**Study Area**

For the purposes of this report, analysis was limited to 2019 block groups within metropolitan statistical areas with populations of at least 500,000 residents according to the 2019 1-year American Community Survey. San Juan, PR was excluded due to a lack of available travel data.

**Data sources**

*Replica:* The travel data analyzed in this report are sourced from Replica, which provides a national synthetic agent-based travel model. Key components of the Replica model include synthetic population and trip characteristics. For each season of data (fall 2019 and fall 2022 are used in this report), Replica generates a synthetic population of agents calibrated to reflect Census demographic realities at the block group level. This synthetic population is then assigned to travel personas, or behavioral choice sets, informed by a combination of anonymized mobile location data (from phones and other mobile GPS), anonymized economic activity data (from credit and debit card transactions), built environment data, and demographic data from public and private sources. Model outputs are subsequently improved and calibrated using ground truth data.

Critically, while the outputs of the Replica model are at the person-trip level, both the person and the trip are synthetic, and therefore cause fewer privacy concerns than anonymized real-world datasets. Modelled trip origins and destinations are reported at the block group level, as are key locations (like work, home, and school) for each member of the synthetic population.

For the purposes of this report, we aggregated individual and household trips into summary metrics based on overall distance travelled by residents of each block group in the study area. The dataset includes all trips, for all purposes (meaning not limited to commutes to work). It also includes all household trips, whether a walk in one's neighborhood to a one-day, multistate trip.

*American Community Survey:* This report makes use of 2019 American Community Survey data for population and demographic estimates. For total metropolitan population across the 110 metropolitan areas in the study area, 2019 1-year estimates were used. For block group level population estimates, 2019 5-year estimates were used.

**Activity Centers**

Activity Centers were identified using the same underlying methodology and definitions used in [Mapping America's activity centers: The building blocks of prosperous, equitable, and sustainable regions](#), but for 2019 rather than 2020 block group geographies. In summary, the activity centers analyzed in this report represent the 2019 block groups with location quotients above the 98th percentile for at least one of five key asset categories, or above the 95th percentile for at least two of the five key asset categories.

Asset categories include community (population density, presence of public libraries, density of places of worship, density of historic sites, density of parks), tourism (presence of major sports stadiums, density of hotels and motels, density of casinos and museums), consumption (density of restaurants, density of retail establishments, density of medical offices, presence of post office, density of retail jobs), institutional (count of college students and staff, count of hospital beds, count of state government buildings, square feet of federal office space, presence of airports and intercity rail stations), and economic (density of tradable jobs).

The resulting set of Activity Centers show very similar characteristics to those described in the original report:

| | 2020 Activity Centers | 2019 Activity Centers |
|---|---|---|
| % of Block Groups | 8.6% | 8.6% |
| % of Land | 3.1% | 4.5% |
| % of Developed Land | 10.8% | 11.3% |
| % of Population | 7.9% | 8.1% |
| % of Private Sector Jobs | 39.9% | 40.5% |
| % of Commercial Real Estate Value | 46.2% | 50.5% |
| % of Public Libraries | 32.8% | 30.7% |
| % of Historical Sites | 44.8% | 45.9% |
| % of Museums | 66.7% | 65.1% |
| % of Post Offices | 26.5% | 26.0% |
| % of Federal Office Space | 87.8% | 89.1% |
| % of Hospital Beds | 83.2% | 80.4% |
| % of College Staff | 90.8% | 89.7% |

While the original Activity Center report further classified Activity Centers as primary, secondary, or monocenters, this report treats all Activity Centers equally. More details on the methodology used to identify activity centers can be found in the methodological appendix to the original report.


**Personal Miles Travelled (PMT)**

Personal Miles Travelled (PMT) is the total distance travelled by an individual—using any mode of transportation from walking to driving, for all trip purposes—over the course of a given time period. This is a key indicator of an individual's overall travel behavior and is tracked by major national data sources like the National Household Travel Survey (NHTS). PMT can be measured at either the individual level or the household level. It can be calculated over the course of a day, week, month, or year. While we calculated both individual and household, weekday, weekend, and annual PMT, we focus the majority of our analysis on annual household PMT, as it is most directly comparable to key PMT metrics published with the 2017 NHTS.

In order to extrapolate annual travel distances from the Thursday and Saturday trip data provided by Replica's model, we referenced the 2017 NHTS breakdown of weekly travel milage by day.

| Travel day - day of week | Adjusted Travel Day Person Miles |
|---|---|
| Sunday | 15.0 |
| Monday | 13.0 |
| Tuesday | 12.2 |
| Wednesday | 13.7 |
| Thursday | 14.8 |
| Friday | 15.9 |
| Saturday | 15.5 |
| **All** | **100.0** |

*Source: 2017 National Household Travel Survey Data Explorer Tool (https://nhts.ornl.gov/)*

Together, Thursdays and Saturdays compose approximately 30% of weekly travel milage in the 2017 NHTS. We therefore calculate weekly travel milage by dividing the total Thursday and Saturday miles travelled by residents of each block group in the study area by the unrounded NHTS share. We then multiply the result by the unrounded number of weeks in a year. Finally, this total annual milage is divided by the number of synthetic households living in each block group in the study area to produce annual household PMT:

$$\frac{\left(\frac{\textbf{Thursday } miles + \textbf{Saturday } miles}{.3028684618342}\right) * 52.1428571}{Synthetic\ Households}$$

We then compared Replica's overall national average annual household PMT against recent NHTS results. When running our PMT calculation for the entire nation—not just the 110 metropolitan areas analyzed in this report—we reach a national average annual household PMT of **31,401.24** miles for the fall of 2019 and **31,563.75** miles for the fall of 2022. The Replica-based estimates fall approximately 3% below the margin of error for the original 2017 NHTS annual household PMT estimate.

| NHTS Survey Year | Annual Household PMT |
|---|---|
| 1983 | 22,802 |
| 1990 | 30,316 |
| 1995 | 34,459 |
| 2001 | 35,244 |
| 2009 | 33,004 |
| 2009 MOE | 1,235.1 |
| 2017 Orig. | 33,587 |
| 2017 Orig. MOE | 1,276.2 |
| 2017 Adj. | 36,302 |
| 2017 Adj. MOE | 1,315.0 |

*Source: Summary of Travel Trends, National Household Travel Survey 2017*
*(https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf)*

It's important to note that many individuals make long-distance trips each day, whether on the road, railways, or by air. Both NHTS and Replica-based estimates include those trips to quantify PMT, as does our analysis. For the purposes of this research, such data can create PMT outliers at the neighborhood scale when relatively high numbers of long-distance travelers live in the same block group.

**Savings Estimates: car ownership costs and emissions**

The estimates of financial saving and emissions reduction associated with lower PMT were largely informed by methods and assumptions used by the Department of Energy Alternative Fuels Data Center's Vehicle Cost Calculator. For the savings estimate, we subtract the estimated financial costs and emissions associated with the travel behavior of those living closer to several activity centers (within 3 miles of the fifth-nearest activity center) from the costs and emissions associated with living further away (7 or more miles from the fifth-nearest activity center). To account for the range of vehicles people may be driving, and their respective range in financial costs and emissions, we run each estimate both for an average-aged sedan (2018 Toyota Corolla) and compact SUV (2018 RAV4). The resulting figures are presented as a range of financial savings in dollars and emissions savings in pounds of $CO_2$.

Assumptions and inputs for cost and emissions estimates are detailed below. All assumptions and inputs—except for annual milage driven—remain constant when calculating cost and emissions in different locations.

Annual milage driven is derived from our PMT metric. The 2017 NHTS found per-driver VMT to equal approximately 73% of daily PMT per person (see *Summary of Travel Trends, National Household Travel Survey 2017, Table 3b)*. Therefore, we multiply individual PMT (total miles driven divided by total population) by 0.73 for each per-driver milage input.

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**Annual cost of ownership, operation, and maintenance**
$Cost\ Estimate = Cost\ of\ purchase + Maintenance\ cost + Fuel\ cost + Insurance, license, and\ registration\ cost$

- ***Annual cost of purchase*** $= \frac{Total\ cost\ of\ purchase}{Vehicle\ lifespan}$
- $Total\ cost\ of\ purchase = year\ 1\ payment + 4 * (years\ 2\ to\ 5\ payments)$
  - Price 2018 Corolla: $20,690
  - Price 2018 RAV4: $31,475
  - 10% down payment
  - 5 year loan
  - 6% interest
- $Vehicle\ lifespan = \frac{200,000\ miles}{Annual\ milage}$

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- ***Annual maintenance cost*** $= Annual\ milage * per\ mile\ tires\ \&\ maintenace\ cost$
  - $Annual\ milage = Individual\ PMT * .73$
  - Per mile tires & maintenance cost: $0.0538

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- ***Annual fuel cost*** $= Gasoline\ price * annual\ fuel\ usage$
  - Gasoline price: $3.11 per gallon
  - $Annual\ fuel\ usage = (Annual\ highway\ miles * highway\ MPG) + (Annual\ city\ miles * city\ MPG)$
    - Highway share of total miles: 57%
    - City share of total miles: 43%
    - Highway MPG 2018 Corolla: 36
    - Highway MPG 2018 RAV4: 29
    - City MPG 2018 Corolla: 28
    - City MPG 2018 RAV4: 23

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- Annual insurance, license, and registration cost: $1,616

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**Annual Emissions (lbs CO$_2$)**
$Emissions\ Estimate = Emission\ factor * fuel\ use$

- Emission factor: 23.5 Pounds of CO$_2$e per gallon of Gasoline
- $Annual\ fuel\ usage = (Annual\ highway\ miles * highway\ MPG) + (Annual\ city\ miles * city\ MPG)$
  - Highway share of total miles: 57%
  - City share of total miles: 43%
  - Highway MPG 2018 Corolla: 36
  - Highway MPG 2018 RAV4: 29
  - City MPG 2018 Corolla: 28
  - City MPG 2018 RAV4: 23

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