

## Appendix: Emissions Reduction Methodology

The potential emissions reductions were calculated on a jurisdictional basis and aggregated to estimate the total benefit of the project. The following section summarizes the methodology and calculations.

|              | 2029 Annual<br>(tons CO <sub>2</sub> e) | 2025 – 2030<br>(tons CO <sub>2</sub> e) | 2040 Annual<br>(tons CO <sub>2</sub> e) | 2030 – 2050<br>(tons CO <sub>2</sub> e) | Total<br>(tons CO <sub>2</sub> e) |
|--------------|---|---|---|---|-----------------------------------|
| Richmond     | 249.73                                  | 499.46                                  | 746.88                                  | 14,937.50                               | 15,436.96                         |
| Chesterfield | 49.95                                   | 99.89                                   | 149.33                                  | 2,986.63                                | 3,086.53                          |
| Petersburg   | 102.99                                  | 205.98                                  | 307.97                                  | 6,159.39                                | 6,365.38                          |
| Henrico      | 13.78                                   | 27.56                                   | 41.55                                   | 831.06                                  | 858.62                            |
|              |   |   |   |   |                                   |
| <b>Total</b> | <b>416.44</b>                           | <b>832.89</b>                           | <b>1,245.73</b>                         | <b>24,914.60</b>                        | <b>25,747.49</b>                  |

### Methodology

#### Step 1: Calculate Average Annual Daily Traffic along Trail Corridor

In this step, the average annual daily traffic (AADT) for roadways parallel to the trail corridors within each jurisdiction was calculated. The AADT and length were obtained from [the 2022 Traffic Data Publications released by the Virginia Department of Transportation](#). To calculate the average for the jurisdiction, the length of the adjacent or parallel segment was divided by the total length of all adjacent or parallel segments along the project.

**Weight = Length of Adjacent or Parallel Segment / Sum of Length of Adjacent or Parallel Segments**

This weight was then multiplied by the AADT to give a length adjusted AADT.

**Adjusted AADT = Weight \* AADT**

Finally, the adjusted AADT for each segment was summed to give a jurisdiction average volume.

**Jurisdiction Average AADT = sum of Adjusted AADT**

#### Step 2: Convert AADT to Travelers

Using an average vehicle occupancy rate of 1.67 people per vehicle from the 2017 National Household Travel Survey, the adjusted AADT was converted to the total number of people travelling along the parallel corridors. The 2017 number was used as the 2022 NHTS was completed during the recovery from the COVID-19 public health emergency. The timing was specifically chosen to capture the reduced rates of travel resulting from COVID-19 and does not provide a good baseline for future forecasts.

**Travelers = Jurisdiction Average AADT \* Average Vehicle Occupancy (1.67)**

### Step 3: Calculate Jurisdictional Active Mode Share

Using the 2022 American Community Survey 5-year Data, the active transportation (biking, walking) share of commutes was calculated. The data was taken from [Table B08301, Means of Transportation to Work](#). This dataset was selected as the best stand in for commuting, as opposed to recreational trips. This average was the baseline for calculating the expected shift from automobiles to active transportation.

**Baseline Mode Share = (Bicycle Commutes + Walking Commutes) / All Commutes**

### Step 4: Increase the Jurisdictional Active Mode Share

Following the literature review in the [Quantifying Reductions in Vehicle Miles Traveled from New Bicycle Facilities Technical Documentation from the California Air Resources Board](#), a uniform growth rate of 100% is appropriate for new facilities, with cyclist and non-cyclists preferring separated facilities. Given the lack of existing facilities along most of the corridor and the overall lack of a comprehensive regional trails network, the current jurisdiction-wide mode share was doubled to account for the increase expected on the Fall Line, ART, and spur trails.

**Adjusted Mode Share = Baseline Mode Share \* Growth Factor (2)**

### Step 5: Calculate new Active Transportation Users

The adjusted mode share was then applied to the total number of people traveling along the corridor to give an estimate of the expected cyclist and pedestrians using the facility. This estimate was reviewed against other regional facilities and was found to be conservative. The expectation is that this figure will continue to grow over the life of the facility.

**Expected Trail Users = Travelers \* Adjusted Mode Share**

### Step 6: Calculate new AADT

Finally, the new average annual daily traffic is calculated. The expected number of cyclists and pedestrians are removed from the total number of travelers along the corridor. The adjusted number of travelers is then converted to daily traffic using average vehicle occupancy.

**New Travelers = Travelers – Expected Trail Users**

**New AADT = New Travelers / Average Vehicle Occupancy (1.67)**

### Step 7: Use AADT Values with CMAQ Toolkit to Estimate Emissions Reduction

The final step in our GHG reduction calculation was to enter the original and new AADT in the [CMAQ toolkit for Bicycle, Pedestrian, and Shared Micromobility Projects](#). Given the length of the overall trail, we used a national distribution of trips with an

average length of 2.0129 miles. To estimate benefits between 2025 and 2029, we used a 2029 evaluation year and applied the reduction to 2029 and 2030.

## Step 7: Apply growth factor for 2040 and calculate benefits

For 2030 to 2050, we used a 2040 evaluation year to represent the midpoint and applied the expected reduction to the full 20-year period.

To estimate benefits for 2040, a growth factor was applied to the numbers of trail users based on the experience of similar facilities around the Commonwealth of Virginia and country. The Virginia Capital Trail, a rural shared use path connecting Richmond to Williamsburg, Virginia, saw 7% annual growth between 2015 ([800,000 annual users](#)) and 2021 ([1.2 million annual users](#)). The Razorback Greenway, a comparable regional spine trail in Bentonville, Arkansas, saw a 5.8% annual growth rate from [2015](#) to [2019](#). Taking a conservative approach, the projected users were estimated to grow at 6% per year.

The resulting calculations and CMAQ toolkit outputs are shown for each jurisdiction.

## Chesterfield

Existing Traffic Volumes:

| Road        | From          | To         | Length | AADT  | Weighted      |
|-------------|---------------|------------|--------|-------|---------------|
| Iron Bridge | Womack        | Harrowgate | 0.67   | 22000 | 2,366         |
| Iron Bridge | Harrowgate    | Chester    | 0.25   | 32000 | 1,284         |
| Chester     | Iron Bridge   | Centralia  | 1.77   | 11000 | 3,125         |
| Chester     | Centralia     | 288        | 0.46   | 23000 | 1,698         |
| Chester     | 288           | Kingsdale  | 0.7    | 6200  | 697           |
| Kingsdale   | Chester       | Rte 1      | 0.84   | 4100  | 553           |
| Rte 1       | Willis        | Chester    | 0.64   | 17000 | 1,746         |
| Rte 1       | Chester       | Gettings   | 0.4    | 19000 | 1,220         |
| Rte 1       | Falling Creek | Walmsley   | 0.5    | 21000 | 1,685         |
|             |               |            |        |       | <b>14,375</b> |

$$\text{Total Travelers} = 14,375 * 1.67 = 24,006$$

$$2029 \text{ AADT} = (24,006 - 339) / 1.67 = 14,172$$

Mode Share Estimate

$$2040 \text{ AADT} = (24,006 - 1,152) / 1.67 = 13,685$$

| 2022 5-Year ACS<br>(Table B08301) |      |
|-----------------------------------|------|
| Walk                              | 0.6% |
| Bike                              | 0.1% |
| Total                             | 0.7% |
| Doubled                           | 1.4% |

$$2029 \text{ Trail Users} = 1.4\% * 24,006 = 339$$

$$2040 \text{ Trail Users} = 339 * 1.06^{11} = 1,152$$

| CMAQ Toolkit Output |         |             |                 |
|---------------------|---------|-------------|-----------------|
| 2029                | kg/day  | kg/yr       | ton/yr          |
| CO2                 | 136.208 | 49716.07467 | 49.71607        |
| CO2e                | 136.838 | 49945.84358 | <b>49.94584</b> |
|                     |         |             |                 |
| 2040                | kg/day  | kg/yr       | ton/yr          |
| CO2                 | 407.351 | 148683.1022 | 148.6831        |
| CO2e                | 409.128 | 149331.7446 | <b>149.3317</b> |

# Henrico

## Existing Traffic Volume

|             | AADT |
|-------------|------|
| Mountain Rd | 3500 |

Total Travelers = 3,500 \* 1.67 = 5,845

## Mode Share Estimate

| 2022 5-Year ACS<br>(Table B08301) |      |
|-----------------------------------|------|
| Walk                              | 0.7% |
| Bike                              | 0.1% |
| Total                             | 0.8% |
| Doubled                           | 1.6% |

2029 Trail Users = 1.6% \* 5,845 = 94

2040 Trail Users = 94 \* 1.06<sup>11</sup> = 320

2029 AADT = (5,845 – 94) / 1.67 = 3,444

2040 AADT = (5,845 – 320) / 1.67 = 3,308

| CMAQ Toolkit Output |          |          |          |
|---------------------|----------|----------|----------|
| 2029                | kg/day   | kg/yr    | ton/yr   |
| CO2                 | 37.57474 | 13714.78 | 13.71478 |
| CO2e                | 37.74839 | 13778.16 | 13.77816 |
|                     |          |          |          |
| 2040                | kg/day   | kg/yr    | ton/yr   |
| CO2                 | 113.3498 | 41372.69 | 41.37269 |
| CO2e                | 113.8443 | 41553.18 | 41.55318 |

# Petersburg

## Existing Traffic Volume

|           | AADT  |
|-----------|-------|
| Grove Ave | 2,300 |
| High St   | 1,800 |

|                        |        |
|------------------------|--------|
| N Washington           | 12,000 |
| Combined Parallel AADT | 16,100 |

Total Travelers = 16,100 \* 1.67 = 26,887

## Mode Share Estimate

| 2022 5-Year ACS<br>(Table B08301) |      |
|-----------------------------------|------|
| Walk                              | 1.2% |
| Bike                              | 0.1% |
| Total                             | 1.3% |
| Doubled                           | 2.6% |

2029 Trail Users = 2.6% \* 26,887 = 699

2040 Trail Users = 699 \* 1.06<sup>11</sup> = 1,423

2029 AADT = (26,887 – 699) / 1.67 = 15,681

2040 AADT = (26,887 – 1,423) / 1.67 = 14,677

| CMAQ Toolkit Output |          |          |          |
|---------------------|----------|----------|----------|
| 2029                | kg/day   | kg/yr    | ton/yr   |
| CO2                 | 280.8712 | 102518   | 102.518  |
| CO2e                | 282.1692 | 102991.8 | 102.9918 |
|                     |          |          |          |
| 2040                | kg/day   | kg/yr    | ton/yr   |
| CO2                 | 840.0876 | 306632   | 306.632  |
| CO2e                | 843.7525 | 307969.7 | 307.9697 |

## Richmond

Existing Traffic Volumes:

| Road         | From      | To        | Length | AADT  | Weighted     |
|--------------|-----------|-----------|--------|-------|--------------|
| Rte 1        | Walmsley  | Bellmeade | 2.1    | 11492 | 2,932        |
| Bellemeade   | Rte 1     | Commerce  | 2.9    | 6800  | 2,396        |
| Chamberlayne | Duval     | Brook     | 0.1    | 6300  | 100          |
| Brook        | Rte 1     | Lombardy  | 0.8    | 8000  | 778          |
| Brook        | Lombardy  | Brookland | 0.6    | 10000 | 729          |
| Brookland    | Brook     | Hermitage | 0.8    | 9300  | 904          |
| Hermitage    | Brookland | Bellevue  | 0.9    | 6500  | 711          |
|              |           |           |        |       | <b>8,549</b> |

Total Travelers =  $8,549 * 1.67 = 14,278$

2029 AADT =  $(14,278 - 1,695) / 1.67 = 7,534$

Mode Share Estimate

2040 AADT =  $(14,278 - 3,451) / 1.67 = 5,098$

| 2022 5-Year ACS<br>(Table B08301) |       |
|-----------------------------------|-------|
| Walk                              | 4.3%  |
| Bike                              | 1.7%  |
| Total                             | 5.9%  |
| Doubled                           | 11.9% |

| CMAQ Toolkit Output |          |          |                 |
|---------------------|----------|----------|-----------------|
| 2029                | kg/day   | kg/yr    | ton/yr          |
| CO2                 | 681.0421 | 248580.4 | 248.5804        |
| CO2e                | 684.1896 | 249729.2 | <b>249.7292</b> |
|                     |          |          |                 |
| 2040                | kg/day   | kg/yr    | ton/yr          |
| CO2                 | 2037.345 | 743631   | 743.631         |
| CO2e                | 2046.233 | 746875.1 | <b>746.8751</b> |

2029 Trail Users =  $11.9\% * 14,278 = 1,695$

2040 Trail Users =  $1,695 * 1.06^{11} = 3,451$

## Full Fall Line Trail Estimate

| <b>Rte</b> | <b>From</b>          | <b>To</b>            | <b>Locality</b> | <b>AADT</b> | <b>Weighted AADT</b> | <b>People</b> |
|------------|----------------------|----------------------|-----------------|-------------|----------------------|---------------|
| US-1       | Ashcake Rd           | Ashland SCL          | Ashland         | 16,000      | 661                  | 26,720        |
| US-1       | Ashland SCL          | Lewistown Rd         | Hanover         | 15,000      | 341                  | 25,050        |
| US-1       | Lewistown Rd         | Sliding Hill Rd      | Hanover         | 15,000      | 205                  | 25,050        |
| US-1       | Sliding Hill Rd      | Henrico CL           | Hanover         | 22,000      | 301                  | 36,740        |
| US-1       | Henrico CL           | JEB Stuart Pkwy      | Henrico         | 22,000      | 384                  | 36,740        |
| US-1       | JEB Stuart Pkwy      | Virginia Center Pkwy | Henrico         | 25,000      | 277                  | 41,750        |
| US-1       | Virginia Center Pkwy | I-295                | Henrico         | 34,000      | 713                  | 56,780        |
| US-1       | I-295                | Parham Rd            | Henrico         | 20,000      | 833                  | 33,400        |
| US-1       | Parham Rd            | Wilkinson Rd         | Henrico         | 17,000      | 238                  | 28,390        |
| US-1       | Wilkinson Rd         | Hilliard Rd          | Henrico         | 21,000      | 440                  | 35,070        |
| US-1       | Hilliard Rd          | I-95                 | Henrico         | 19,000      | 459                  | 31,730        |
| US-1       | I-95                 | NCL Richmond         | Henrico         | 14,000      | 122                  | 23,380        |
| US-1       | NCL Richmond         | Laburnum Ave         | Richmond        | 7,000       | 243                  | 11,690        |
| US-1       | Laburnum Ave         | Brookland Park Blvd  | Richmond        | 9,100       | 221                  | 15,197        |
| US-1       | Brookland Park Blvd  | Lombardy St          | Richmond        | 10,000      | 192                  | 16,700        |
| US-1       | Lombardy St          | Chamberlayne Pkwy    | Richmond        | 8,000       | 161                  | 13,360        |
| US-1       | Chamberlayne Pkwy    | US 250               | Richmond        | 34,000      | 396                  | 56,780        |

|      |                        |                        |                  |        |       |        |
|------|------------------------|------------------------|------------------|--------|-------|--------|
| US-1 | US 250                 | Franklin St            | Richmond         | 37,000 | 162   | 61,790 |
| US-1 | Franklin St            | 2nd St                 | Richmond         | 30,000 | 803   | 50,100 |
| US-1 | 2nd St                 | Semmes Ave             | Richmond         | 34,000 | 752   | 56,780 |
| US-1 | Semmes Ave             | US 360                 | Richmond         | 26,000 | 295   | 43,420 |
| US-1 | US 360                 | Hopkins Rd             | Richmond         | 20,000 | 588   | 33,400 |
| US-1 | Hopkins Rd             | Bellemeade             | Richmond         | 14,000 | 350   | 23,380 |
| US-1 | Bellemeade             | SCL Richmond           | Richmond         | 11,000 | 682   | 18,370 |
| US-1 | SCL Richmond           | SR 150                 | Chesterfield     | 21,000 | 715   | 35,070 |
| US-1 | SR 150                 | Chester Rd             | Chesterfield     | 19,000 | 1,333 | 31,730 |
| US-1 | Chester Rd             | Willis Rd              | Chesterfield     | 17,000 | 317   | 28,390 |
| US-1 | Willis Rd              | SR 288                 | Chesterfield     | 19,000 | 896   | 31,730 |
| US-1 | SR 288                 | SR 10                  | Chesterfield     | 25,000 | 1,201 | 41,750 |
| US-1 | SR 10                  | Old Bermuda Hundred Rd | Chesterfield     | 20,000 | 524   | 33,400 |
| US-1 | Old Bermuda Hundred Rd | Happy Hill Rd          | Chesterfield     | 15,000 | 1,048 | 25,050 |
| US-1 | Happy Hill Rd          | Woods Edge Rd          | Chesterfield     | 17,000 | 89    | 28,390 |
| US-1 | Woods Edge Rd          | Harrowgate Rd          | Chesterfield     | 18,000 | 692   | 30,060 |
| US-1 | Harrowgate Rd          | NCL Colonial Heights   | Chesterfield     | 24,000 | 154   | 40,080 |
| US-1 | NCL Colonial Heights   | Sherwood Ave           | Colonial Heights | 26,000 | 469   | 43,420 |
| US-1 | Sherwood Ave           | Ellerslie Ave          | Colonial Heights | 27,000 | 149   | 45,090 |

|                |                    |                    |                  |        |               |                  |
|----------------|--------------------|--------------------|------------------|--------|---------------|------------------|
| US-1           | Ellerslie Ave      | Lakeview Ave       | Colonial Heights | 23,000 | 114           | 38,410           |
| US-1           | Lakeview Ave       | Temple Ave         | Colonial Heights | 21,000 | 452           | 35,070           |
| US-1           | Temple Ave         | Branders Bridge Rd | Colonial Heights | 25,000 | 189           | 41,750           |
| US-1           | Branders Bridge Rd | Westover Ave       | Colonial Heights | 23,000 | 221           | 38,410           |
| US-1           | Westover Ave       | Dupuy Ave          | Colonial Heights | 23,000 | 268           | 38,410           |
| US-1           | Dupuy Ave          | NCL Petersburg     | Colonial Heights | 14,000 | 216           | 23,380           |
| Weighted Total |                    |                    |                  |        | <b>18,867</b> | <b>31,507.48</b> |

| Locality         | Active Mode Share | Growth Factor | New Mode Share | Sum of Length | Weighted Mode Share |
|------------------|-------------------|---------------|----------------|---------------|---------------------|
| Ashland          | 7.93%             | 100.00%       | 15.86%         | 1.42          | 0.66%               |
| Chesterfield     | 0.71%             | 100.00%       | 1.41%          | 12.51         | 0.51%               |
| Colonial Heights | 1.87%             | 100.00%       | 3.75%          | 3.24          | 0.35%               |
| Hanover          | 1.20%             | 100.00%       | 2.41%          | 1.72          | 0.12%               |
| Henrico          | 0.81%             | 100.00%       | 1.61%          | 5.46          | 0.26%               |
| Richmond         | 5.94%             | 100.00%       | 11.87%         | 10.003        | 3.46%               |
| Grand Total      | 2.65%             | 100.00%       | 5.30%          | 34.353        | <b>5.36%</b>        |

Average FLT Commuters per Day (2029) = 31,507 \* 5.36% = 1,688

Average FLT Commuters per Year (2029) = 1,688 \* 365 = 616,120

Average FLT Commuters per Day (2040) = 1,688 \* 1.06 ^ (2040 – 2029) = 3,204

Average FLT Commuters per Year (2040) = 3,204 \* 365 = 1,169,460