Priority Active Connections Explorer (PACE) Methodology Report

COLORADO
Department of Transportation

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PACE Overview

Designed by the Colorado Department of Transportation (CDOT), the PACE (Priority Active Connections Explorer) Tool is an interactive, map-based decision-support platform to help planners and engineers assess and prioritize highway segments for active transportation improvements. Built on a robust framework of data-driven criteria, the PACE Tool guides decision-making across four key goal areas: Safety, Equity, Mobility Choice, and Connected Communities. It offers three core functions—Heat Map, Compare, and Filter—to support a range of planning activities, from statewide screening to site-specific evaluation.

- **Heat Map: Statewide Visualization of Needs**: The Heat Map function provides a powerful visualization of scoring results across Colorado's state highway network. Users can view relative performance in each of the four goal areas, along with a combined total score. Color-coding indicates segment performance and helps users quickly identify high-priority locations based on data such as vulnerable road user crashes, equity indicators, facility gaps, access to recreation and transit, and more. Clicking on a segment reveals detailed information via a pop-up that offers transparency into the underlying scoring.
- **Filter: Focused Identification of Priority Locations:** The Filter function allows users to refine their analysis to a specific geography and set of goals. Users can define an area of interest, such as a CDOT Region, metropolitan planning organization (MPO), county, or individual state highway, and select which Active Transportation Plan (ATP) goal areas to emphasize. The tool highlights the top-performing segments based on this customized focus and considers gaps in the active transportation network and other key factors. This targeted output helps planners and engineers quickly generate a shortlist of candidate locations for active transportation improvements.
- **Compare: Side-by-Side Evaluation of Segments or Corridors:** The Compare function enables side-by-side analysis of two or more highway segments or corridors. This function is especially useful when evaluating potential projects for funding or prioritization. Users can select routes or specific mileposts on two parallel maps (Map A and Map B) and review scoring and attribute data in synchronized panels. The tool dynamically updates results as users select segments and calculates average scores when multiple segments are selected. A dedicated dialog box presents attribute details and evaluation criteria to offer a comprehensive snapshot of each location's performance.

Together, these tools form a comprehensive system for prioritizing investments that enhance safety, equity, mobility, and connectivity for all road users. The PACE Tool is designed for use by CDOT, regional planners, and local jurisdictions and reflects a commitment to transparent, data-informed planning for active transportation across Colorado's state highway network.

Use in Context: A Tool to Inform, Not Prescribe

While the PACE Tool provides robust, data-driven insights about where improvements may have the greatest impact, it does not recommend specific facility types or designs. The tool should be used in conjunction with professional engineering judgment and a nuanced understanding of local conditions, community priorities, and the surrounding active transportation network. Ground-truthing, engagement, and contextual analysis remain essential components of planning and project development.

Methodology

The methodology behind the PACE Tool provides the technical foundation for scoring and prioritizing Colorado's highway segments for active transportation investment. The PACE Tool was developed to support data-driven, transparent decision-making. The methodology outlines how each of the four goal areas—Safety, Equity, Mobility Choice, and Connected Communities—is quantified using publicly available datasets, geospatial analysis, and normalized scoring techniques. A distinct set of metrics supports each goal area to reflect statewide priorities and conditions, such as vulnerable road user (VRU) crashes, community demographics, facility gaps, and access to transit, parks, schools, and employment.

The state highway network was analyzed in one-mile segments, using CDOT's milepost highway layer. A total of 9,337 segments were analyzed for the PACE Tool. This section details how each criterion is defined and calculated to ensure that users understand the structure and rationale behind the PACE Tool's scoring system and can apply it appropriately in their planning efforts.

Safety

The Safety component of the PACE Tool evaluates the potential for improving conditions for vulnerable road users (VRUs) across Colorado's state highway network. This evaluation draws on three complementary data sources—VRU crashes, the High Injury Network (HIN), and Level of Traffic Stress (LTS)—to provide a multifaceted understanding of safety challenges. Together, these indicators capture both documented crash history and systemic risk factors that impact the comfort and safety of people walking, biking, and using mobility devices. While VRU crashes highlight where incidents of any severity level have occurred, HIN identifies locations with high concentrations of severe crashes, and LTS reflects the underlying roadway conditions that may deter less confident or less experienced users. This combined approach ensures that both reactive and proactive safety needs are represented in the scoring, allowing planners and engineers to prioritize improvements where they can make the greatest impact—even in locations that have not yet experienced serious incidents. The Safety score for each segment is calculated as the average of its VRU, HIN, and LTS scores, providing a comprehensive indicator of potential need for safety-focused active transportation investments.

VRU Crashes

- 2021–2023 data for crashes involving a motor vehicle and a bicyclists or pedestrian of any severity level.
- Calculated VRU crashes per mile.
- Normalized by the volume of bicycle/pedestrian trips from Streetlight data (by census tract, 2019-2022), resulting in VRU crashes per mile per 1,000 bike/ped trips.
- VRU score is the VRU/Mile/1,000 Bike Ped Trips on a segment divided by the MAX VRU/Mile/1,000 Bike Ped Trip (47.0).
- VRU score ranges from 0 to 1.
- 8,533 segments have 0 VRU crashes.

Figure 1 provides a histogram of the remaining 804 segments (non-zero value segments). Approximately 375 segments have VRU/Mile/1,000 Bike Ped Trip values less than 1, and approximately 160 segments have VRU/Mile/1,000 Bike Ped Trip values between 1 and 2. Very few segments (less than 1 percent) have values above 9.

Figure 1. Histogram of VRU/Mile/1,000 Bike Ped Trip

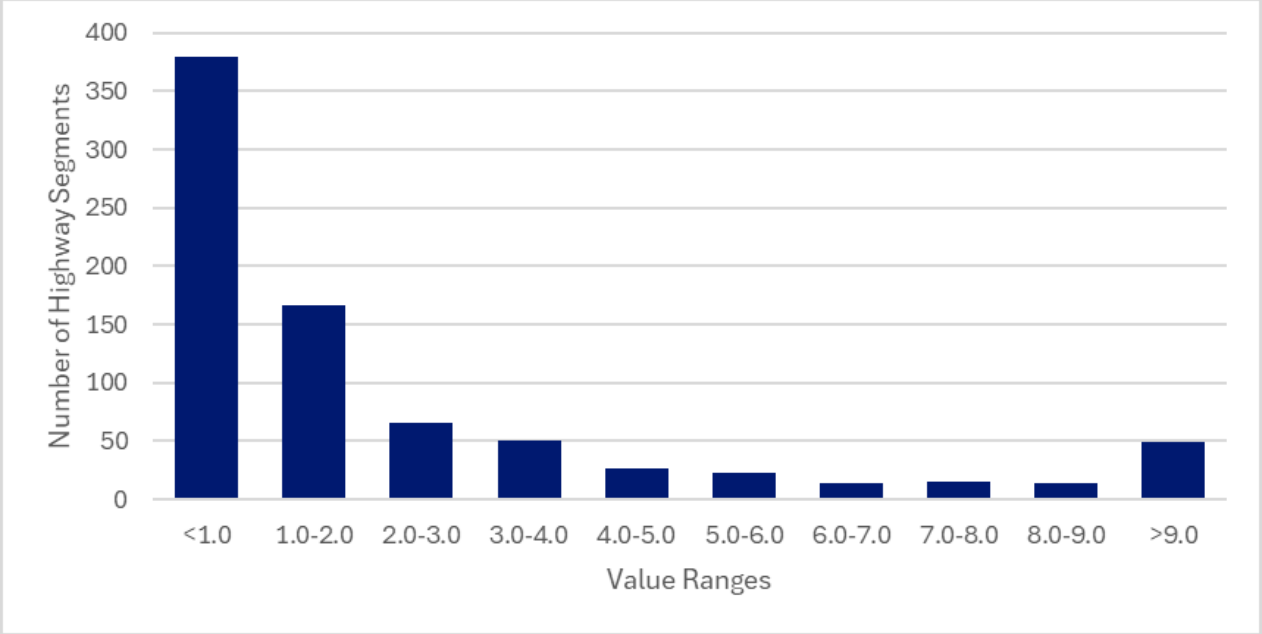
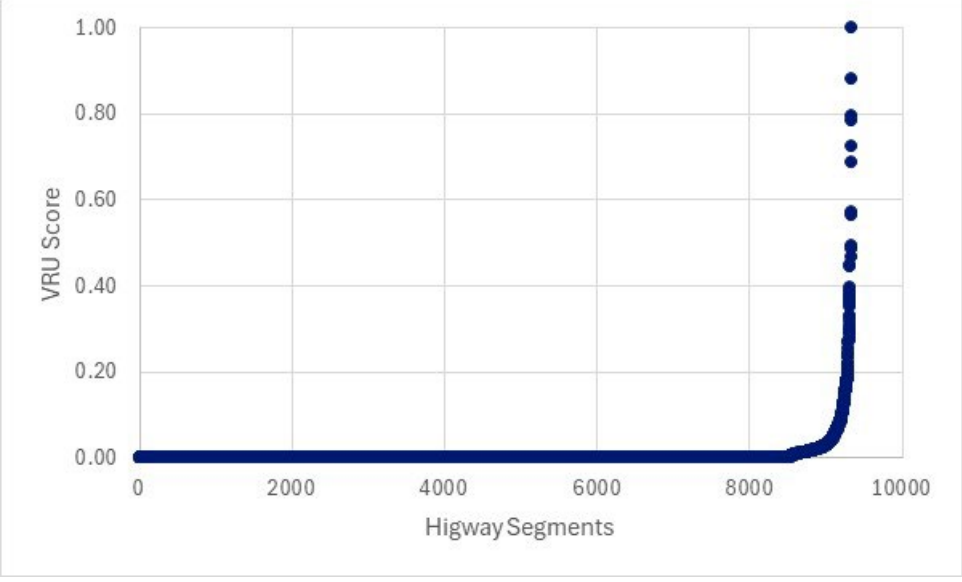


Figure 2 shows the distribution of VRU scores (from 0 to 1) across the 9,337 segments. Most of the state highway network (91 percent) did not experience a VRU crash during the three-year period and, therefore, received a VRU score of 0. As this metric only includes reported crashes involving a VRU and a motor vehicle, it does not reflect VRU-involved crashes that were not reported to law enforcement or VRU crashes that did not involve a motor vehicle.

Figure 2. Distribution of VRU Scores

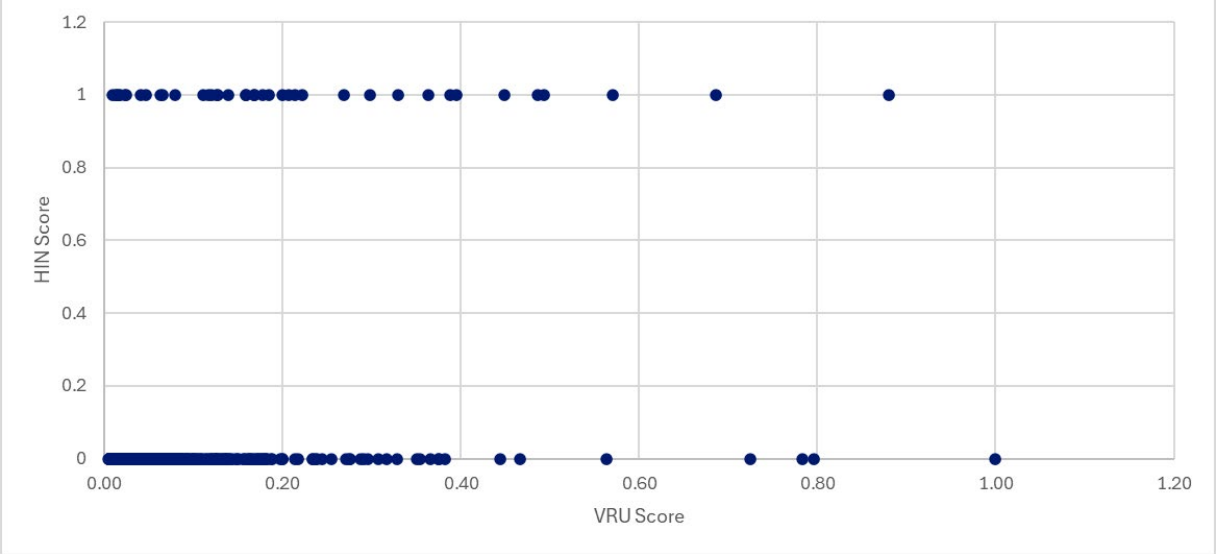


High Injury Network (HIN)

- HIN is defined in the 2023 CDOT VRU Safety Assessment by analyzing serious injury and fatal crashes involving VRUs (pedestrians, bicyclists, and other non-motor vehicle users) from 2017-2021 crash data. The HIN includes corridors and intersections with the highest concentrations of these severe crashes, effectively identifying the road segments where safety improvements can have the greatest impact.
- HIN includes 26 locations on the state highway network. These 26 locations are associated with 40 of the 1-mile segments used in the PACE analysis. The VRU Safety Assessment also identifies 13 HIN locations for locally-owned roads, which are not included in the PACE tool.
- HIN is located in only five MPO/Transportation Planning Regions (TPRs): Denver Regional Council of Governments (DRCOG), Pikes Peak Area Council of Governments (PPACG), Grand Valley, Gunnison Valley, and Southwest.
- HIN score: If a segment is on the HIN, then the score is 1; otherwise, the score is 0.
- All HIN segments have at least one VRU crash (2021–2023).

Figure 3 presents a comparison of VRU scores versus HIN scores. The HIN Score is binary (0 or 1), reflecting whether a location is part of the High Injury Network. In contrast, the VRU Score is continuous, ranging from 0 to 1, and captures a broader set of risk indicators for vulnerable road users, such as exposure, relative frequency, and conflict points. The lack of clustering or a clear upward trend indicates no strong correlation between the two scores. Many locations with high VRU Scores are not part of the HIN, and vice versa. This supports the conclusion that the two metrics capture different dimensions of safety risk and are not duplicative. Including both ensures that locations with systemic risk factors (VRU Score) are not overlooked simply because they haven't yet experienced severe crashes (HIN Score).

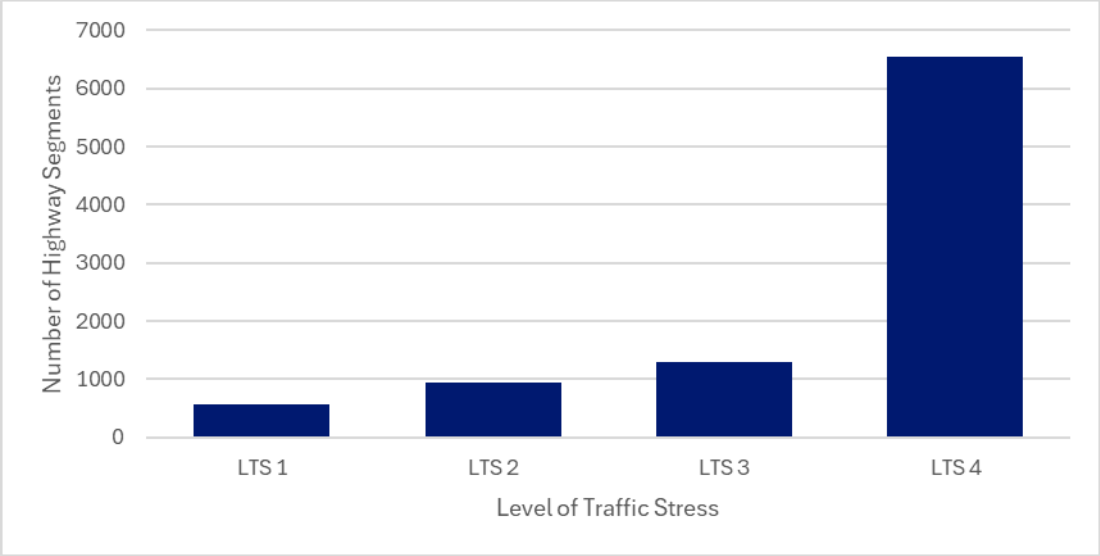
Figure 3. VRU Scores versus HIN Scores



Level of Traffic Stress

- Used CDOT 2016 Level of Traffic Stress (LTS) analysis as the basis. Level of Traffic Stress (LTS) is a method used to classify streets based on how safe and comfortable they feel for people biking, especially those who are less experienced or confident. It ranges from LTS 1, suitable for all ages and abilities with low-speed, low-volume streets or protected bike paths, to LTS 4, which includes high-speed, high-volume roads only comfortable for the most fearless cyclists. LTS is calculated using roadway characteristics such as traffic speed, volume, number of lanes, presence and type of bike infrastructure, and intersection design. This data-driven approach helps identify gaps in low-stress networks, prioritize improvements, and support planning for safer, more accessible bicycling infrastructure.
- **Figure 4** shows a histogram of LTS by segment. More than 6,000 segments have LTS 4 (the least comfortable). Only around 500 segments have LTS 1.

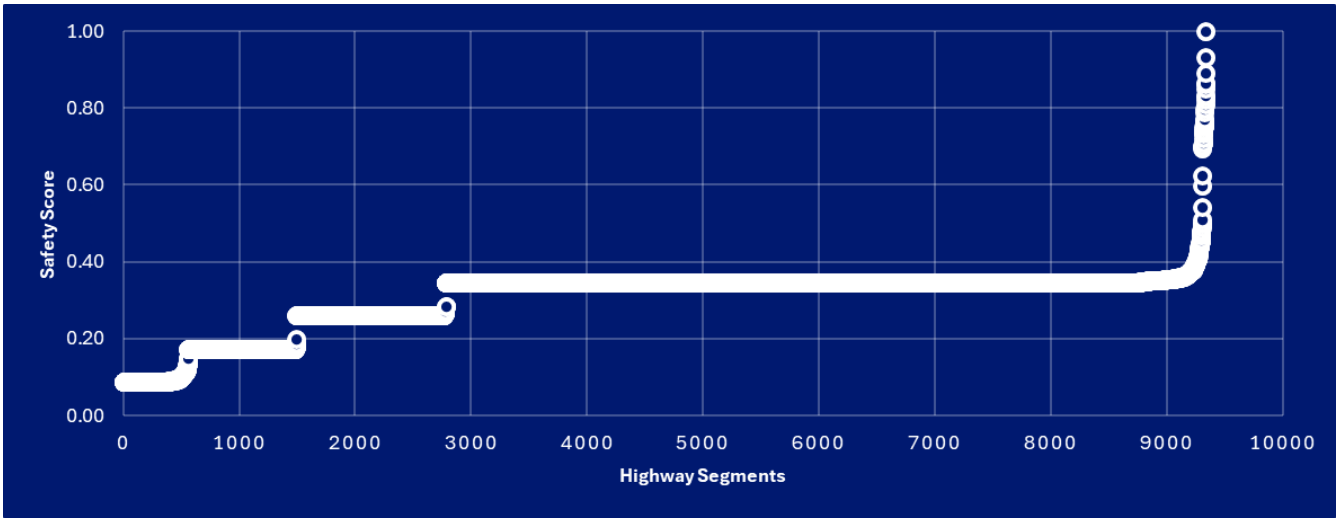
Figure 4. Level of Traffic Stress



- LTS 4 received the highest score (1) representing the greatest need for improvement.
- LTS 1 received a score of 0.25; LTS 2, a score of 0.5; and LTS 3, a score of 0.75.
- The LTS analysis provided an LTS 1 rating for highway segments with a parallel multiuse path.
- If a highway segment included multiple LTS values, the highest (i.e., most stressful) LTS was assigned to represent the segment, ensuring that any high-stress conditions within the one-mile stretch were accurately captured.

The distribution of the total Safety score, shown on **Figure 5,** is calculated as the average of the VRU, HIN, and LTS scores for each segment. Around 9,200 segments have Safety scores less than 0.40, and around 500 segments have Safety scores of 0.10. The 90 segments that scored above 0.40 represent the greatest opportunities to address safety for active transportation.

Figure 5. Distribution of Safety Scores



Equity

The Equity component of the PACE Tool identifies highway segments where active transportation investments can most directly benefit populations that face systemic barriers and transportation-related disparities. It combines two complementary indicators, Disproportionately Impacted (DI) Communities and Mobility Barriers, to assess the degree to which different communities may lack equitable access to safe, comfortable, and connected active transportation options. The DI Community score is based on the number of environmental justice and socioeconomic risk factors present within a segment's surrounding area, drawing from the Colorado Department of Public Health and Environment's EnviroScreen data and other statewide equity designations. These include metrics such as high percentages of low-income households, communities of color, linguistically isolated populations, and residents experiencing housing cost burdens.

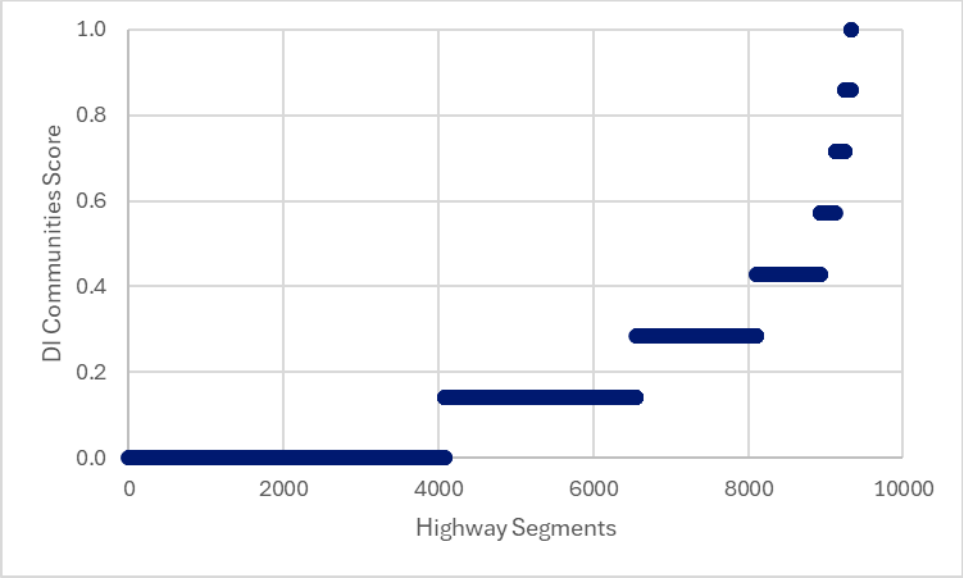
The Mobility Barrier score reflects demographic characteristics that can impact transportation access and independence, such as a high proportion of households without a vehicle, or a greater share of youth, older adults, or people with disabilities. Together, these two indicators help highlight locations where active transportation improvements can advance transportation equity by addressing longstanding mobility and access challenges. The final Equity Score combines both indicators using a balanced weighting approach, ensuring that environmental justice factors and population-specific mobility needs are considered equally.

Disproportionately Impacted Communities

- Used the Colorado Department of Public Health and Environment (CDPHE) EnviroScreen block group level data (2022) November 2024 analysis updates (Disproportionately Impacted Community map)
- Determined the number of Disproportionately Impacted (DI) Community factors in the intersecting block group(s)
  - Mobile home community (within 1 mile)
  - Low-income population above 40 percent
  - People of color population above 40 percent
  - Housing cost-burdened population above 50 percent
  - Linguistically isolated population above 20 percent
  - Colorado EnviroScreen percentile score above 80
  - Within a Justice40 census tract
  - Area under tribal jurisdiction
- The maximum number of factors in one road segment = 7 (out of 8).
- DI Community score is based on the number of DI Community factors divided by 7.

Figure 6 shows the distribution of the DI scores. Around 4,000 segments have a DI Community score of 0, while around 8,000 segments have DI score less than 0.40.

Figure 6. Distribution of DI Community Scores

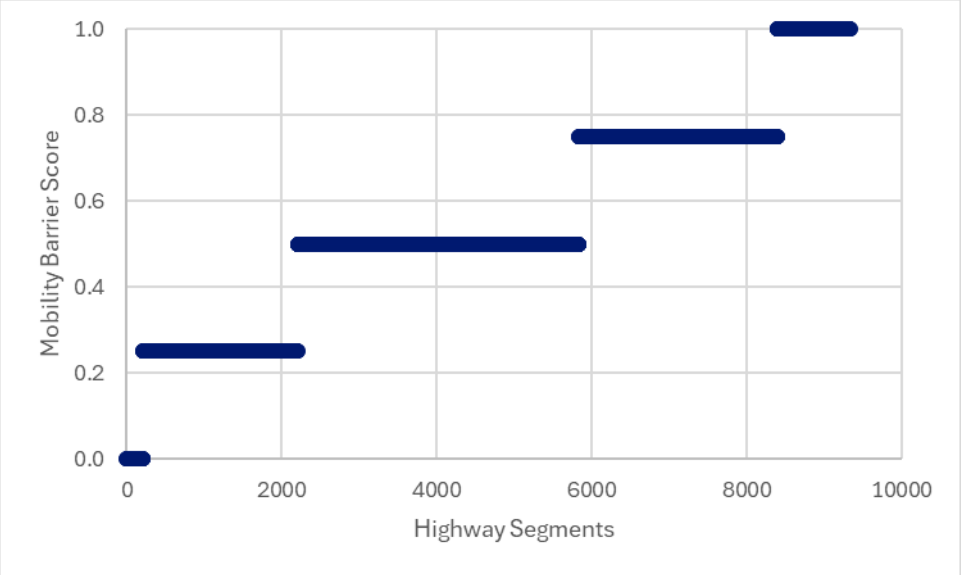


Mobility Barriers

- Determined the number of Mobility Barrier factors in the intersecting U.S. Census block group(s), using 2023 American Community Survey (ACS) 5-Year Estimates
  - Above statewide average percentage of households with zero vehicles (Table B08201)
  - Above statewide average percentage of population under 18 (Table DP05)
  - Above statewide average percentage of population over 65 (Table DP05)
  - Above statewide average percentage of population with a disability (Table S1810)
- The maximum number of factors in one road segment = 4.
- Mobility Barrier score is based on the number of Mobility Barrier factors divided by 4.

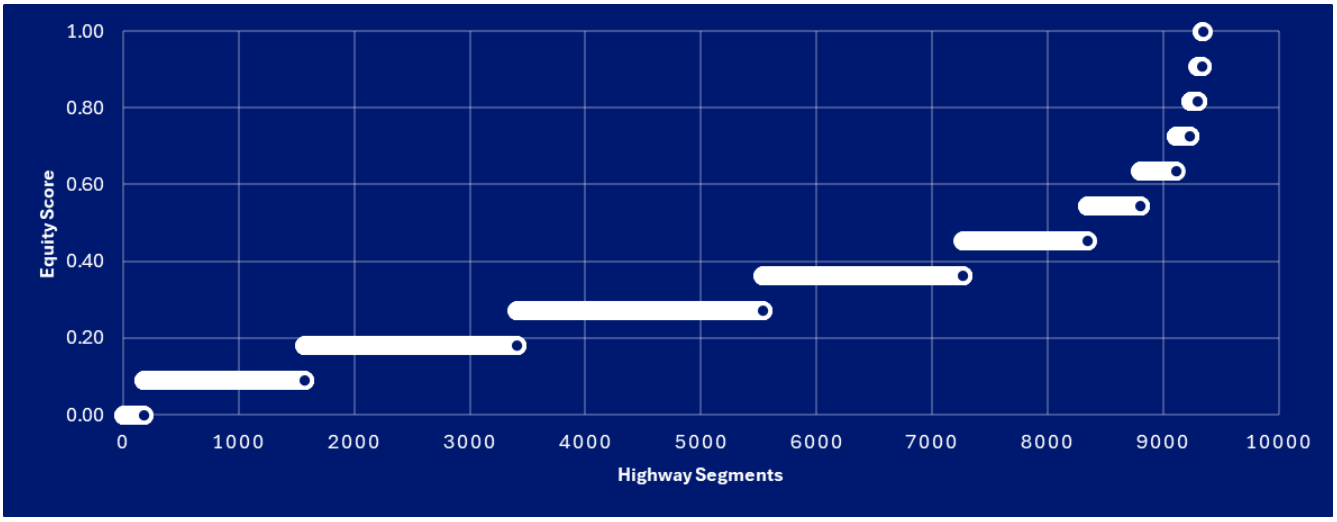
Figure 7 shows the distribution of the Mobility Barrier scores. Nearly all (98 percent) of state highway segments have at least one Mobility Barrier factor in the surrounding area. Around 2,900 segments (31 percent) have 3 or 4 Mobility Barrier factors in the surrounding area, resulting in a score of 0.75 or 1.0.

Figure 7. Distribution of Mobility Barrier Scores



The Equity Score is calculated as the DI Community score times 7 plus the Mobility Barrier score times 4, all of which is divided by 11 to give each equity factor equal weight. **Figure 8** illustrates the distribution of the total Equity Score. Around 7,300 segments have an Equity Score less than 0.40. The nearly 2,100 segments with an Equity Score above 0.4 represent the greatest opportunities to improve active transportation for DI communities and those with mobility challenges.

Figure 8. Distribution of Equity Scores



Mobility Choice

The Mobility Choice component of the PACE Tool evaluates opportunities to expand and enhance active transportation options across Colorado's state highway network. This goal area focuses on identifying where investments can increase the availability and attractiveness of walking, biking, and rolling as viable alternatives to vehicle travel. The score is based on three key factors: existing facility presence, potential for short active trips, and current demand for recreational active transportation.

Network connectivity is assessed using the presence or absence of existing bicycle and pedestrian infrastructure, with higher scores assigned to segments lacking facilities or containing network gaps (a lack of existing bicycle or pedestrian facilities on a portion of the one-mile segment). This ensures that investment is directed where infrastructure is most needed. The potential for mode shift is reflected in the volume of short trips (0–3 miles) estimated and forecasted by the Statewide Travel Demand Model; trips that are most likely to be made by active modes if safe and comfortable facilities are available. Finally, actual bike usage data from Strava Metro provides insight into current levels of recreational active transportation demand across the state.

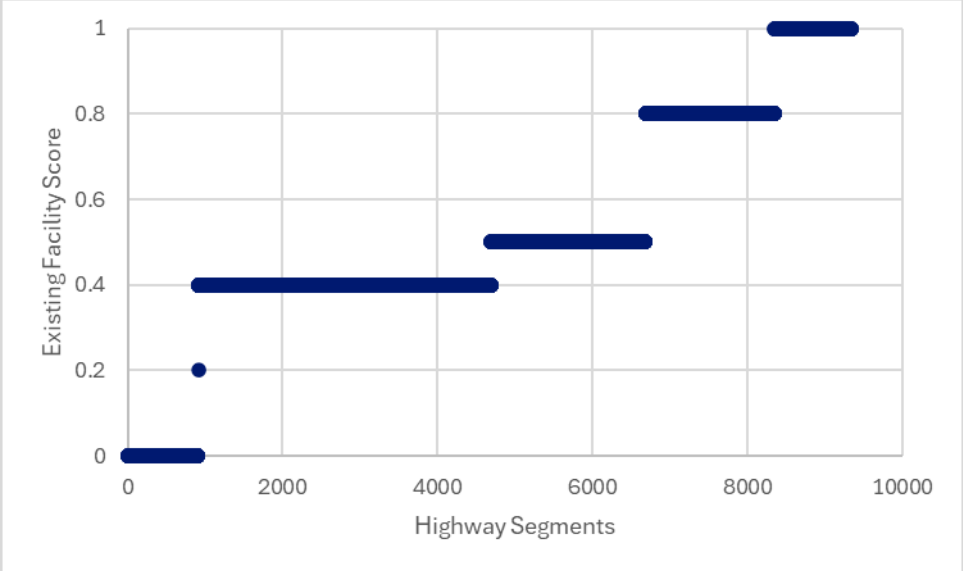
These three elements are averaged to create a comprehensive Mobility Choice score for each segment, highlighting locations where investments can meaningfully expand multimodal travel options.

Network Connectivity

- The presence of an existing active transportation facility on each state highway segment was determined using the CDOT Bicycle and Pedestrian Facility Inventory from 2016, updated to reflect shoulder width data as of 2023. Refer to the "Bicycle and Pedestrian Infrastructure Inventory Technical Overview" from March 1, 2017 for information on how facilities were defined. Additional bicycle facilities were identified using 2023 roadway data, by determining the roadway segments for which bicycling was permitted that had paved, continuous shoulders at least 4 feet wide. Segments received the following scores based on facility type:
  - 0 if bike **and** ped facility exist along the entire length
  - 0.25 if parallel multiuse path exists within ½ mile of corridor but there is no facility on the corridor
  - 0.5 if bike **or** ped facility exists along entire length
  - 1 if no facility exists or if there is a gap in facilities (favors investment in locations where no facility exists and where there is a gap)
- Proposed or designated U.S. Bikeway and/or designated Scenic Byway
  - Score of 1 if either; otherwise, score of 0
- The full Facility score is awarded if the segment is part of a proposed or designated U.S. Bikeway or a designated Scenic Byway; otherwise, the score is reduced by 20% to prioritize the addition of facilities along designated routes.

Figure 9 shows the distribution of existing Facility scores. Ninety percent of state highway segments score 0.4 or higher, indicating a lack of existing active transportation facilities.

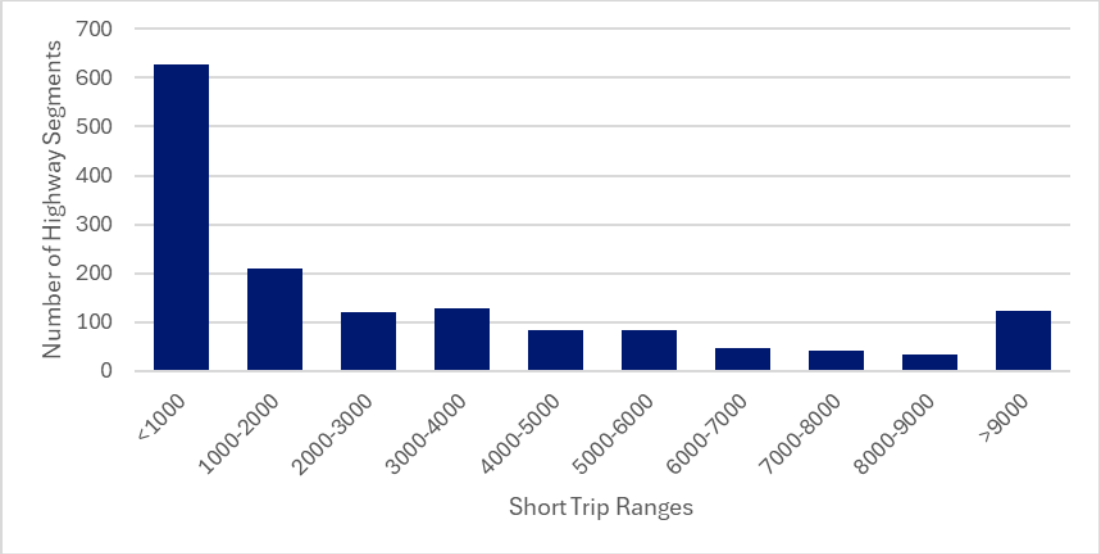
Figure 9. Distribution of Existing Facility Scores



Short Trips

- The Statewide Travel Demand Model (2015 Existing and 2045 Future) was used to identify the volume of short trips (one-way trip length of 0-3 miles) on each state highway segment.
- Summed the Existing and Future Short Trips.
- Identified 7,840 segments as having 0 short trips. **Figure 10** presents a histogram of the remaining 1,497 segments. Over 600 segments have between 1 and 1,000 short trips. The number of segments with higher volumes of short trips tapers off quickly, with the highest volume of short trips (existing plus future) at 48,463.

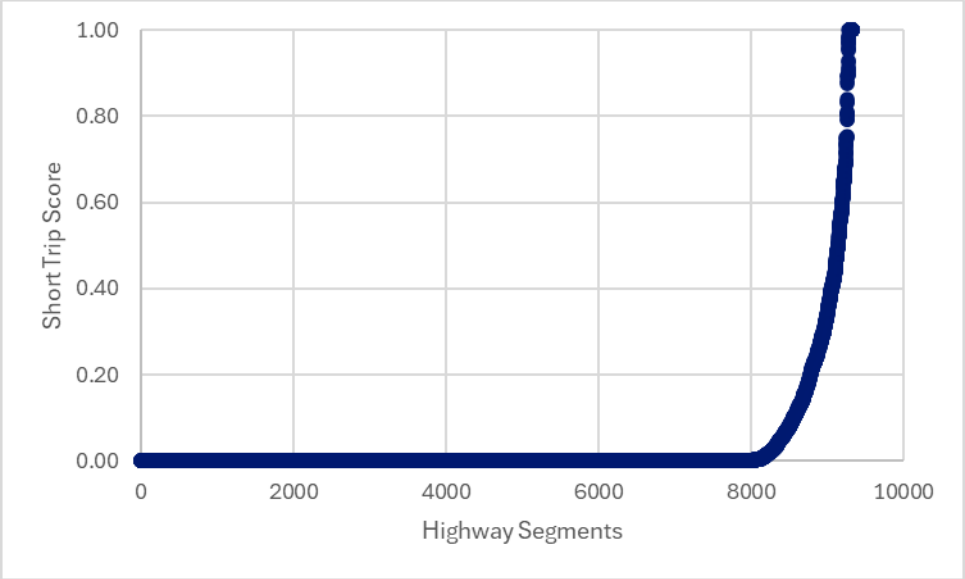
Figure 10. Histogram of Short Trips (Existing + Future)



- The maximum score in a rural Transportation Planning Region (TPR) (excluding the five Metropolitan Planning Organizations [MPOs]) is 14,038 (there is one higher TPR score of 30,959, but it is an outlier). Any segment with 14,038 short trips or more receives a score of 1. Remaining segments are scored as short trips divided by 14,038.

Figure 11 shows the distribution of Short Trip scores, ranging from 0 to 1. More than 8,000 segments (85 percent) have a Short Trip score of 0.

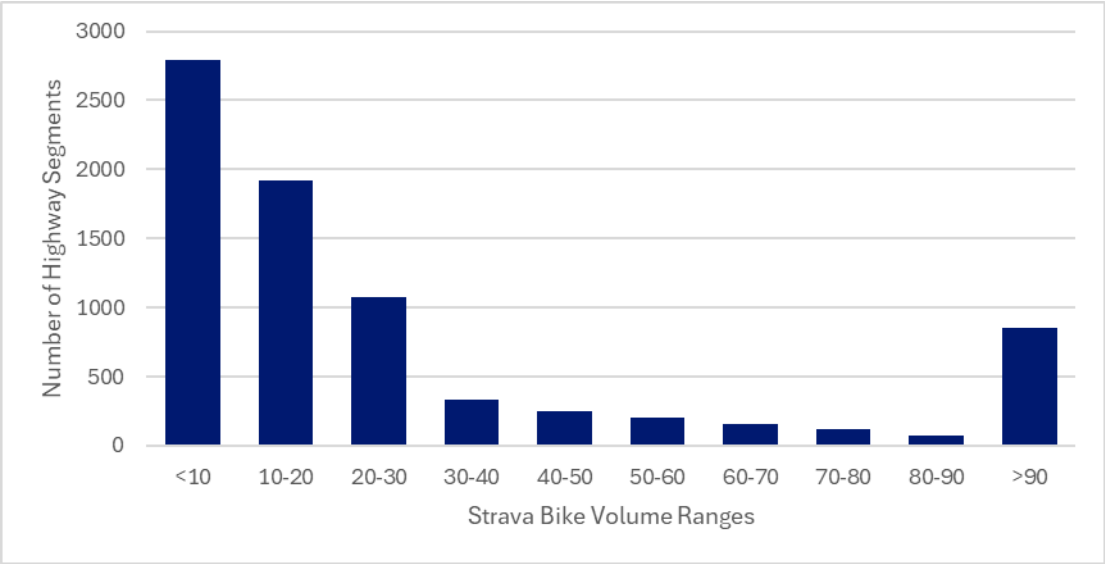
Figure 11. Distribution of Short Trip Scores



Current Recreational Active Transportation Demand

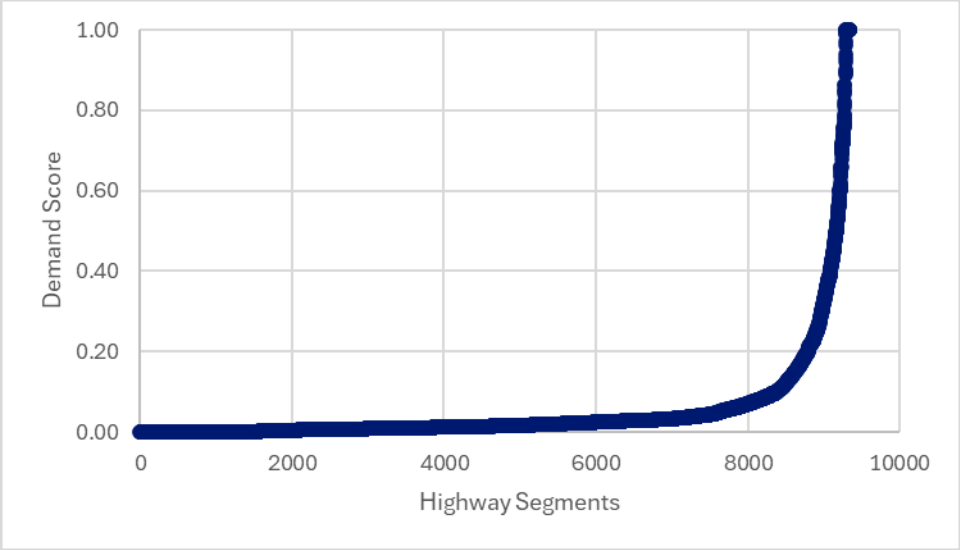
- The current recreational active transportation demand was estimated using Strava Metro bike data from 2022 and 2023 (average). While Strava is used by cyclists to record both recreational trips and transportation trips, it primarily reflects recreational trip purposes.
- 1,570 segments have 0 Strava bike trips. **Figure 12** presents a histogram of the remaining 7,767 segments. Around 5,500 segments have annual Strava bike volumes between 2.5 and 26.5. Around 900 segments have annual Strava bike volumes between 26.5 and 50.5.

Figure 12. Histogram of Strava Bike Volumes



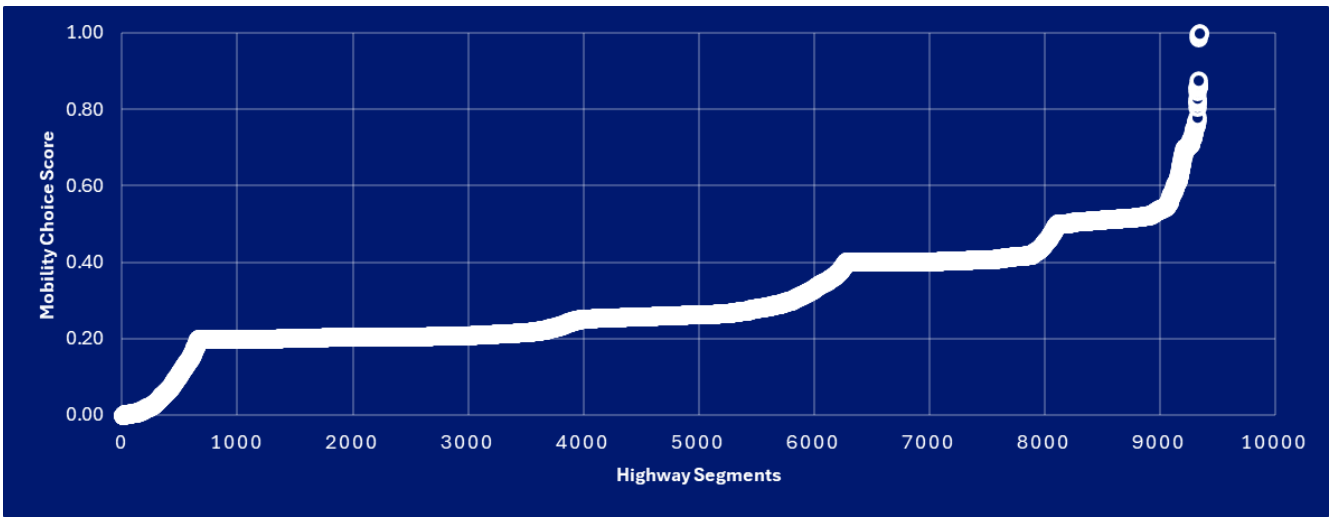
- The maximum score in a rural TPR (excluding the five MPOs) is 751 (there is one higher TPR score of 1,385, but it is an outlier). Any segment with 751 Strava trips or more receives a score of 1. The remaining segments are scored as Strava trips divided by 751. **Figure 13** shows the distribution of the Demand score. Around 8,000 segments have a Demand score less than 0.10.

Figure 13. Distribution of Demand Scores



The Mobility Choice score, shown on **Figure 14**, is calculated as the average of three components: the Facility score, Short Trips score, and Demand score. In this analysis, the highest combined score observed was 0.68. To simplify comparison across segments, scores were normalized—meaning the highest scoring segment was assigned a value of 1.0, and all other segment scores were scaled proportionally relative to that maximum. Around 650 segments have a Mobility Choice score less than 0.2. Approximately 70 percent of the segments have a Mobility Choice score between 0.2 and 0.4. The nearly 2,100 segments with a score greater than 0.4 represent the greatest opportunities to advance the ATP Mobility Choice goal.

Figure 14. Mobility Choice Scores



Connected Communities

Transportation infrastructure plays a vital role in shaping the fabric of our communities, influencing how people connect to essential destinations, public services, and each other. The Connected Communities element of the PACE Tool recognizes this relationship by evaluating how well highway corridors support access to transit, parks, schools, main streets, and concentrated populations and employment. These factors are foundational to enhancing livability and economic opportunity in both urban and rural settings.

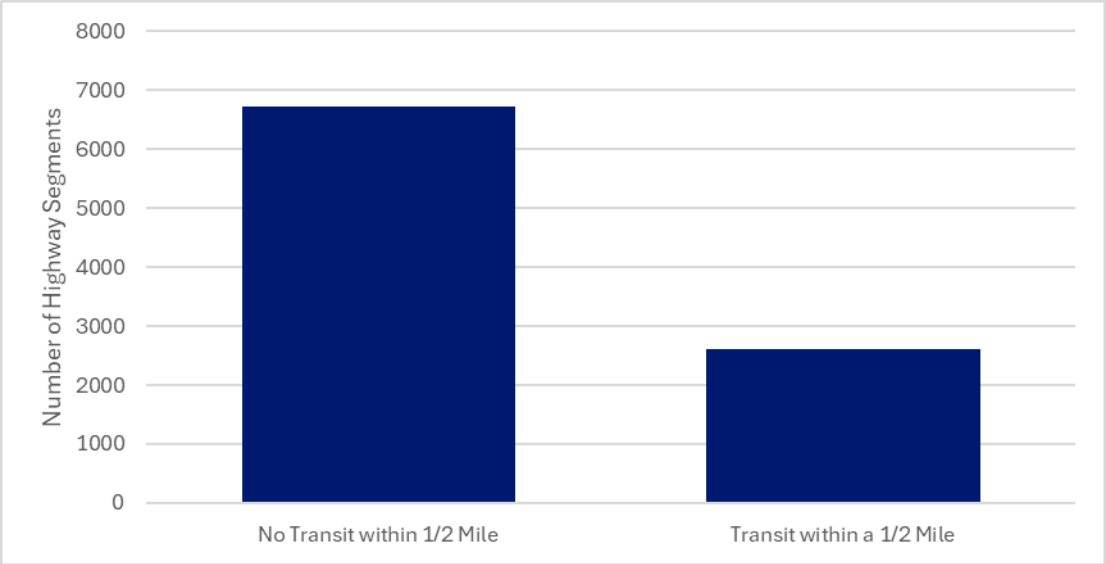
This section presents a composite analysis of five key indicators: Transit Access, Access to Recreation, Access to Schools, Main Street Presence, and Population and Employment Density. Each highway segment is scored based on proximity to these assets, highlighting where corridors are most integrated into the life of a community.

By quantifying these elements, the Connected Communities score helps identify priority areas where transportation investments can make the greatest impact. Whether supporting residents' ability to walk or bike to school, linking visitors to regional parks, or reinforcing the vitality of a town's main street, this analysis informs strategies that enhance mobility and strengthen community connections across the state.

Transit Access

- Transit route and stop data was gathered in late 2024, reflecting transit service as of late 2024.
- If an Amtrak or a Bustang stop is within ½ mile and/or a local transit route is within ½ mile, the segment receives a transit access score of 1; otherwise, score of 0 (see **Figure 15**). More than 6,700 segments do not have any transit within a half mile. Only 2,600 segments have transit within a half mile.
- 56 segments have an Amtrak stop within ½ mile.
- 259 segments have a Bustang stop within ½ mile.
- 2,518 segments have a local transit route within ½ mile.

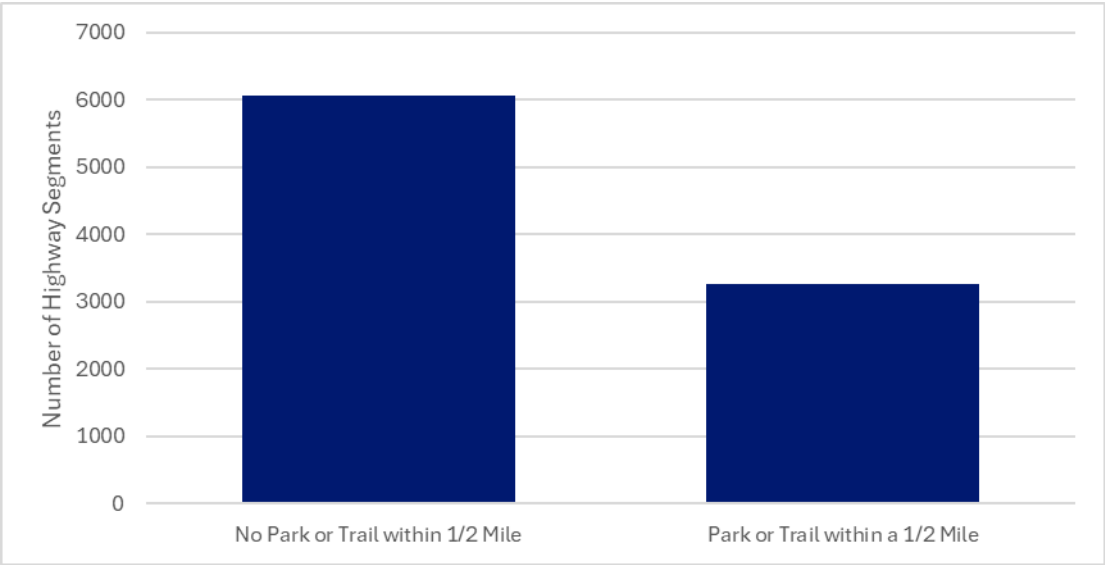
Figure 15. Transit Access



Access to Recreation

- If a State Park, National Park, National Monument, Site, Local Park (source: ParkServe - Trust for Public Land) and/or Trail (source: Cotrex) exists within ½ mile, the segment receives a score of 1; otherwise, score of 0 (see **Figure 16**). Around 6,000 segments do not have any park or trail within a half mile. Approximately 3,000 segments have a park or trail within a half mile.
- 3,271 segments have either a park or a trail within ½ mile.

Figure 16. Access to Recreation



Access to Schools

- If a US Department of Housing and Urban Development (HUD) designated Educational facility (using the 2024 dataset) exists within ½ mile, the segment receives a School Access score of 1; otherwise, score of 0.
- 1,331 segments have a school within ½ mile.

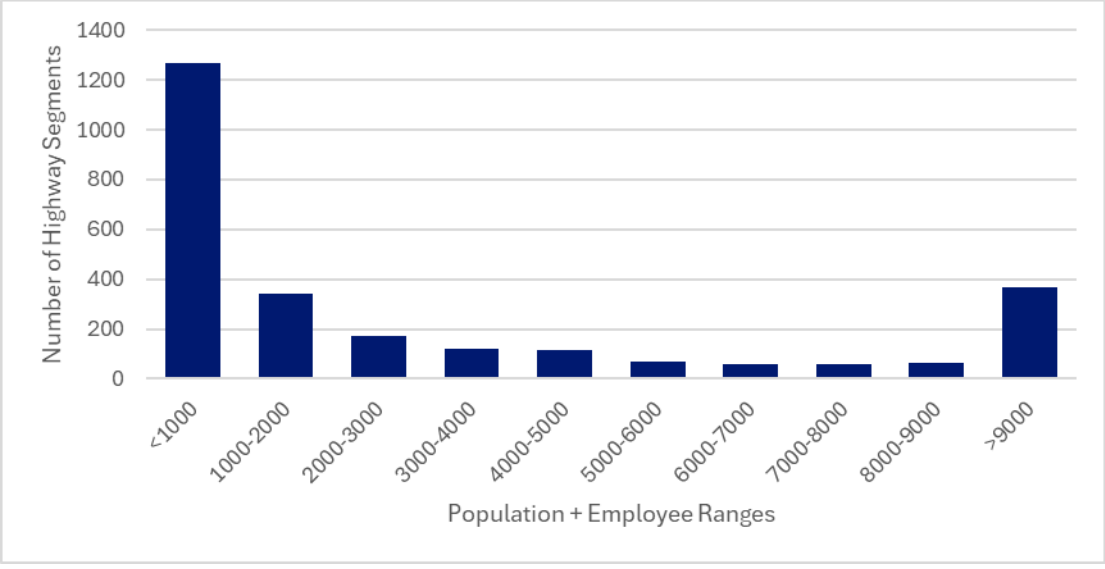
Main Street

- If a segment is a designated or affiliated Main Street by the Colorado Department of Local Affairs (DOLA), it receives a score of 1.
- If a segment has a posted speed of 30 miles per hour (mph) or lower within a municipal boundary, it receives a score of 1, as this indicates that the highway is likely functioning as a main street through a community.
- The Community Advisory Committee (CAC) identified a few additional corridors that function as "Main Street" but do not fit these criteria: Route 040A mile 229-235 in Winter Park/Fraser, Route 040A mile 256-257 in Empire, Route 006B mile 31-32 in Grand Junction, and Route 070B mile 5-6 in Grand Junction.
- 299 segments are identified as Main Streets in the PACE tool.

Population and Employees

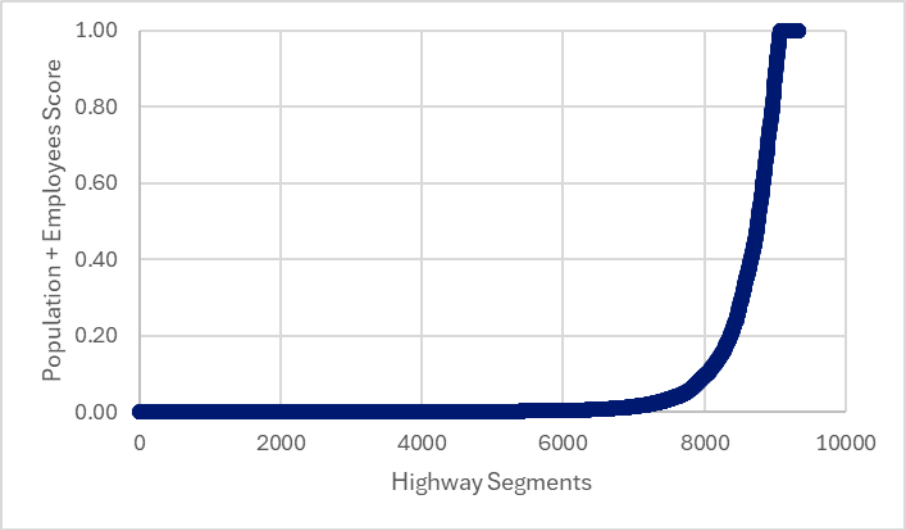
- The number of people (population + employees) within a ½-mile buffer of the corridor was calculated using the 2015 Statewide Travel Demand Model.
- 1,323 segments have 0 population or employees within a ½-mile buffer.
- 5,380 segments have between 1 and 99 population + employment within a ½-mile buffer. **Figure 17** shows a histogram for the remaining 2,634 segments. Around 1,500 segments have between 100 and 1,600 population + employees within a ½-mile buffer.

Figure 17. Histogram of Population and Employees



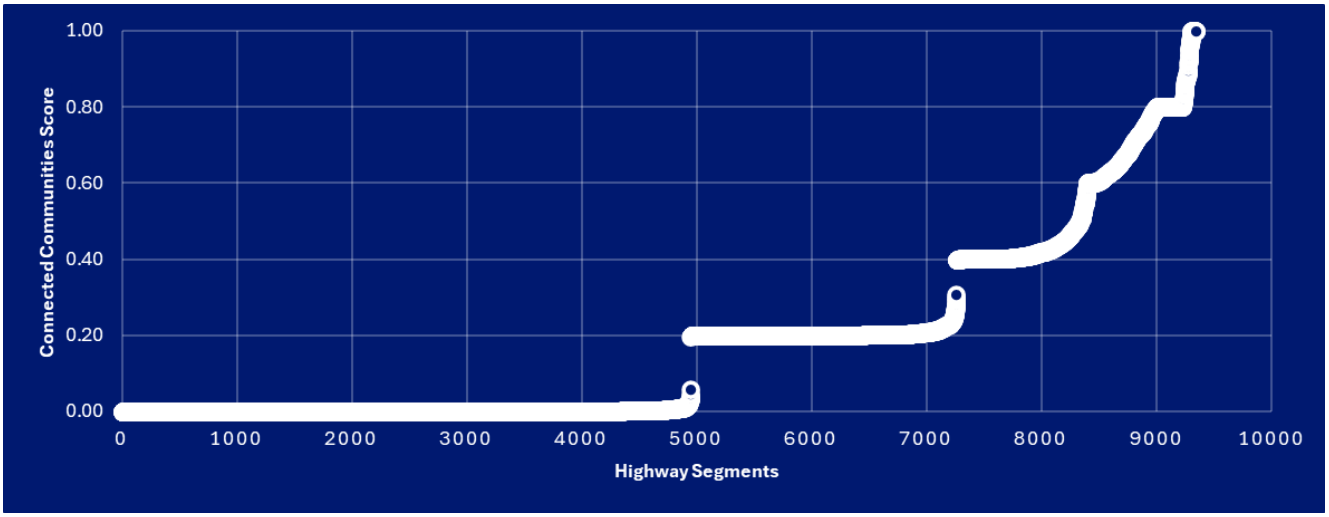
- The maximum score in a rural TPR (excluding the five MPOs) is 11,197. Any segment with population + employment of 11,197 or more receives a score of 1. The remaining segments are scored as population + employment and divided by 11,197. **Figure 18** shows the distribution of the population + employment score.

Figure 18. Distribution of Population + Employment Scores



The Connected Communities score, as shown on **Figure 19** is calculated as the average of the five components: Transit Access, Recreation Access, School Access, Main Street, and Population + Employment. Approximately 7,300 segments have a score less than 0.4. The more than 2,000 segments that score 0.4 or higher represent the greatest opportunities to advance the ATP Connected Communities goal.

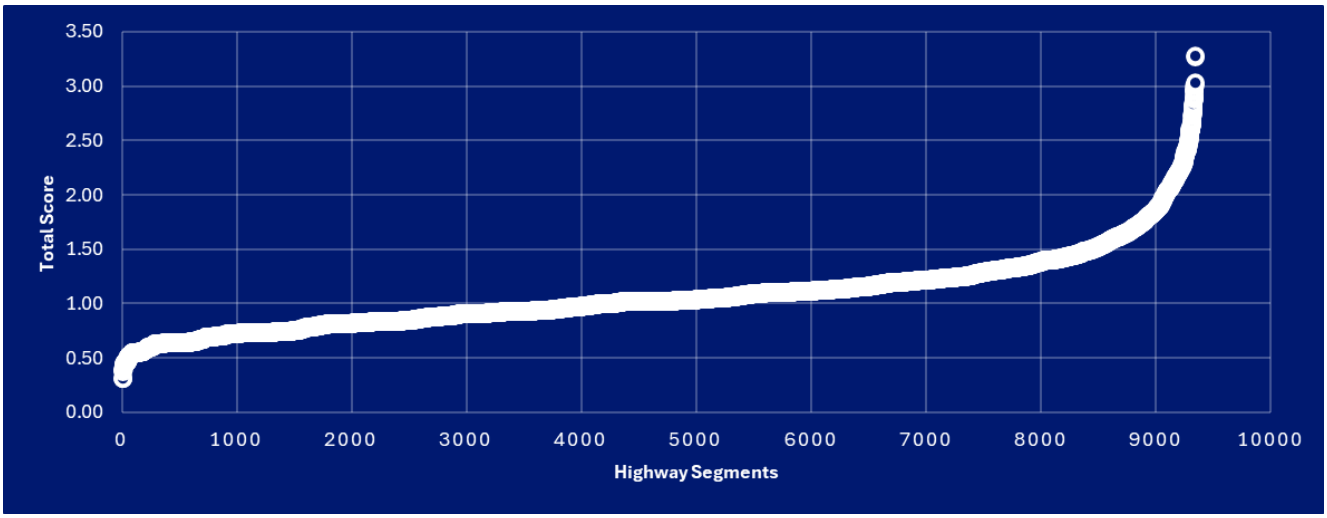
Figure 19. Connected Communities Score



Total Score

- Sum of the four scores: Safety + Equity + Mobility Choice + Connected Communities
- Scores range from 0.31 to 3.24
- As shown on **Figure 20**, the distribution of Total scores shows a relatively linear distribution of scores for approximately 90 percent of the segments, with a sharp increase in Total score for the highest 10 percent.
- Approximately 9,100 segments have a total score less than 2.0, with more than half of all segments scoring between 1.0 and 2.0. The more than 250 segments that score 2.0 or higher represent the greatest opportunities to advance multiple Active Transportation Plan goals simultaneously.

Figure 20. Total Scores



Customizing Goal Area Weights

While the PACE Tool applies equal weight to each of the four goal area scores—Safety, Equity, Mobility Choice, and Connected Communities—in its default scoring, the underlying data spreadsheet provides users with the flexibility to adjust these weights to reflect local priorities or planning goals. This customization allows planners and engineers to explore how shifting emphasis among the goal areas might influence project rankings. For example, a region seeking to address transportation disparities might assign a higher weight to the Equity score, resulting in a different set of top-performing segments than the default equal-weight approach. This feature supports a more tailored analysis and helps ensure that investment decisions align with community values and strategic objectives.