Pathways to the Future
TRANSPORTATION

Technical Report J:
Constrained Plan Evaluation Report

Long Range Transportation Plan 2050



Richmond Regional Transportation Planning Organization
POWERED BY PlanRVA



Constrained Plan Evaluation Report

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ABSTRACT
The Richmond Regional Transportation Planning Organization (RRTPO) is in the process of updating the regional Long-Range Transportation Plan (LRTP) to the horizon year 2050. This LRTP has been branded Pathways to the Future: Transportation 2050. As part of this process and in keeping with federal regulations, RRTPO staff worked with regional partners to create a systematic plan for evaluating metrics in three broad performance areas to calculate relative impact to be derived from the implementation of the constrained list of projects.

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ACKNOWLEDGEMENT

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Introduction

This section details the evaluation of the region's long-range transportation plan, focusing extensively on Title VI compliance, non-discrimination, and environmental justice. It outlines the specific spatial methodology used to analyze how regional transportation spending and project allocations impact historically underserved and marginalized communities. By assessing investment distribution relative to these demographic concentrations, the section examines whether the regional allocation of resources equitably benefits these communities or leaves them subject to disproportionate adverse effects.

Additionally, the section outlines a federal performance-based planning framework alongside the Pathways to the Future exploratory scenario planning model. It evaluates how the region's core 2050 transportation goals perform when stress-tested across five distinct future growth and land-use scenarios.

Title VI and Non-Discrimination

Title VI of the Civil Rights Act of 1964 §2000d prohibits discrimination on grounds of race, color, and national origin and is a foundation of Federal civil rights law. For the plan, research was conducted to study high-needs areas for transportation projects. Historically, minority populations have been identified as the most impacted and disenfranchised group, which struggle the most with transportation access and the ability to input public feedback in the planning process. In consideration of groups protected under Title VI, the analysis identified the region’s minority populations, foreign born populations, and populations with Limited English Proficiency (LEP) as indicators of protected classes. Identifying the investment in transportation projects by concentrations of Title VI populations shows how the allocation of resources might impact historically underserved communities.

2023 American Community Survey (ACS) 5-year census estimates were reviewed to determine the regionwide metrics for each of these populations. The Title VI area in the analysis, as illustrated in *Figure 1*, is comprised of census tracts containing any of the identified demographic groups with a population count above their designated threshold.

Table 1 Title VI Data Sources

Population	Universe	Data Source
Foreign Born	Total Population	ACS Table B05012
Minority Population	Total Population	ACS Table B03002
Populations Speaking Little to No English	Total Population (5 years and older)	ACS Table B16004

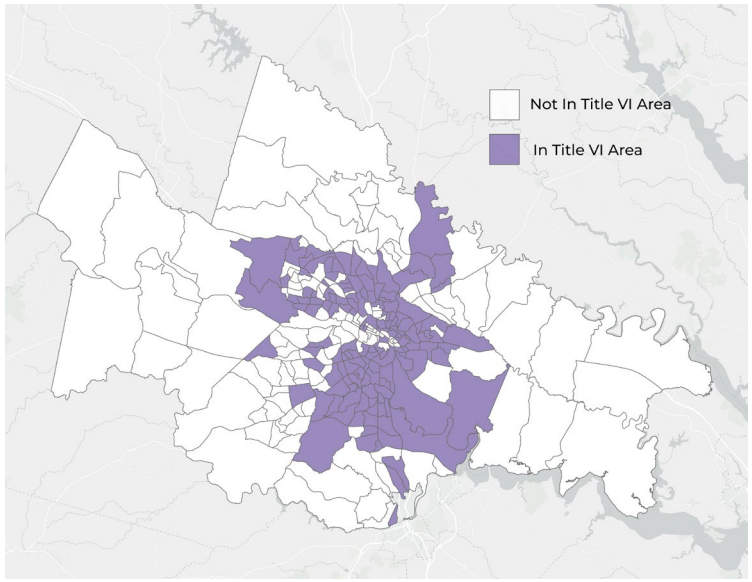
For the foreign born population, a regional average was calculated for all census tracts. If any tract had a foreign born population count above the regional average, it was identified as part of the Title VI area. For the minority population and the population speaking limited English, census tracts were identified using one standard deviation above their regional averages. These rules for flagging Title VI populations identified 148 of the region's 279 census tracts (53% of total census tracts). The total population of all people in the Title VI area is 51% of the region's total population.

The minority population in the region is heavily concentrated in census tracts to the east of I-95. The localities with the highest percentage of minority population are Richmond City, Charles City, and Henrico. Richmond City, Charles City, and Henrico have the highest percentages of those who self-identify as Black or African American, while Chesterfield, Richmond City and Henrico have the highest percentages of those who self-identify as Hispanic or Latino. Henrico has the highest percentage of those who self-identify as Asian at 9% of the total population, and Charles City has the highest percentage of those who self-identify as American Indian or Alaska Native. Over the last 5 years, the minority population has increased to 45% in 2022. Being a large population in the region, the regional mean was mapped with one standard deviation, to be census tracts higher than 71.4% minority population.

The ACS data on limited English is for a population over the age of 5. The population with limited ability to speak English has a regional mean of 1.9% per census tract. Regionally, 2% of the population speak English 'not well,' and 1% does not speak English at all. These tracts overlap with those featuring a high minority population, around I-295 and 288 to the west of the city boundary, or the outer loop suburbs. Richmond City has the highest percentage of the population that is limited English, followed by Charles City and Henrico. Over the last five years, this demographic group has been increasing in the Richmond region. As the limited English population in geographically spread over a large area, this demographic grouped was mapped with a regional mean that included one standard deviation, or census tracts with greater than 6.9% limited English population.

Much like the limited English population, the foreign-born population surrounds I-295 and 288 to the west of the city boundary. Other census tracts high in foreign born population occur around US-301 and eastern Henrico. This demographic group made up 8.15% of the population in 2017 and rose to 8.56% in 2022. The regional mean for this demographic group is 8.85% foreign born population per census tract.

Figure 1 Title VI Analysis Area



To evaluate the impact of project spending on Title VI census tracts, each project was given a 0.5 mi buffer around the centerline. If the census tract was overlapped by the buffer, it was determined to be served by the project, and its mileage and associated costs were allocated proportionally to the percentage of the buffer overlapping the tract. This is a high-level spatial analysis to see which projects will serve communities in the Title VI area. Since 51% of the region's population is in the Title VI area and the percentage of base cost spending in the area is 56%, the value of investments spent in the area is proportionate to the population in the area.

Table 1 Summary of Constrained Plan Spending in Title VI Area

Population	Mileage In Title VI Area	% of Total Constrained Plan Mileage (271 miles)	Base Cost Spending in Title VI Area	% of Total Plan Base Costs ($4.8 billion)	Future Inflated Cost Spending in Title VI Area
Minority Populations	47.75 mi	18%	$1 billion	22%	$1.7 billion
Limited English	18.16 mi	7%	$487 million	10%	$806 million
Foreign Born	98.93 mi	37%	$1.6 billion	35%	$2.7 billion
Total Title VI Area	**141.12 mi**	**52%**	**$2.7 billion**	**56%**	**$4.5 billion**

Figure 2 Limited English Population Census Tracts Above/Below the Regional Mean

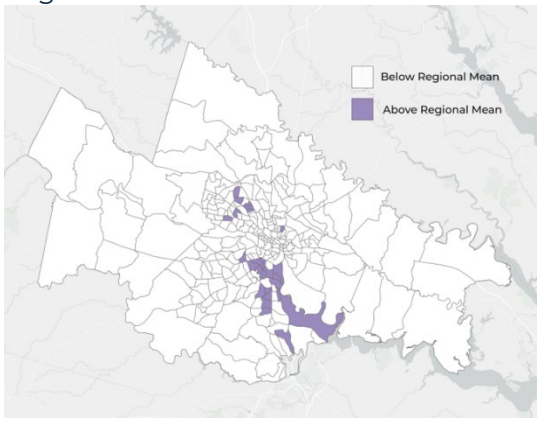


Figure 3 Minority Population Census Tracts Above/Below the Regional Mean

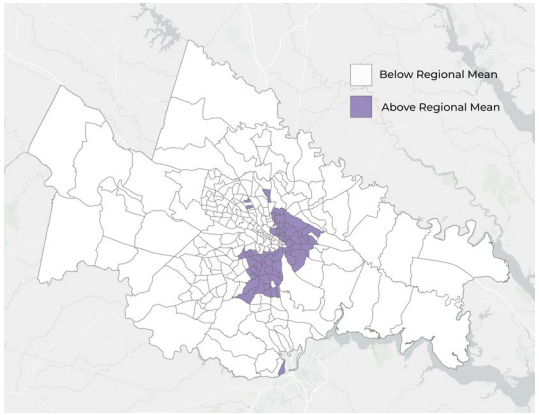


Figure 4 Foreign Born Population Census Tracts Above/Below the Regional Mean

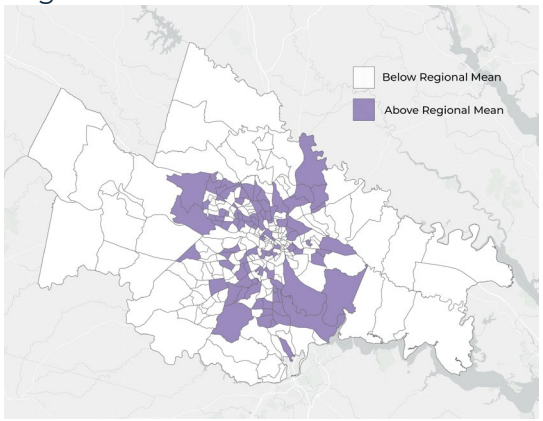


Table 2 Title VI Population Breakdowns

Population	**Percent of Population Total in Title VI Area**	**Percent of Total Population in the Region**
Minority Populations	66.7%	30.1%
Limited English	79.8%	1.7%
Foreign Born	72.8%	6.2%

The Title VI area makes up 53% of the region's census tracts and 51% of the region's total population. This area includes 66.7% of the region's total minority population, 79.8% of the region's total limited English-speaking population, and 72.8% of the region's total foreign born population. The higher percentages of Title VI demographics relative to the total population identify a pattern in where these communities are concentrated. There is not an equal distribution among all other populations compared to the Title VI demographic in the selected tracts. The comparison between the Title VI area and transportation projects shows a more proportional level of investment. Project mileage within these areas makes up 52% of the total mileage and 56% of the total base costs—these numbers are closer to the 51% of the total population rather than the higher percentages of Title VI groups.

Environmental Justice

Beyond Title VI, Federal and state non-discrimination laws identify a broader range of historically disadvantaged populations. For example, the Americans with Disabilities Act (ADA) established requirements for accessibility and access for people with disabilities. ThIn the spirit of this state policy and the broad range of federal non-discrimination authorities, this plan has also been evaluated to consider how transportation investments impact vulnerable communities more broadly.

Environmental justice builds on the demographics mentioned in the Title VI analysis with additional factors. These additional demographics are key indicators of inequality in the region. Additional factors include low-income populations, population with a disability, population in female headed households, population without a vehicle, population cost burdened 50% or more, and population aged 65 or above. ACS data was reviewed to determine the regionwide mean and standard deviations for each demographic group. All census table sources are referred to in Table 5.

For each demographic group, a census tract was flagged for analysis if the tract was above the regional mean plus one standard deviation. A higher threshold was used due to the more complex, multifaceted nature of this evaluation relative to the Title VI analysis. The core environmental justice area was mapped based on flagged areas with significant concentrations of people in poverty or people from racial or ethnic minority groups as well as former

federal priority environmental justice areas. In addition, all census tracts meeting the threshold for 4 or more indicators were included due to the overlapping indicators of disadvantage.

Figure 5 Environmental Justice Analysis Area

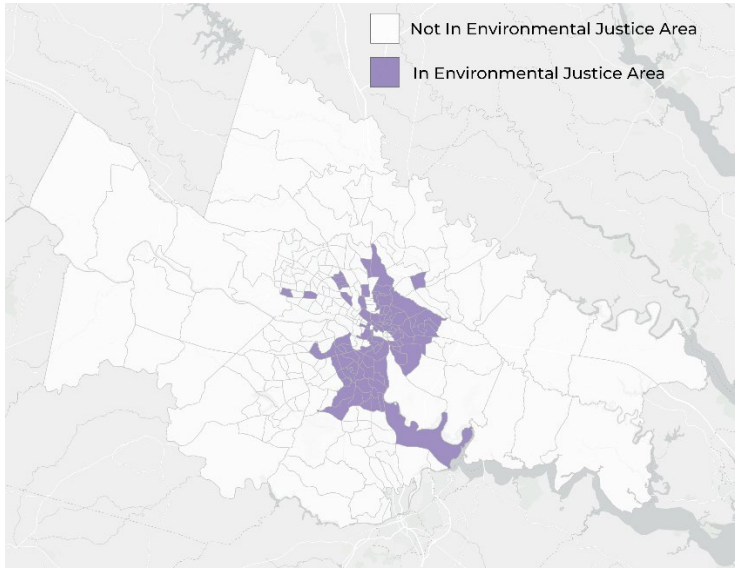


Table 3 Environmental Justice Populations Breakdown

Population	Percent of Population in EJ Area	Percent of in the Region
Population with a Disability	37%	12%
Population in Female Headed Households	45%	12%
Population in Poverty	55%	9%
Population without a Vehicle	58%	5%
Population Cost Burdened 50% or More	47%	10%
Population Aged 65 or Above	25%	15%

Richmond City has the highest percentage of those living in poverty, followed by Charles City and Henrico. The counties with the highest percentages of elderly population are Charles City, Goochland and Powhatan.

Census tracts that are above the mean in population with a disability or elderly population are primarily in the suburban and rural areas of the region. These demographics highlight a need for planning and investment in paratransit in the region. Similarly, female headed households are spread around the region. Female headed households have a regional mean by tract of 11.96% and a regional percentage of 12.47%. Planning with gender in mind is important; it is known that women who are caregivers take alternative routes to destinations that are safer and often make multiple stops in one trip. Census tracts with high female headed household percentages are areas for safe routes to school and transit investments.

The geography of the population that is in poverty and the geography of households without a vehicle in the region overlaps heavily. Many census tracts on the east side of Richmond City and Henrico and along the I-95 corridor have high poverty and low vehicle ownership. Those areas with low vehicle ownership present a population in need of transit and active transportation infrastructure. Richmond City has the highest percentage of households without a vehicle, followed by Charles City and Henrico. Much of the urban census tracts are serviced by fixed-route transit. Charles City represents an area in need of demand-response transit, vanpool or carpool services.

Households where housing costs make up 50% or more of their living expenses, for either owner or renter occupied, make up roughly 12% of households in the region. These areas overlap with population in poverty include fewer tracts than poverty overall, as poverty is a stricter definition. Richmond City has the highest percentage of households that are cost burdened, followed by Henrico and Chesterfield. Cost burdened households represent an area in need of transit and active transportation infrastructure. Through utilizing alternative modes of transportation, this demographic group would benefit from savings on car payments, insurance, and maintenance.

The environmental justice area contains 28% of the region's total population. To evaluate project impact on the environmental justice area, buffered projects that overlapped a census tracts were determined to serve the tract, and its mileage and associated costs were allocated proportionally to the percentage of the buffer overlapping the tract.

Project mileage and spending evaluation for census tract was performed for the environmental justice area. The census tracts in the environmental justice area contain 73 miles of projects, or 27% of total miles in the constrained plan. The projects total $1.6 billion in base costs, or 34% of base cost spending. The environmental justice area was

then analyzed to ensure communities fairly receive investment are not subject to disproportionate adverse effects from projects. When compared with the Title VI area, the environmental justice area contains a smaller percentage of its project miles allocated to highway miles, and a higher percentage of mileage invested in active transportation. A breakdown of project mileage in each analyzed area by project type is provided in Table 3.

Table 4 Title VI and Environmental Justice Project Mileage by Type

	Highway Mi	Transit Mi	Active Transportation Mi	Total Project Miles
EJ Area	32.18 mi	25.05 mi	15.61 mi	73 mi
Percent of Total Project Miles in Area	44%	34%	21%	
Title VI Area	69.75 mi	31.14 mi	39.04 mi	141 mi
Percent of Total Project Miles in Area	49%	22%	28%	

The populations researched and mileage of funding assessed for these census tracts show a concerted effort to improve livelihoods in the region. The project types invested in the environmental justice area show a benefit to those who are dependent on transit and are car free and are less likely to contribute to the population experiencing disproportionate amounts of pollution, as historically disenfranchised populations often have.

Table 5 Environmental Justice Data Sources

Population	Universe	Data Source
Cost Burdened Households, Owner and Renter	Total Occupied Housing Units	ACS Tables B25070, B25091
Elderly Population	Total Population	ACS Table B01001
Female Headed Households	Total Occupied Housing Units	ACS Table B25011
Foreign Born	Total Population	ACS Table B05012
Individuals with Disabilities	Civilian Noninstitutionalized Population	ACS Table B18101
Low Income Population	Population for Whom Poverty Status Can Be Determined	ACS Table B17001
Minority Population	Total Population	ACS Table B03002
Zero Car Households	Total Occupied Housing Units	ACS Table B08201

Performance Based Planning

Federal law mandates specific performance measures to ensure transportation investments directly align with national goals. Through data collection and target setting established by the USDOT, these short-term targets guide near-term programming decisions within the Transportation Improvement Program (TIP), establishing a clear link between funding priorities and anticipated regional outcomes. To build toward robust, long-term regional objectives, the plan evaluates long-range performance against these baseline federal targets across five key categories. The latest performance targets for 2026 are discussed in depth the TIP and are incorporated by reference here.

- **Roadway Safety**: Near-term targets focus on reducing fatalities and serious injuries for both motorized and non-motorized travel, measured by total counts and rates per 100 million vehicle miles traveled (VMT). A dedicated baseline protects vulnerable road users like pedestrians and cyclists. Long-term plan objectives expand on this foundation by striving toward a regional target of zero transportation-related deaths and serious injuries through systematic infrastructure modifications and active transportation investments.
- **Infrastructure Condition (Pavement & Bridge)**: Short-term federal targets dictate specific minimum thresholds for National Highway System (NHS) pavement and bridge deck areas classified in "Good" condition, while strictly limiting infrastructure allowed to fall into "Poor" condition. The long-term plan maintains state-of-good-repair standards adopted by VDOT and other asset owners and emphasizes proactive system resiliency, ensuring continuous preservation of the existing system.
- **Roadway Performance & Reliability**: Current targets evaluate travel time dependability by tracking the percentage of person-miles traveled that remain reliable across interstate and non-interstate corridors. Long-term objectives look past individual segments to focus on structural congestion management, prioritizing systemic land-use integration and operational strategies over pure capacity expansion to mitigate non-recurrent delay.
- **Freight Movement**: Short-term metrics utilize the Truck Travel Time Reliability (TTTR) Index to assess predictability along major logistics corridors. The plan's long-term horizon aims to secure regional economic competitiveness by optimizing targeted freight bottlenecks and supporting multimodal freight access points.

- **Transit Performance & Safety:** Short-term federal transit metrics focus on maintaining a State of Good Repair (SGR) for rolling stock, equipment, facilities, and infrastructure under Transit Asset Management (TAM) targets. Concurrently, transit safety targets track total fatalities, serious injuries, safety events, and system reliability metrics per vehicle revenue mile. Long-term plan objectives look beyond these baseline operational standards to emphasize regional transit utility—shifting focus toward structural service expansions, high-frequency corridors (such as the Pulse BRT extensions), and zero-fare structural sustainability to maximize system-wide accessibility and regional connectivity. In the Richmond Region, GRTC sets targets for its system whereas smaller operators follow the state Tier 2 TAM plan.

Pathways to the Future: Scenario Planning

Traditional long-range transportation planning has historically operated under the assumption of a single, fixed future. By treating baseline growth projections as definitive, legacy planning methods risk optimizing a region's infrastructure for a reality that rarely aligns with actual long-term development patterns, demographic shifts, or technological disruptions.

To move beyond these rigid constraints, the Pathways to the Future (P2F) framework introduces exploratory scenario planning. Rather than attempting to precisely predict the future, this approach maps a broader uncertainty space by manipulating regional "drivers of change"—such as socioeconomic growth rates, technological adoption levels, climate resilience behavior, and geographical land-use allocation. By cross-testing transportation performance against a variety of structurally distinct futures, the region can identify vulnerabilities, anticipate critical turning points, and prioritize robust policy interventions that provide cumulative benefits regardless of how the future ultimately unfolds.

The framework establishes a comparison standard through a historical baseline and evaluates the region's resilience across four alternative scenarios:

1. **Baseline ("Trendline Growth"**): Serves as the quantitative benchmark. It assumes that regional population and employment growth follow standard historical trajectories, that clean energy and technology are adopted purely along national trend lines, and that spatial settlement matches currently adopted local comprehensive plans.

2. **RVA Sinks (Doomsday Scenario)**: Tests system resilience under severe economic and environmental strain. It models low regional growth driven by consecutive man-made and natural disasters, compounding challenges in housing affordability, and a loss of major regional employers, resulting in a net out-migration of businesses and residents.
3. **Ecotopia (Resilient Growth Scenario)**: Explores a high-growth, highly compact future centered on aggressive climate change mitigation. This scenario assumes a substantial influx of climate refugees and digital nomads, prioritizing a highly dense, multimodal land-use pattern where residents can travel seamlessly without a reliance on single-occupancy vehicles.
4. **Back to the Future (New Traditional Growth Scenario)**: Models a high-growth future defined by decentralized settlement patterns. It assumes continuing auto-dominance, traditional low-density suburban and rural sprawl expansion, lower rates of emerging technology adoption, and conventional development dynamics.
5. **Meh and Safe (Balanced Scenario)**: Represents a moderate-growth future that acts as a middle ground between conventional expansion and resilient practices. It simulates balanced growth across urban, suburban, and rural tiers while combining gradual technological integration with localized community resilience measures.

By stress-testing the region's transportation investments across these five distinct envelopes of growth rates and spatial patterns, the planning process shifts from reactive planning toward robust, proactive risk management.

Plan Performance

To track progress toward the region’s long-term vision, the plan establishes four core goals, backed by 15 quantifiable performance objectives targeted for 2050. Because the underlying forces driving these goals vary, the plan utilizes a dual-track analytical framework to evaluate performance across the alternative futures.

Scenario Outcome Modeling

For objectives directly dependent on spatial growth patterns, travel behavior, and technology adoption, metrics are modeled dynamically across all five scenarios. These objectives yield distinct quantitative outputs for each future. These results were compared against a no-build scenario using the baseline future to demonstrate how changes in growth rates, land use patterns, and technology adoption can alter the performance of the exact same set of investments.

Fixed-Investment Narrative Evaluation

For objectives tied to fixed programmatic funding, system baseline expansions, or macro-level external variables, the plan evaluates performance through a single strategic trajectory, paired with a qualitative risk narrative. This narrative explores how external scenario uncertainties will accelerate or hinder the region's ability to achieve its goals.

Safety

Roadway safety performance is tracked through a single, regionally aggregated Equivalent Property Damage Only (EPDO) index to weight crash severity. The projects selected through the constrained plan development process were assessed using a conservative approach that used crash modification factors (CMFs) based only on the principal improvement for each project to calculate the expected reduction in fatal and injury crashes.

Based on the investments in regional projects in the plan, a 23.4% reduction in fatal and injury crashes is expected from projects that directly reduce crashes. Based on current crash ratios across the region, this would be equivalent to approximately 28 fatal (known as category K crash) and 165 serious injury (known as a category A crash) crashes per year in 2050. The table below shows the current distribution of crashes and the expected impact of the proposed projects.

	K Crash	A Crash	B Crash	C Crash	Fatal & Injury Crash Total
Crashes 2020 - 2024	596	3,523	19,237	2,402	25,758
Average Annual Crashes	119.20	704.60	3,847.40	480.40	5,152
Planning Level EPDO Value	178	178	19	11	
Weighted Value	21,218	125,419	73,101	5,284	225,021
Percent Share	9.4%	55.7%	32.5%	2.3%	
Total Annual EPDO Reduced					52,579.64
Distributed Weight	4,957.81	29,305.99	17,081.06	1,234.78	
Annual Crash Equivalent	28	165	899	112	1,204

Figure 6: Fatal and Injury Crash Reductions

For bike and pedestrian specific crashes, this plan primarily includes shared-use paths as part of regional approach to building an inclusive all-ages and abilities (AAA) network. Sidewalks, pedestrian crossings, and other more localized improvements are expected to be addressed at the locality level through the funding in the flexible local investments bucket.

In addition to the regional capacity projects in the plan, this plan also includes over **$700 million for systemic safety investments** through the Virginia Highway Safety Improvement Program. These systemic investments have been shown to provide the most cost-effective solution to safety. The systemic approach to safety focuses on targeting risk factors throughout the region with proven countermeasures which are generally low cost. An example of this type of systemic investment would be adding chevron signs to unmarked curves with high driveway density and high-speed limits on rural two-lane roads to prevent roadway departures. By addressing these risk factors with a particular focus on the regional high-injury network, this approach will bring us closer to our goal of zero deaths and serious injuries.

Beyond the investments in the plan, actual future safety outcomes are a shifting balance of competing forces across the uncertainty space that the scenarios in this plan consider. For example, high-growth, decentralized scenarios increase total VMT, speed differentials, and conflict points, structurally elevating regional crash exposure and severity relative to more compact development patterns with lower speeds or lower growth scenarios. Similarly, advancements in autonomous vehicle safety technology, connected infrastructure, and emergency medical response times will naturally suppress fatality and injury rates over time, independent of localized infrastructure design but are unable to be modeled at this time.

Accessibility

This plan aims to increase 30-minute access to jobs and weighted destinations per person across all modes during AM peak hours by 15%. Jobs are measured by the number of jobs in a destination area (Traffic Analysis Zone) weighted by how long it takes to get there. This weighting reflects the reality that jobs that are closer are more useful and convenient. The table below shows the estimated change relative to the baseline future with no new projects. For driving and transit, this was measured using the travel demand model. For biking and walking, this was measured using a network dataset in ArcGIS that reflects low stress streets and existing infrastructure. With higher rates of growth, driving becomes less convenient due to greater congestion while biking and walking are significantly more useful. Across all explored land use scenarios, **transit access outcomes meet or exceed the plan objectives**. Driving

appears to show more modest improvements in most scenarios with population growth outpacing infrastructure in the highest growth scenarios, resulting in reduced access.

For biking and walking, most of the investments envisioned over the course of this plan are local projects not captured individually. However, with completion of the Fall Line trail and the other shared use paths within the regional capacity projects, moderate progress will be achieved with the greatest benefits accruing when accompanied by compact development (the Ecotopia scenario).

Mode of Travel	Build Scenarios relative to Do Nothing Baseline				
	Baseline	**RVA Sinks**	**Meh & Safe**	**Ecotopia**	**Back to the Future**
Driving	5.8%	73.1%	6.0%	-23.0%	-15.2%
Bus	125.2%	176.2%	127.9%	122.1%	100.2%
Biking	0.0%	17.0%	0.0%	33.0%	20.0%
Walking/Rolling	17.0%	7.0%	16.0%	35.0%	26.0%

Access to destinations is more difficult to measure as the location of future services is not easily projected. The destinations examined in this measure included government offices, parks, schools, groceries, and pharmacies weighted based on how important they are to day-to-day life. For example, not everyone needs to attend a university, but everyone needs access to food regularly. Based on the **current location** of these destinations, access improvements are uneven across scenarios. **Transit access to services is robust against all modeled futures and meets the plan objectives**. Improvements for driving are highly uneven with the best results in the low growth RVA Sinks scenario and declining access across high growth scenarios as demand outpaces capacity. Finally, active transportation is most improved in the concentrated growth scenario, Ecotopia, with minimal benefits across other explored futures. This modeling does not capture the development of new locations for these services which would likely improve outcomes in high growth scenarios, especially for biking and walking access.

Mode of Travel	Build Scenarios relative to Do Nothing Baseline				
	Baseline	RVA Sinks	Meh & Safe	Ecotopia	Back to the Future
Driving	6.6%	109.0%	6.4%	-35.0%	-24.1%
Bus	137.9%	223.1%	141.7%	96.2%	94.1%
Biking	0%	-6%	1%	27%	2%
Walking/Rolling	0%	0%	1%	4%	2%

Finally, this plan aims to expand the transit network to cover the places where people live and work with a target of 10% increase in coverage by 2050. Using the population and employment distributions, an estimate of population within ½ mile of transit can be calculated. Across all future growth and land use scenarios explored, **the plan appears poised to meet this target** with the greatest benefits accruing in scenarios with higher growth and development patterns aligned with major proposed transit spines.

Transit Access	Build Scenarios relative to Do Nothing Baseline				
	Baseline	RVA Sinks	Meh & Safe	Ecotopia	Back to the Future
People	55.6%	38.9%	56.9%	85.1%	71.2%
Jobs	63.3%	46.2%	66.1%	94.6%	78.8%

Vehicle Miles Traveled & Emissions

This plan aims to reduce Vehicle Miles Traveled (VMT) by 10% per capita and reduce overall emissions from transportation by 75%. Across the land use futures, the three higher growth scenarios (Meh & Safe, Back to the Future, and Ecotopia) show expected reductions while the remaining scenarios show an increase in VMT per capita. The Ecotopia and Back to the Future scenarios show the most progress toward the overall

goal. As discussed above, these scenarios show significant improvement to transit, bike, and walk job access while experiencing reduced access for driving.

Travel & Emissions	Build Scenarios relative to Do Nothing Baseline				
	Baseline	**RVA Sinks**	**Meh & Safe**	**Ecotopia**	**Back to the Future**
Vehicle Travel Demand per Capita	0.30%	6.00%	-0.10%	-8.80%	-8.10%
Emissions Reduced per Capita	1.20%	-2.80%	-0.10%	6.60%	5.90%

For emissions reduction, the story is more mixed. Under lower growth scenarios (RVA Sinks, Meh & Safe) emissions per capita increase as the region experiences less congestion and driving remains the most convenient choice. By contrast, emissions per person are reduced the most in the higher growth scenario where other modes of travel become more convenient and more goods and services are provided locally. Across all five scenarios, emissions were modeled using the same emissions rates to provide a level comparison of the impacts of the land use patterns and growth rates directly.

Beyond the land use and growth factors, vehicle technology such as electrification, connected and autonomous vehicle (CAV) adoption, and evolving federal Corporate Average Fuel Economy (CAFE) standards will play a large role in helping to achieve the 75% target for emission reduction relative to current levels. As an example, recent emissions modeling in the regional Air Quality plan suggests that in the case of the greenhouse gas emissions from transportation will decline by 38% under a business-as-usual scenario due to these factors, without changes to land use or transportation networks.

Congestion & Reliability

CI. By 2050, peak-hour traffic delays (hours of delay) will be reduced by 10%.

The plan aims to reduce the peak-hour traffic delay (hours of delay) by 10%. This is measured in the change in all vehicle delay per 1000 people during AM and PM peak hours. In the highest growth scenarios (Ecotopia and Back to the Future) peak hour delay is expected to increase, considerably. This is particularly true for car-centric growth scenarios in secondary/tertiary areas of the region (Back to the Future). When high-growth future land use scenarios

are explicitly car-centric, the increase in peak hour delay becomes even more severe because the transportation network is forced to absorb the absolute maximum number of vehicular trips possible. In a car-centric scenario, growth typically manifests as low-density sprawl or decentralized employment centers that lack viable transit, walking, or biking alternatives. This means that every single household and job added to the model translates directly into new private vehicle trips. As such medium to low growth scenarios (Baseline, Meh & Safe, and RVA sinks) see decreases in peak hour delay because the volume of new vehicles entering the system matches or falls below the physical capacity of the transportation network. In these lower-intensity scenarios, population and employment expansion is either stagnant or heavily moderated, which means the trip-generation algorithms in travel demand models inject far fewer new vehicles onto the roadway network during peak commuting hours.

Peak Hour Delay and SOV Trips	**Build Scenarios relative to Do Nothing Baseline**				
	Baseline	**RVA Sinks**	**Meh & Safe**	**Ecotopia**	**Back to the Future**
Change in Peak Hour Delay	-6.70%	-22.50%	-6.30%	30.5%	201.83%
SOV Trips per Capita	-0.2%	2.3%	0.10%	-7.20%	-7.9%

C2. By 2050, the percentage of single-occupancy vehicles trips will be reduced by 70%.

The Plan also aims to reduce single occupancy vehicle trips by 10%. The shifting balance of single-occupancy vehicles reveals that regional travel behavior is entirely dictated by how closely the land-use patterns and increases in population align with our transportation investments. In the doomsday scenario (RVA Sinks), where the regional infrastructure collapses or stagnates without any proactive resilience or alternative transit funding, private vehicle becomes the only feasible option, thereby increasing the probability of single occupancy vehicle trips.

Medium growth scenarios (Baseline and Meh & Safe) see a status quo expansion where single-occupancy vehicles still tick slightly upward or remain stagnant. This happens because standard, moderate growth patterns mirror historic trends, spreading development outward into suburban patterns faster than incremental transit lines, active transportation, or TDM can keep up.

Finally, high growth scenarios (Ecotopia and Back to the Future) have shown to have significantly lower SOV trips per capita compared to other future land uses. Significant regional population increases within these scenarios mathematically dilutes the single-occupancy vehicle share of total travel while and increases the statistical probability of successful trip matching.

Multimodal Future

The plan aims to increase intermodal freight volumes by 50%. While the plan anticipates a substantial shift toward rail and port infrastructure, regional planning frameworks traditionally focus their formal scoring phases on highway and transit investments. Because rail infrastructure is privately owned and primarily funded through state and federal channels, these initiatives are currently positioned on the plan's unranked "vision list." This ensures they are recognized as vital long-term priorities for the region, even if they operate outside the standard MPO scoring matrix.

This distinction is important because future freight movement will largely be shaped by supply chain development and operations surrounding the Richmond Marine Terminal (RMT) rather than future land use. Local comprehensive plans are effective at guiding where distribution and industrial facilities can locate, but the actual volume moving through the region is driven by the RMT's role as a macro-economic funnel. Its throughput is tied directly to global supply chains and container activity at the Port of Virginia. Keeping rail projects on the vision list keeps the door open for strategic partnerships, ensuring the region remains positioned to support the RMT's growth and effectively manage the transition of goods from the port to the local logistics network.

C3. By 2050, the average annual daily transit ridership will increase by 75%.

Transit ridership variations across the scenarios are fundamentally driven by the scale of regional population growth and its spatial alignment with the transit network. The Ecotopia scenario reaches regional targets and generates the highest ridership increase because it concentrates rapid population growth into dense, transit-oriented development patterns, placing large swaths of residents within a half-mile of transit lines. Conversely, the Back to the Future scenario experiences the second-highest increase; despite its decentralized sprawl, a massive high-growth population still forces many residents into the transit footprint through regional BRT expansion, while escalating roadway congestion elevates transit's utility as a network relief valve. Meanwhile, the Baseline and Meh & Safe scenarios track moderate growth in transit ridership, as their status quo and balanced expansion patterns yield steady, incremental gains that fall predictably between the high-growth and low-growth futures. Finally, the RVA Sinks scenario yields the lowest ridership gains due to economic contraction, where consecutive disasters and a net out-migration of major employers drastically reduce the pool of potential transit users.

Transit Ridership	Build Scenarios relative to Do Nothing Baseline				
	Baseline	RVA Sinks	Meh & Safe	Ecotopia	Back to the Future
Change in Transit Ridership	27.4%	8.5%	31.0%	75.0%	43.1%

The plan aims to increase the miles of dedicated infrastructure for biking and walking by 25%. From the consensus plan, mileage of dedicated infrastructure for biking and walking increased 60% growth in active transportation infrastructure. This is the same across any scenario. The 60% expansion is tied to a committed bucket for active transportation funding. A clear success from the constrained plan development process is that 100% of all active transportation needs from the transportation issues compilation process were addressed and funded. Because the financial resource blueprint is held constant across all scenarios to ensure a fiscally constrained plan, the total mileage achievable within that budget remains identical, regardless of how population and employment shift.

Asset Management

The Commonwealth Transportation Board has adopted a funding formula and prioritization process for maintenance of pavements and bridges under the State of Good Repair (SGR) program (Code of Virginia (§ 33.2-369) and a pavement maintenance formula using a proactive, preservation-focused approach rather than a reactive "worst-first" strategy. Combined with the dedicated funding for special structures like the moveable Benjamin Harrison Bridge, these programs are expected to invest nearly $13 billion over the life of this plan to maintain, rehabilitate, and reconstruct pavements and bridges throughout the region to maintain State-approved levels of good repair.

VDOT has mapped the expected impact of maintenance investments across the Commonwealth. Over the life of this plan, these investments levels are expected to achieve 82% sufficiency (fair or better condition) on interstate and high-volume roadways (AADT >= 3,500) with lower percentages on low volume primary (75%) and secondary (60%) roads. Over time, the expectation is that fewer roads would be in fair condition as proactive, preventative maintenance leads to more roadways being in good condition through early, lower cost interventions. This approach is consistent with the plan goal of 70% of NHS pavements in good condition.

In terms of bridges, the currently approved levels of investment are expected to result in 93% of bridges across the state being in a state of good repair (fair condition or better) by 2050 with an average general condition rating of 5.8

(fair condition). While these investments will not achieve 0% poor condition, these investments are expected to continue to increase the deck area in good condition through proactive maintenance and repair.

Resiliency & Redundancy

D1. By 2050, 10% of the at-risk transportation infrastructure on the LRTP Network will be improved to withstand extreme weather evets and natural disasters.

The plan aims to reduce the at-risk infrastructure by 10%, or get the at-risk lane miles to be below 394 miles. The base year value is 437.7 lane miles, or 13% of the LRTP network. Since the dataset was selected based on VTRAN's model, the consensus will be evaluated the same as scenario plannings' resiliency model.

The model for scenario planning was built to evaluate the proportion of population, jobs, and land use acreage that would be impacted. It additionally found the mileage of flooded network links based on sea level rise, dam inundation zones, and 500-year floodplains (2060 inundation predictions).

The difference between each scenario was the sea level rise, with Base 2050 and **B2F** having 3 ft sea level rise, Meh & Safe and Ecotopia having 2 ft sea level rise, and RVA Sinks having 5 ft sea level rise. Most of the difference in sea level rise can be found in low-lying areas along the river in the eastern part of PlanRVA (very little of the region). Therefore, all scenarios impact the same amount of P2F project mileage:

P2F All	P2F AT	P2F Transit	P2F Highway	P2F Bridge
40.49	17.14	4.03	18.73	0.46

The plan aims to increase the redundant capacity of the Transportation Network in the PM Peak Period (4:30-6:30 PM) by 5%. We see a sharp decline in redundant capacity in high growth scenarios which is a direct reflection of spatial and temporal pressures on the network. High growth scenarios funnel concentrated population and employment into specific TAZs, the volume-to-capacity ratio increases significantly during PM peak hours. Traditionally, the PM peak period (4:30–6:30 PM) is more compressed than the morning commute because it mixes standard employment commute trips with school, retail, commercial, and freight traffic.

In high-growth centers, thousands of trips are generated simultaneously within this two-hour window. As a result, the network experiences a massive surge that instantly overwhelms any regional baseline capacity gains. The extra capacity is entirely utilized trying to clear the immediate peak load.

Additionally, as the 2050 Plan focuses strictly on regional-scale network improvements, the travel demand model does not take into localized transportation improvements that potentially help meet the 5% capacity regional increase threshold.

Network Circuity	Build Scenarios relative to Do Nothing Baseline				
	Baseline	**RVA Sinks**	**Meh & Safe**	**Ecotopia**	**Back to the Future**
Redundant Capacity (PM Peak)	9%	27%	-1%	-40%	-200%
Network Connectivity	-3.20%	-10.10%	5.0%	14.10%	17.0%

D3. By 2050, the overall average systemwide Transportation Network connectivity will be increased by 2%
The plan also increase the overall average systemwide Transportation Network connectivity by 2%. A direct correlation exists between regional land-use distribution and network connectivity metrics. Performance modeling indicates that the network connectivity of the consensus investment list scales positively under medium- and high-growth land-use scenarios (Meh & Safe, Ecotopia, and Back to the Future), whereas it experiences a net decrease under low-growth and baseline conditions.

Conclusion

This scenario analysis shows that the success of this plan will be highly contingent on regional decisions around land use and growth. The results of this analysis demonstrate that infrastructure investments alone cannot guarantee the realization of the region's long-term transportation goals. Because performance metrics fluctuate significantly depending on spatial distribution and growth rates, the physical network remains fundamentally bound to the land-use patterns that surround it. For instance, highly decentralized, car-centric development styles can rapidly outpace and overwhelm baseline capacity gains, whereas compact, transit-oriented development patterns dramatically amplify the utility of active transportation and transit corridors. Consequently, the return on these major capital investments is entirely contingent upon local and regional coordination regarding where homes, businesses, and

services are physically established. To realize the benefits of these major investments, the RRTPO needs to proactively track the development of the region and develop flexibility and agility to adapt to changing circumstances.