Virginia Population Projections Methodology

This methodology document provides an overview of the steps involved in developing population projections for the Commonwealth of Virginia, its 133 localities (95 counties and 38 independent cities), and its large towns (population of 5000 or more) for 2030, 2040, and 2050. The results consist of projections for the following variables:

* Total population
* By age
* By sex

We apply a combination of exponential growth, linear extrapolation, and Hamilton-Perry method to derive these projections; this updated methodology also uses the most recently available estimates and births data in addition to Decennial Census Counts, to improve the output data quality.

**Input data:**

* 2010 Census Count total, by age
* 2020 Census Count total, by age, by sex
* 2024 Estimates by Weldon Cooper Center total
* 2014-2023 annual births data from Virginia Department Health (geocoded and tabulated by the Weldon Cooper Center)

# Total Population Projections

The state level totals are developed first; then the total population for each locality is calculated individually based on their past trends and raked according to the state control totals.

## Approach for projecting Virginia State total population:

* For 2030, exponential population growth rate using data from 2020 and 2024, is applied with 2024 as the launch year, to yield the final projected $StatePopulation\_{2030}$
* For 2040, the annualized growth between 2010 and 2024 is calculated and linear extrapolation is applied to the 2030 projections to construct the final projected $StatePopulation\_{2040}$.
* For 2050, the annualized growth between 2000 and 2024 is calculated and linear extrapolation is applied to the 2040 projections to construct the final projected $StatePopulation\_{2050}$.
* For mid-decade timepoints, projections for 2035 and 2045 are interpolated, and those for 2055 are extrapolated from the end-of-decade projected populations.

## Approach for projecting Virginia Locality total population:

* For 2030, the localities are initially projected to grow as per their individual exponential growth rates between 2010 and 2024. The final locality level population projection for 2030 is set by redistributing the state control total to yield $LocalityPopulation\_{2030}$.
* For 2040, the localities are initially projected to grow by their individual absolute population change between 2010 and 2020. The final locality level population projection for 2040 is set by redistributing the state control total to yield $LocalityPopulation\_{2040}$.
* For 2050, the localities are initially projected to grow by their individual annualized growth between 2000 and 2020. The final locality level population projections for 2050 is set by redistributing the state control total to yield $LocalityPopulation\_{2050}$.
* For mid-decade time points, projections for 2035 and 2045 are interpolated, and those for 2055 are extrapolated from the end-of-decade projected populations.

## Approach for projecting Virginia Town total population:

* Projections are constructed for Virginia towns with a population over 5000 as per the latest 2020 Census Count.
* The ratios of town population to parent-county population is used to create their respective shares and project the 2030, 2040, and 2050 totals for large towns in Virginia.

# Age and Sex Population Projections

The projections by demographic characteristics, such as by age and sex, are developed by five-year age cohorts (18 groups at 5-year intervals: 0-4, 5-9, 10-14 … 80-84, and 85+).

## Approach for projecting Virginia State and Locality population by Age:

Benchmarked on the 2020 Census data, age distribution for each locality is constructed using the Hamilton-Perry cohort-component method.

* Generating CPR (child population ratio) and CCR (cohort change ratio) for every age cohort within each locality, using data from 2010, and 2020.

For cohorts 0-4 and 5-9, CPRs capture the birth rates in the prior decades. We divide the child population by the appropriate population of child-bearing age to generate the CPRs.

$$CPR\_{0-4}^{2010-2020}=\frac{LocalityPopulation\_{0-4}^{2020}}{LocalityPopulation\_{15-44}^{2020}} \& CPR\_{5-9}^{2010-2020}=\frac{LocalityPopulation\_{5-9}^{2020}}{LocalityPopulation\_{20-49}^{2020}} $$

For cohorts 10-14, …. 80-84, 85+, CCRs measure the combined effects of deaths and migration. We use the ratio of population in an age-group (*a*) in one decade, to the population in age-group (*a-10*) in the previous decade, to calculate CCRs.

$$CCR\_{Age Cohort}^{2010-2020}=\frac{LocalityPopulation\_{Age Cohort}^{2020}}{LocalityPopulation\_{Age Cohort-10}^{2010}}$$

* Calculating the projected locality population by age for 2030 from Hamilton-Perry age forwarding, using population data from 2020 as the launch year and locality specific CPRs (for children under-10) or CCRs (for all others) over 2010-2020.

$$LocalityPopulationHP\_{Age Cohort}^{2030}≅CPR\_{Age Cohort}^{2010-2020}\*LocalityPopulation\_{Age Cohort-10}^{2020}$$

$$LocalityPopulationHP\_{Age Cohort}^{2030}≅CCR\_{Age Cohort}^{2010-2020}\*LocalityPopulation\_{Age Cohort-10}^{2020}$$

Now the total population of the locality for 2030 from Hamilton-Perry method can be calculated by summing across all age cohorts,

$$LocalityPopulationHP\_{2030}=\sum\_{Age Cohorts}^{}LocPopulationHP\_{Age Cohort}^{2030}$$

* Calculating the locality’s population for 2030 for each age interval, by redistributing the total population for 2030 as per the age distribution from Hamilton-Perry method.

$$LocalityPopulation\_{Age Cohort}^{2030}=\frac{LocalityPopulationHP\_{Age Cohort}^{2030}}{LocalityPopulationHP\_{2030}}\*LocalityPopulation\_{2030}$$

* To accommodate for the expected 2030 age-structure amongst the older cohorts, each of the 65+ intervals are held at their Hamilton-Perry levels for localities, and they add up to the Virginia aggregate for these older cohorts. The remaining age groups are re-distributed according to their shares in the residual of the locality’s total population.
* To accommodate for the expected 2030 age-structure amongst the younger cohorts, locality level annual births data are used as a proxy for the (0-4) and (5-9) cohorts in 2030.
* Calculating the projected state population for 2030 by each age cohort, from summing the projected locality populations for 2030 by each age cohort.

$$VAPopulation\_{Age Cohort}^{2030}=\sum\_{Locality}^{}LocalityPopulation\_{Age Cohort}^{2030}$$

This yields the projected age distribution for Virginia’s overall population in 2030.

* The process is repeated for 2040 and 2050 by applying the Hamilton Perry age forwarding to the locality population in the immediately preceding decade, and using this age distribution to redistribute the previously calculated locality total projections. No special age adjustment is made here, as the 2030 age projections already capture the expected trends for the decades ahead.
* The state projected population for Virginia by age for 2040 and 2050 is similarly calculated by summing over the projected age categories across all the localities.

## Approach for projecting Virginia State and Locality population by Sex:

Projections by sex are determined by maintaining the population’s age-specific sex-ratio as per the 2020 Census. Since sex-ratios are historically stable, this ensures that localities with unique sex-distribution (prisons, military barracks etc.) can retain their characteristics. The sex-ratio is applied to the projected population in each age cohort within each locality, for 2030, 2040, and 2050. The male and female population groups within each age cohort are then summed across all the localities, to get the population projections by sex for Virginia as a whole.