as shown in Table 2.
52. Table 2 (below) shows, for the ten largest counties in the state, the estimated share of households with round-trip travel exceeding 90 minutes to access a county ballot drop box, as well as the same figure for travel exceeding 70 minutes.

Table 2: Travel burden in the top 10 counties by population

County	Total population	Share of AECVAs with travel time > 90 min.	As multiple of TX county average	Share of AECVAs with travel time > 70 min.	As multiple of TX county average
HARRIS	4,602,523	12.7%	2.0	37.7%	3.9
DALLAS	2,586,552	10.4%	1.6	11.4%	1.2
TARRANT	2,019,977	6.5%	1.0	6.9%	0.7
BEXAR	1,925,865	8.1%	1.3	9.2%	0.9
TRAVIS	1,203,166	8.7%	1.4	15.1%	1.6
COLLIN	944,350	4.1%	0.6	5.2%	0.5
HIDALGO	849,389	8.3%	1.3	10.6%	1.1
EL PASO	837,654	8.3%	1.3	9.7%	1.0
DENTON	807,047	3.7%	0.6	6.3%	0.6
FORT BEND	739,342	5.5%	0.9	11.1%	1.1

Source: Chatman analysis (using block group centroid travel time estimates and American Community Survey 2013-2018 PUMA, Census tract and block group population estimates)

53. I also conducted an analysis of the relative travel burden by race/ethnicity, focusing on Whites, African Americans, and Hispanics who are citizens and are also eligible for absentee ballots due to age or disability. As noted above, Hispanics and particularly African Americans are much less likely to have auto access in the household which makes it substantially more likely that they will experience a travel burden accessing a ballot drop box.

54. The block group level analysis across the state confirmed this likelihood. I found that among citizens eligible for absentee ballots, African Americans statewide are twice as likely as Whites to have a round trip to access a ballot drop box location exceeding 90 minutes, at 14.6 percent in comparison to 6.7 percent for whites, largely because eligible African American

voters are far more likely to live in a household without a car available. Absentee-eligible Hispanic citizens were somewhat more likely to experience a travel burden exceeding 90 minutes, with a rate of 8.3 percent across the state (24 percent higher than Whites). When looking at the 70-minute burden definition, the difference between African Americans and Whites was not as large, but still quite significant. About 20 percent of African Americans eligible for absentee ballots would have to travel more than 70 minutes to access a ballot drop box, which is 58 percent higher than the rate of 12.6 percent for Whites. The share of absentee-eligible Hispanic and White citizens who would have to travel more than 70 minutes round trip to access a county ballot drop box was about the same statewide.

55. The pattern of disparity in burden by race/ethnicity holds within counties in addition to across the state. Here I focus on the 90-minute definition of travel burden, since it is both longer, and more onerous as it largely excludes more comfortable and less physically taxing trips conducted via auto. While the pattern varies, in the top counties by population the African American rate of 90-minute travel burden is consistently far higher than the rate for Whites (Table 3, below). It is also higher on average for Hispanics.

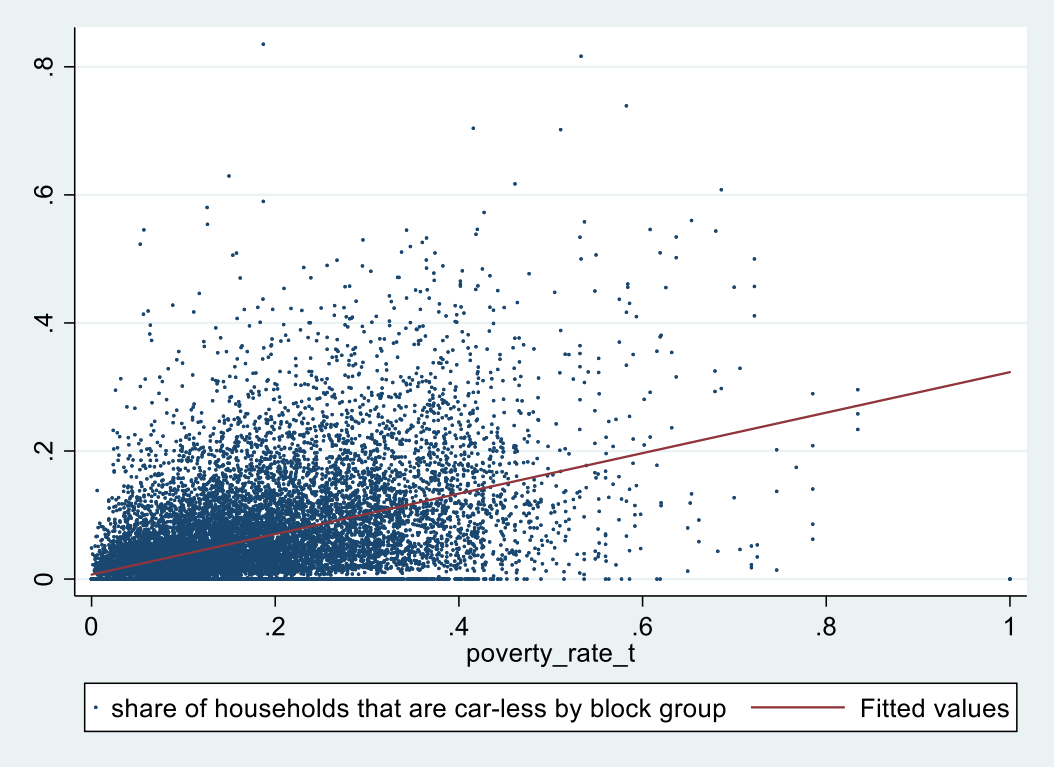
Table 3: Travel burden in the most populous Texas counties, for Whites, African Americans and Hispanics

		Share AECVAs with travel time > 90 min, by race/ethnicity				
County	Total population	Whites	African Americans	As multiple of White rate	Hispanics	As multiple of White rate
HARRIS	4,602,523	11.4%	17.1%	1.5	10.4%	0.9
DALLAS	2,586,552	7.3%	18.8%	2.6	7.6%	1.0
TARRANT	2,019,977	5.5%	13.3%	2.4	6.8%	1.2
BEXAR	1,925,865	7.6%	14.0%	1.9	9.2%	1.2
TRAVIS	1,203,166	7.7%	13.9%	1.8	8.8%	1.1
COLLIN	944,350	3.9%	4.3%	1.1	4.3%	1.1
EL PASO	837,654	7.9%	14.2%	1.8	9.2%	1.2
DENTON	807,047	3.5%	7.3%	2.1	4.5%	1.3
FORT BEND	739,342	6.2%	7.9%	1.3	5.5%	0.9

Source: Chatman analysis (using block group centroid travel time estimates and American Community Survey 2013-2018 PUMA, Census tract and block group population estimates)
Note: Hidalgo County not available due to a reporting problem in ACS data.

56. Finally, I conducted some analysis of the relationship between the poverty rate at the block group level and the share of household lacking access to a personal vehicle, which is the single greatest predictor to determine whether AECVAs would have to travel more than 90 minutes round trip to access a ballot drop box. I found that the level of poverty predicts the auto ownership share at a high level of statistical significance. Each 10 percent increase in the poverty rate within a block group in Texas is associated with a 3 percent increase in the share of households who do not have a car available (Figure 4). Poverty is also highly associated with race/ethnicity. In Texas, 8.2 percent of non-Hispanic Whites are under the poverty line, half the poverty rate of non-Hispanic African Americans at 16.6 percent. The Hispanic poverty rate in Texas in the 2013-2018 PUMS data is also quite high, at 15 percent.

Figure 4: Travel burden as a function of the poverty rate, for Texas block groups



57. To corroborate the relationship between income and the travel burden I looked at data from the Nationwide Household Travel Survey of 2017 (see Table 3).

Table 3: Household Income by Vehicle Ownership

Household Vehicle Ownership	Mean Income Bracket
No vehicle available	$15,000 to $24,999
One or more vehicles	$50,000 to $74,999

Source: National Household Transportation Survey, 2017

58. The table shows that household income among households with access to at least one auto is about twice as high as households without a car. This relationship is also highly statistically significant. As noted previously, auto ownership is the mediating relationship that associates poverty status with a travel burden to access a ballot drop box location.

Queuing Analysis: Methodology and Results

59. In this analysis I estimated the length of queues and average waiting times hour by hour on Election Day by county across the state. This was carried out in three steps. First, I estimated Election Day demand, i.e. the estimated number of individuals attempting to drop off ballots on Election Day, for each county. Second, I conducted a simple deterministic input-output analysis to estimate queue length and delays on an hour by hour basis. Third, I estimated the number of voters likely to be dissuaded from voting due to extraordinarily long queue lengths and delays, by county.

A. Methodology: Estimating Election Day Demand for Drop Boxes

60. To conduct the queueing analysis, I first estimated overall demand for ballot drop boxes by county. This required obtaining data and making inferences about the following parameters: (a) the number of registered voters in each county; (b) the share of registered voters who will request and receive absentee ballots; (c) the share of those holding absentee ballots choosing to deliver those ballots to a county drop box location; and (d) the share of those drop box ballots which will be delivered on Election Day. As described below, in estimating the latter parameters (b), (c) and (d), I tested several inputs in order to help provide a probable range of outcomes for all the counties in the state.

61. For parameter (a), the number of registered voters in each county, I used the official list made available by the Texas Secretary of State from January 2020 (https://www.sos.state.tx.us/elections/historical/jan2020.shtml). The number of registered voters no doubt has changed since that time, but I was not able to obtain more recent figures.

62. In estimating (b), the share of registered voters voting absentee, I used the 2013-2018 Census data described in the previous section to calculate the share of CVAs who were eligible for absentee voting because of age or disability and used these shares for the baseline parameter.

These shares ranged between 17 and 55 percent of January registered voters across the 254 counties in the state; the share for the top ten counties by population ranged from 18 to 26 percent of registered voters. An announcement about expected numbers of absentee ballot requests by the county clerk for Travis County stated that she expected 200,000 absentee ballot requests in the general election, which would be 24 percent of registered voters (6 percent higher than the 18 percent EACVA share for Travis County that I calculated using the 2013-2018 ACS data) (see https://www.austinmonitor.com/stories/2020/08/travis-county-plans-for-drive-thru-voting-drop-off-for-mail-in-ballots/). Based on this discrepancy, which likely reflects population growth since the 2013-18 estimates, along with some other news reports about the high number of absentee ballot requests to date, I used an upper bound of 125 percent of this figure for the total number of absentee ballots, and I used 90 percent as a lower bound.

63. In estimating parameter (c), the share of absentee voters choosing to deliver their ballots to a drop box, I searched for data on ballot deliveries from other states. Washington is one of only two states I am aware of that maintains data about the use of drop boxes in delivery of absentee ballots. Data for King County show that the share of absentee ballots that were delivered to drop boxes ranged from 45 to 57 percent in the last four general elections in the State of Washington. There are fewer drop boxes in Texas, and a shorter tradition of using them. But it appears likely that absentee voters may have a strong tendency to distrust returning absentee ballots by mail due to widespread publicity about the possible inability of the U.S. postal service to return ballots on time. Furthermore, absentee ballots tend to be returned at the last minute, based on inspecting detailed returns data from several locales in the United States including Washington and Colorado, which is likely to mean voters will

strongly prefer drop boxes to mail boxes because of the increased possibility their ballots will not delivered on time. I reduced this figure substantially downward from the Washington case, using figures that are 50 percent lower. To reflect uncertainty about this estimate, I used three different figures– 30 percent, 35 percent, and 40 percent – to represent three possible scenarios for the use of drop boxes by those who choose to vote absentee.

64. In estimating parameter (d), the share of drop box users delivering their ballots on Election Day, I relied again on data from Denver, Colorado and Kings County, Washington. In King County, Washington in the August 2020 primary election, 63 percent of drop box ballots were deposited on Election Day; in the previous 2018 general election, the figure was 72 percent. Figures for Denver are similar. In this analysis for Texas I used 40 percent as a midpoint (more than 50 percent lower than King County), also testing 35 percent as a low-end estimate and 45 percent as a high-end estimate.

65. The combination of the parameters above yielded a number of different possible outcomes in terms of the share of registered voters who I estimate will attempt to deliver absentee ballots via drop box on the day of the election. The lowest share obtained by the variance in assumptions ranges from 1.7 to 2.5 percent of registered voters, depending on the county's share of AECVAs; the middle and "baseline" share ranges from 2.5 to 3.7 percent of registered voters; and the high estimate yields a range from 4.1 to 5.9 percent of registered voters attempting to drop off their ballots at a county drop box location on Election Day.

B. Methodology: Estimating Queue Lengths and Wait Times on Election Day

66. The second step of the analysis, estimating drop box queue lengths and wait times on Election Day, consisted of an input-output analysis requiring a set of parameters about (e) how demand would be distributed over the course of the day on Election Day; (f) the

configuration of receiving stations at each of the county boards of elections offices across the state; and (g) the service capacity of those reception lines—i.e., how many ballots per hour they could receive depending on how quickly individuals can have their photo identification cards checked, sign the roster, and deposit their ballots.

67. Regarding parameter (e), the ballot drop boxes are said to be available from 7 am to 7 pm at most locations. I further inferred, based on common travel patterns in the United States, that 30 percent of this travel would occur during the morning peak (8 am to 10 am) and 35 percent during the evening peak (4 pm to 7 pm), with the remainder distributed throughout the other hours of the day from 7 to 8 am and from 10 am to 4 pm. This parameter turns out to have very little effect overall on queue formation in the populous counties, because in those counties voter demand estimates exceed drop box service capacity by a very wide margin.

68. For parameter (e), I assumed that every county board of elections office has one drive up queue managed in the following way: one staffed station checks ID, a second staffed station takes signature and receives the ballot. Separating the stages in this way has the potential to increase capacity by allowing the queue to keep moving after the first step is conducted. I assume there are two such staffed queues available for Harris County because it is held at NRG Arena, which has the potential to manage two queues because of its size.

69. Parameter (g), the service capacity of each drop box, depends on the speed of elderly and disabled individuals completing the three steps required to drop off a ballot: having their photo ID checked, signing the register, and depositing their ballots or handing their ballots to an attendant. (I assume that physical capacity of the boxes is not an issue, i.e., staff are available to empty the boxes when needed.) At some locations there may be drive up boxes

and in others voters may have to park and join a pedestrian queue. Drive-up queues move particularly slowly because of the awkwardness of reaching for the box from a car window, undoing one's seatbelt, etc. and because of the necessity to keep some distance between cars (for an illustration, see news footage of a drive up box in Minneapolis at https://www.youtube.com/watch?v=Kg61Jr9Dm7k).

70. Regardless of whether the queues are pedestrian or drive-up, given the fact that several steps must be completed in the Texas situation due to the need to check identification and collect a signature, I used three ballots per minute (one every 20 seconds) as an estimate of service time that I consider to be highly conservative. Even if two queues were possible to maintain (which is highly unlikely in the queue lengths I calculate later in the analysis), I estimate that sites would not be able to achieve a rate of ballot deposition exceeding three ballots per minute, with one exception. For the case of Harris County, with the assumption of two staffed drop-off sites and queues being possible at the NRG Arena, I assumed six ballots per minute, twice the rate of the other counties.

71. I modeled the ballot drop box locations at each county board of elections office as a simple D/D/s queueing system with a constant hourly capacity as explained above, and deterministic arrival times that varied by the hour as explained in the paragraph prior. In this model, queues form whenever the demand exceeds the capacity, and the queue length at a given hour is simply the excess demand in that hour plus the queue length at the end of the previous hour, as given in the following equation:

$$Q(t) = Q(t-1) + D(t) - C(t)$$

where $Q(t)$ is the queue length at hour *t*, $Q(t-1)$ is the queue length at hour *t-1*, $D(t)$ is the demand at hour *t*, and $C(t)$ is the capacity at hour *t*.

72. Given the queues at a given hour, the average delay in that hour is given by the following equation

$$W_{average}(t) = \frac{Q_{average}(t)}{C(t)}$$

where $W_{average}(t)$ is the average expected wait time for a voter arriving at hour t, $Q_{average}(t)$ is the average queue length at hour t, and $C(t)$ is the capacity at hour t.

73. For a concise overview of the input-output method for analyzing queueing, see Daganzo (1983). A more thorough explanation is set forth in a textbook by the same author (Daganzo, 1997).

C. <u>Results: Estimates of Election Day Queue Lengths and Wait Times, By County</u>

74. I generated outputs by county for three different scenarios: low demand, "baseline" demand (my best estimate of actual demand for drop boxes on Election Day), and high demand.

75. The baseline scenario is shown in Tables 4 and 5, found after the references at the end of this Declaration. Table 4 shows projected Election Day queue lengths for the most populous counties throughout the course of the day, and Table 5 shows projected wait times for people who arrive during those hours of the day. Only the 25 largest counties by voter registration are shown in the tables, because with 254 counties it is not possible to fit all on a page.

76. In the baseline scenario, 25 counties have queues at the end of Election Day exceeding 1,700 and ranging up to 64,000 vehicles (Table 4); with wait times exceeding nine hours and ranging up to 340 hours (Table 5). The impacts in more populous counties are much more severe than in less populous counties. The wait at the end of a day to drop off a ballot over the course of a day in the ten most populous counties in the state is estimated at baseline to average 135 hours, with a range from 54 to 340 hours – estimates that are so astronomical they clearly communicate gridlock that will simply keep people from being able to drop off

their ballots. A total of about 337,000 voters across the state are potentially affected by an inability to drop their ballots off in the baseline scenario. Meanwhile the 209 least populous counties in the state are not projected to have any wait time in the baseline scenario.

77. I also calculated the "low demand" and "high demand" results, creating output tables similar to Tables 4 and 5. I describe the results here, without displaying the detailed results in tables.

78. For the low demand scenario (in which from 1.7 to 2.5 percent of registered voters attempt to drop off their ballots on Election Day), the 22 most populous counties in the state have significant queues (of more than 1,000 vehicles at the end of Election Day) and waiting times (of more than six hours). The ten most populous counties have end-of-day queue lengths averaging more than 16,000 vehicles and wait times averaging 87 hours. A total of about 200,000 voters are potentially affected by an inability to drop off their ballot in this minimum demand scenario.

79. In the high demand scenario, in which the share of registered voters who plan to deliver their absentee ballots to a drop box on Election Day ranges from 4.1 to 5.9 percent, the 25 most populous counties have average queue lengths of 22,000 vehicles, and wait times for the ten most populous counties range from 94 to 606 hours. The total number of Texas voters driven away by the inability to reach a ballot drop box in this scenario is more than 600,000.

80. The range of potential outcomes based on variance in the input inferences can be shown as I do here for three counties: Harris, Travis and Fort Bend. Figures 5 to 10 (below) visualize the variance in possible incomes for queue lengths and wait times for those three counties.

Figure 5: Range of Possible Election Day Queue Lengths in Harris County

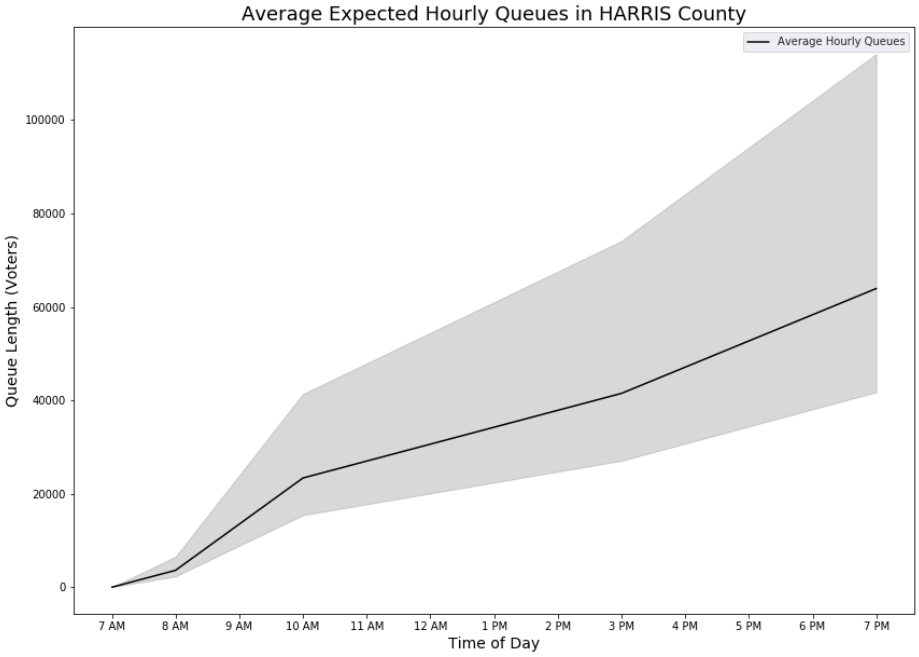


Figure 6: Range of Possible Hourly Delay Per Capita in Harris County

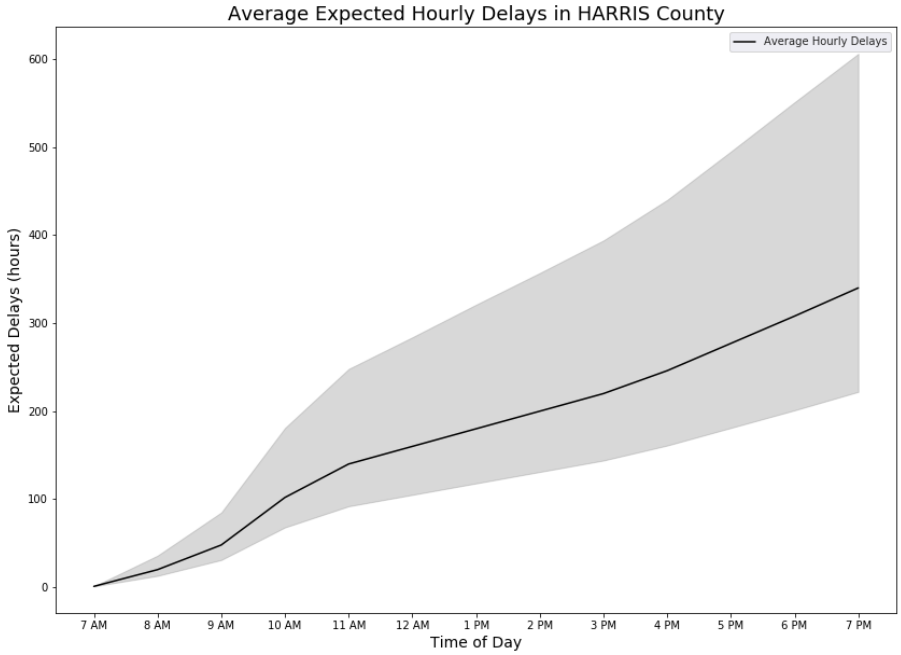


Figure 7: Range of Possible Election Day Queue Lengths in Travis County

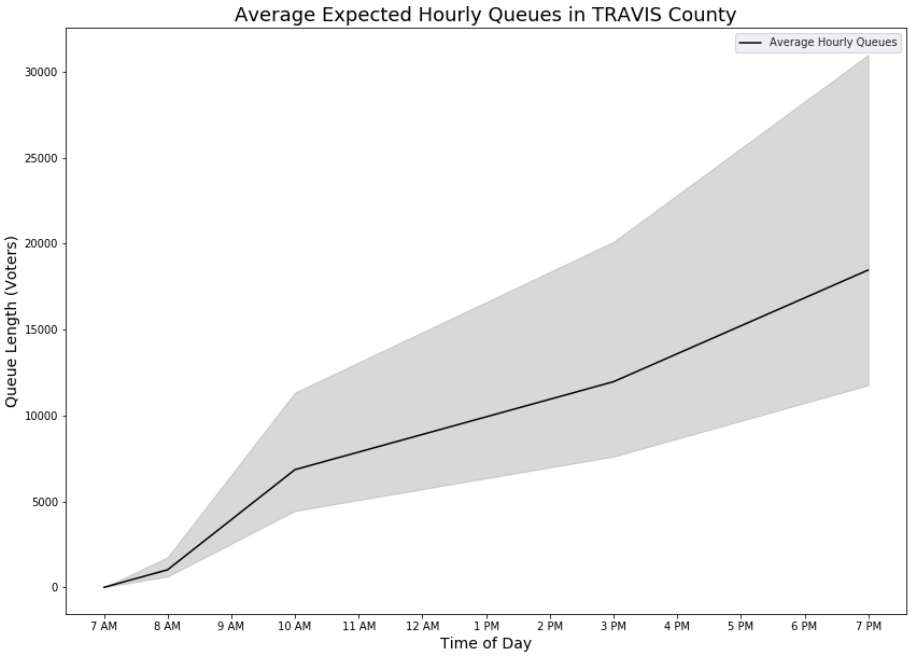


Figure 8: Range of Possible Hourly Delay Per Capita in Travis County

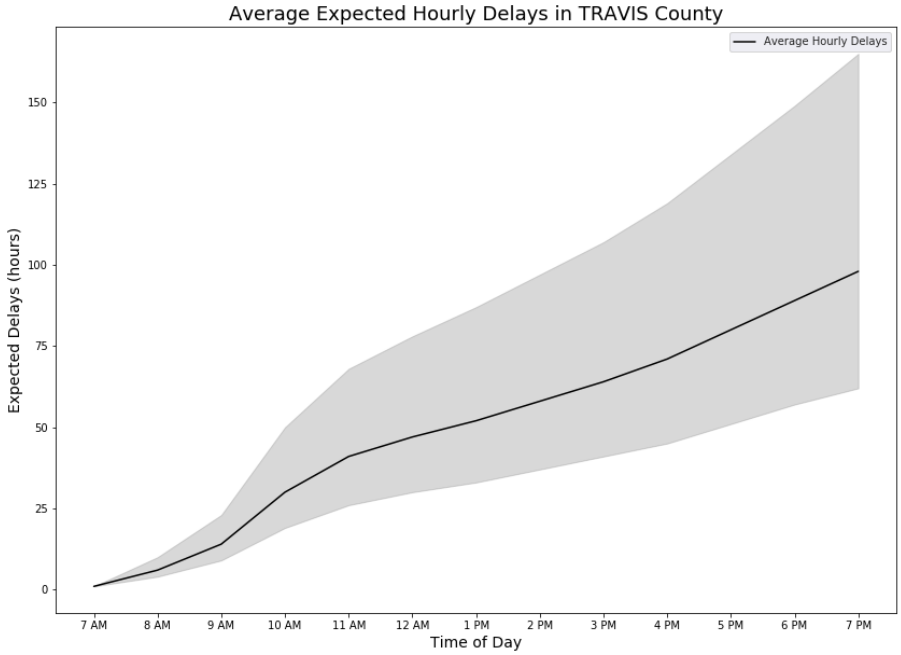


Figure 9: Range of Possible Election Day Queue Lengths in Fort Bend County

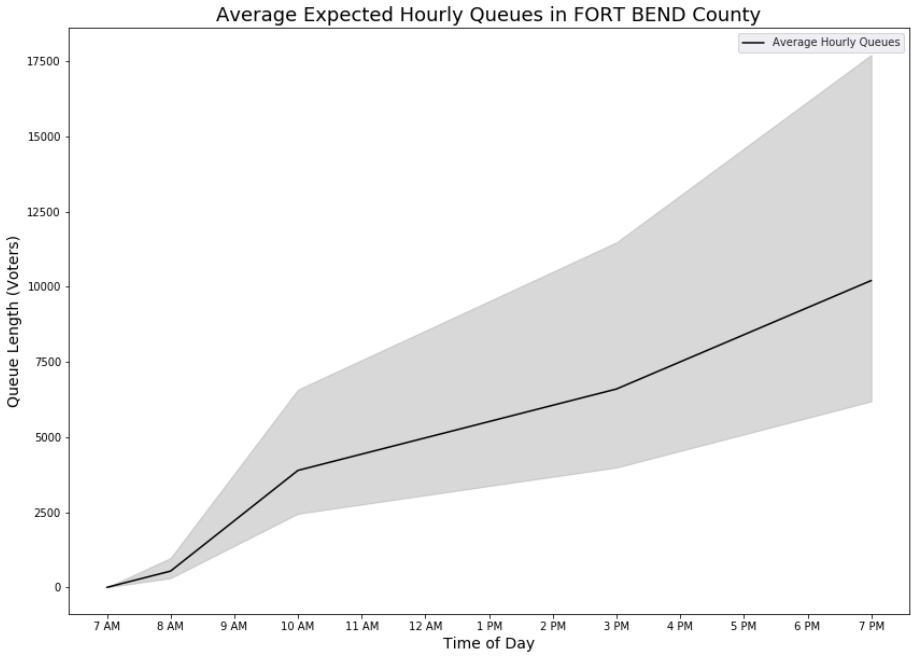
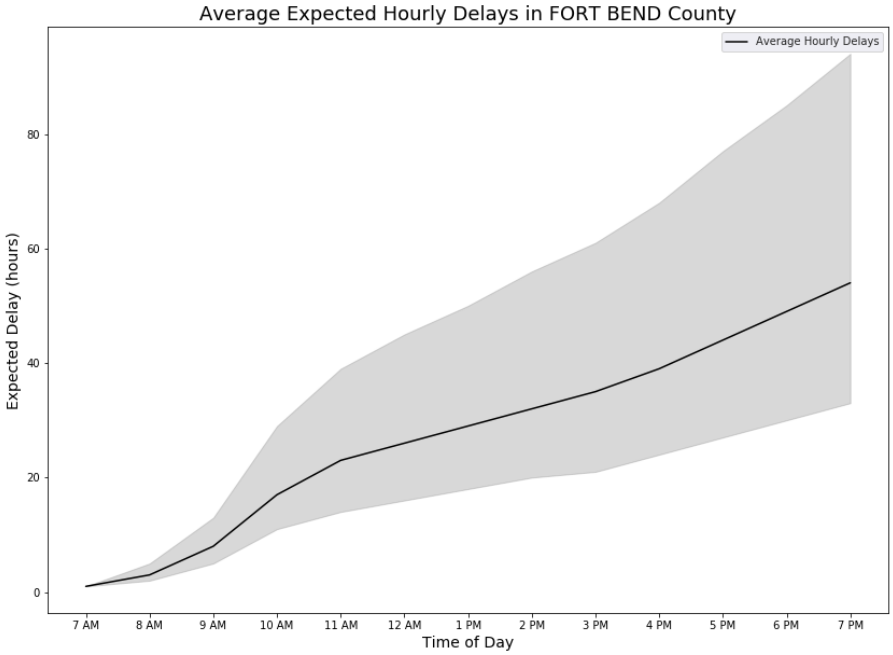


Figure 10: Range of Possible Hourly Delay Per Capita in Fort Bend County



D. Results: Impacts on Voters

81. The figures discussed above, shown in Tables 4 and 5, and displayed for three counties in Figures 5 to 10, show projected scenarios that help estimate the magnitude of the impact of not allowing more than one location for ballot drop boxes in each county. Plainly, it is unlikely that the massive queues and wait times shown by these analyses would occur, because once the queues and wait times become long, voters are likely to either abandon the queue; arrive at their county drop box site and be deterred from joining the queue; or hear about the long wait times on the news or from friends and not even begin a trip to the county elections office. In other words, queues of much shorter than the projected lengths would likely dissuade voters from attempting to deliver their ballots long before the queues achieve the length demonstrated by demand. For example, a queue of 30,000 vehicles would stretch for about 150 miles; and one has difficulty imagining a voter willing to tolerate a wait of more than 8 hours.

82. The estimated queue lengths at the end of Election Day are a good estimate of the number of voters who could be dissuaded from dropping off their ballots by the intense traffic that would be associated with county drop box locations once only a few hundred vehicles are lined up, in addition to the prospect of intolerably long vehicle queues and wait times. Thus, one estimate of the number of voters who might forgo casting their ballots due to the small numbers of drop box locations in populous counties would be the surplus demand in the remaining queues at the end of Election Day. Statewide, this would be about 330,000 ballots in the baseline scenario, with a range as low as 200,000 ballots in the low-demand scenario and as high as 600,000 ballots in the high-demand scenario.

83. The impacts of queues can be expected to have a disparate impact on African Americans and Hispanics. The most populous counties with the longest expected queues and wait times have

a higher fraction of the population that is African American or Hispanic. About 71 percent of African Americans and 65 percent of Hispanics in Texas live in the top 10 counties by population, as compared to 55 percent of Whites. Harris County, which is expected to have the longest queues and wait times in the state, contains 26 percent of all African Americans and 18 percent of Hispanics in the state, compared to 14 percent of Whites.

CONCLUSION

84. I have analyzed two potential impacts of the Texas Governor's decision not to allow counties to provide multiple satellite ballot drop off locations for voters in the November general election. The first is the travel burden for those elderly and disabled individuals who will have time-consuming and uncomfortable trips, disproportionately on public transportation or on foot due to their not having access to a personal vehicle in their household, to access a ballot drop box under the current rule. The second is the queue lengths associated with large potential demand for access to ballot drop boxes due to the circumstances of this election and based on comparisons with other locations that have implemented drop boxes as a ballot delivery option.

85. I find that more than 89 percent of the 321,000 absentee-eligible citizens of voting age in the state who lack access to a car would have a round trip to access a county ballot drop box location exceeding 90 minutes, which is substantially longer than the average amount of travel undertaken in an entire day in the State of Texas, under conditions that are typically much more difficult than driving in a personal vehicle. Overall, from 7.7 to 13.5 percent of the population of the state is affected by a significant travel burden, with the ten most populous counties accounting for the majority of those individuals. The share of the population with a travel burden is particularly high in Harris County, where 38 percent of the

population is estimated to have a round trip of more than 70 minutes to access the county ballot drop box, and which contains a disproportionate share of affected voters in the state. Senior citizens and disabled individuals under the poverty line are much more likely to be affected by this burden across the state, because they are less likely to have access to a personal vehicle in their household. Such long travel durations under uncomfortable or impossible conditions, given age and disability, are likely to dissuade affected voters from delivering their absentee ballots to drop boxes, and may consequently discourage voting altogether, given reasonable fears of COVID-19 infection at in-person polling places, and skepticism that the postal service will deliver ballots on time if they are put in a mailbox.

86. I estimate that the demand for drop boxes would generate extraordinarily lengthy queues in the most populous counties in the state, with intolerably long wait times to drop off a ballot. It appears likely that in those counties more than 300,000 people could be turned away from drop box locations, or could be dissuaded from attempting to drop off their ballots on Election Day by reports of long lines or by encountering intense traffic on the way to or upon arriving at the drop box, if the state does not permit affected counties to provide additional drop box locations in order to mitigate queuing delays.

87. Both of these types of impact would be disproportionately borne by African Americans and to a lesser extent Hispanics. African Americans are twice as likely to experience a significant travel burden in comparison to Whites. African Americans and Hispanics are also substantially more likely to live in larger counties where longer queues and higher wait times are expected in order to deposit a ballot at a drop box.

I declare under penalty of perjury that the information set forth in this declaration is true and correct to the best of my knowledge.

Dated: October 8, 2020

Dr. Daniel G. Chatman

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Table 4: Hourly Election Day Queues, Baseline Scenario, for Top 25 Counties by Number of Registered Voters

County Nam	7 AM	8 AM	9 AM	10 AN	11 AN	12 PN	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM
HAYS	49	458	868	917	966	1015	1064	1113	1277	1441	1605	1768
GRAYSON	50	462	874	925	975	1025	1075	1125	1291	1456	1622	1787
WEBB	59	494	929	988	1047	1106	1165	1224	1403	1582	1760	1939
COMAL	98	633	1167	1265	1363	1461	1559	1657	1893	2130	2367	2604
MCLENNAN	144	797	1449	1593	1737	1881	2025	2169	2474	2780	3086	3392
JEFFERSON	146	806	1465	1612	1758	1905	2051	2198	2507	2817	3127	3436
SMITH	164	867	1571	1734	1898	2062	2225	2389	2724	3060	3395	3730
LUBBOCK	191	963	1736	1927	2118	2308	2499	2689	3065	3441	3817	4193
BRAZORIA	206	1019	1832	2039	2245	2451	2657	2863	3263	3662	4061	4460
BELL	249	1173	2097	2346	2595	2844	3094	3343	3807	4271	4734	5198
NUECES	275	1266	2256	2531	2806	3081	3357	3632	4135	4637	5140	5643
CAMERON	286	1304	2322	2608	2894	3180	3466	3752	4271	4790	5309	5828
GALVESTON	303	1366	2429	2732	3035	3338	3641	3945	4490	5034	5579	6124
WILLIAMSON	475	1981	3486	3962	4437	4913	5388	5864	6667	7470	8273	9077
MONTGOMERY	497	2058	3619	4116	4613	5110	5607	6104	6939	7774	8610	9445
FORT BEND	542	2217	3893	4435	4976	5518	6060	6601	7504	8406	9309	10211
HIDALGO	595	2410	4224	4819	5415	6010	6606	7201	8185	9168	10151	11134
DENTON	601	2431	4260	4862	5463	6064	6666	7267	8259	9251	10244	11236
COLLIN	740	2927	5113	5854	6594	7334	8074	8815	10015	11216	12416	13616
EL PASO	801	3144	5487	6288	7089	7890	8691	9492	10784	12076	13368	14659
TRAVIS	1023	3937	6851	7874	8898	9921	10944	11967	13592	15217	16842	18467
TARRANT	1921	7145	12369	14291	16212	18134	20055	21976	24949	27921	30893	33865
DALLAS	2163	8006	13850	16013	18175	20338	22500	24663	27997	31331	34665	37999
BEXAR	2236	8267	14298	16534	18769	21005	23240	25476	28919	32362	35805	39249
HARRIS	3621	13500	23378	26999	30620	34242	37863	41485	47097	52709	58321	63934

Table 5: Hourly Delays (in hours), Baseline Scenario, for Top 25 Counties by Number of Registered Voters

County Nam	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM
HAYS	0	1	4	5	5	6	6	6	7	8	8	9
GRAYSON	0	1	4	5	5	6	6	6	7	8	9	9
WEBB	0	2	4	5	6	6	6	7	7	8	9	10
COMAL	1	2	5	7	7	8	8	9	10	11	12	14
MCLENNAN	1	3	6	8	9	10	11	12	13	15	16	18
JEFFERSON	1	3	6	9	9	10	11	12	13	15	17	18
SMITH	1	3	7	9	10	11	12	13	14	16	18	20
LUBBOCK	1	3	7	10	11	12	13	14	16	18	20	22
BRAZORIA	1	3	8	11	12	13	14	15	17	19	21	24
BELL	1	4	9	12	14	15	16	18	20	22	25	28
NUECES	2	4	10	13	15	16	18	19	22	24	27	30
CAMERON	2	4	10	14	15	17	18	20	22	25	28	31
GALVESTON	2	5	11	14	16	18	19	21	23	26	29	33
WILLIAMSON	3	7	15	21	23	26	29	31	35	39	44	48
MONTGOMERY	3	7	16	21	24	27	30	33	36	41	46	50
FORT BEND	3	8	17	23	26	29	32	35	39	44	49	54
HIDALGO	3	8	18	25	28	32	35	38	43	48	54	59
DENTON	3	8	19	25	29	32	35	39	43	49	54	60
COLLIN	4	10	22	30	35	39	43	47	52	59	66	72
EL PASO	4	11	24	33	37	42	46	51	56	63	71	78
TRAVIS	6	14	30	41	47	52	58	64	71	80	89	98
TARRANT	11	25	54	74	85	95	106	117	130	147	163	180
DALLAS	12	28	61	83	95	107	119	131	146	165	183	202
BEXAR	12	29	63	86	98	110	123	135	151	170	189	208
HARRIS	20	48	102	140	160	180	200	220	246	277	308	340