Valley OnBoard

Toward a 20-year Vision for an Accessible, Equitable, Efficient Network for PVTA

Prepared by UMass Amherst
Regional Planning Studio
Fall 2021

A HOPE Project

PVTA

LA&RP
Landscape Architecture & Regional Planning

VOB
Valley OnBoard

Public transportation can offer a "ladder of opportunity"

TRANSIT EQUITY DASHBOARD

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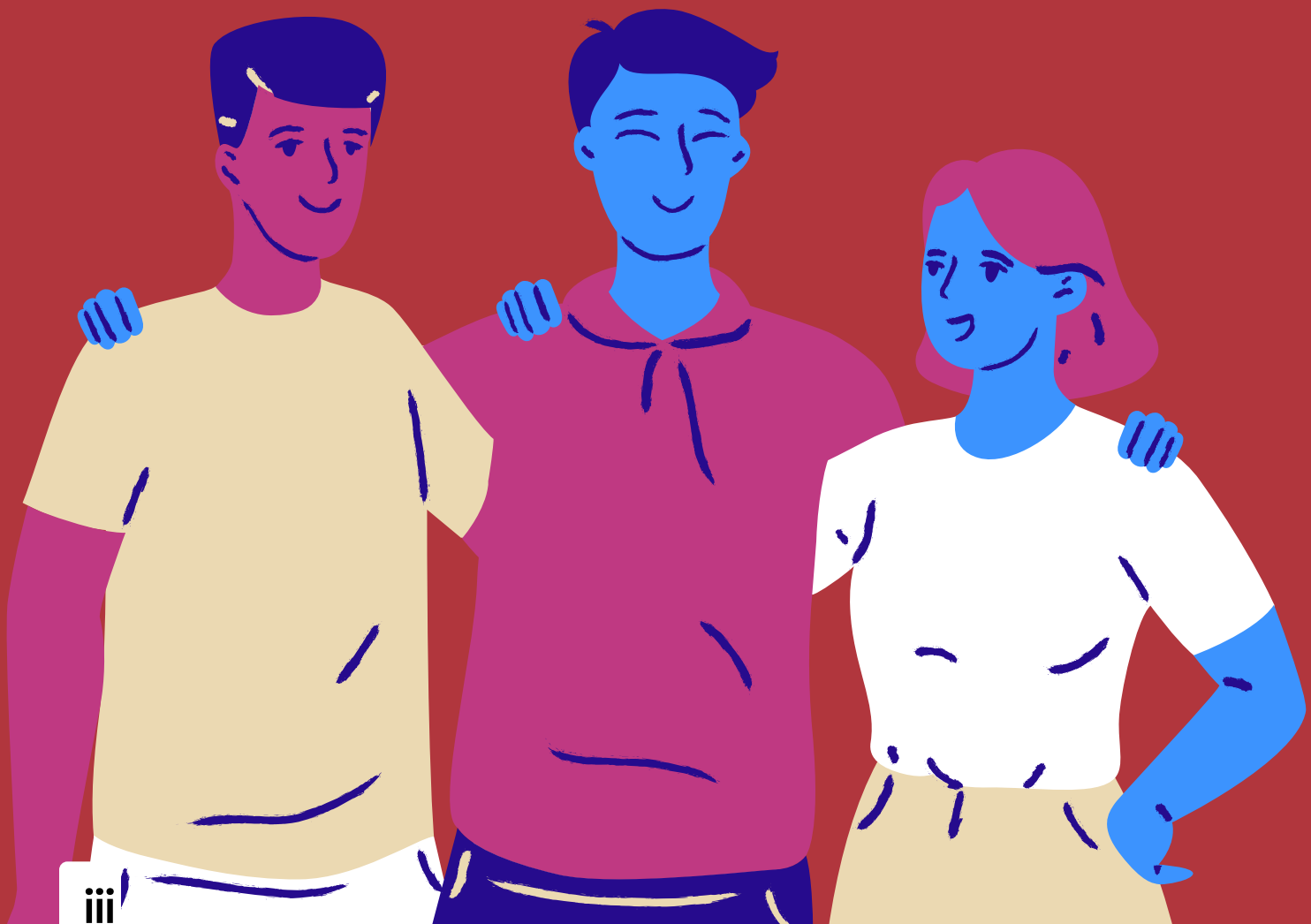

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Glossary and Abbreviations

Express/Limited Stop Service - Transit service that is designed to get riders between the two end points of a route/line without many intermediate stops

Flex Service- Provides scheduled service to fixed bus stops and allows the bus to travel closer to the passenger's starting and ending points, if requested

Farebox- Profits from ticket sales

Flex Zone- Predefined geographic areas where curb-to-curb on-demand service can be accessed

Grid Network- Design system as a grid so that most destinations can be reached from most origins with only one transfer

Headway - the time between two transit vehicles going the same direction on the same route/line

Hub and Spoke - Route originate and terminate at prominent stations

Limited Service - Traditionally, a fixed-route service that makes only limited stops at a small number of fixed-stops (less stops compared to a local bus service)

BEB - Battery Electric Bus

CTTransit - Connecticut Transit

EJ(C) - Environmental Justice (Community)

FRTA - Franklin Regional Transit Authority

FTA - Federal Transit Administration

HOPE - Helping Obtain Prosperity for Everyone

HUD - The Department of Housing and Urban Development

LANTA - Lehigh and Northampton Transportation Authority

MBTA - Massachusetts Bay Transportation Authority

NAR - North Atlantic Rail

NFTA - Niagara Frontier Transportation Authority

PVPC - Pioneer Valley Planning Commission

PVTA - Pioneer Valley Transit Authority

PV-TRIPS - Pioneer Valley Transit Review and Improvement Planning Study

RTA - Regional Transit Authority

SATCO - Springfield Area Transit Company

VATCO - Valley Area Transit Company

Executive Summary

The Pioneer Valley Transit Authority (PVTA), Massachusetts' largest regional transit authority (RTA), has partnered with the University of Massachusetts at Amherst (UMass) on a two-year project. The goal of this project will be to analyze and redesign the current transit network and service offerings to enhance equity and economic vitality throughout its service area in Hampshire and Hampden counties. The UMass project, dubbed Valley On Board (VOB), is part of a larger Pioneer Valley Transit Review and Improvement Planning Study (PV-TRIPS) that also included an update to the comprehensive regional transit plan. Funded by a Helping Obtain Prosperity for Everyone (HOPE) grant from the Federal Transit Administration (FTA) and the US Department of Transportation, Valley On Board advances the goal of the Federal HOPE Program, which is to improve public transit in areas of persistent poverty in the U.S. The Fall 2021 UMass Regional Planning Studio's portion of the two year project proposes a set of route alternatives to improve transit outcomes over the next 20 years for riders throughout the Pioneer Valley, with a specific focus on those living in areas that meet the State's criteria for Environmental Justice Communities (EJCs).

This report summarizes Phase I of the two-year planning project. Phase I consisted of five components:

1. SWOT analysis to identify PVTA's service strengths, weaknesses, opportunities and threats
2. Scenario Planning to envision four possible futures within which PVTA must deliver transit services
3. Analysis of industry-wide transit best practices
4. Route Alternatives development to offer four potential redesigns that address the different futures envisioned in the Scenario Planning process
5. Evaluation of each Route Alternative using the metrics of Access, Equity and Efficiency to assess how well each alternative performs within the given parameters of each scenario

In Phases II and III, which will take place in 2022, UMass will conduct fare/revenue and energy use analysis of the recommended routes, and then engage the public in a process of reviewing and refining the route recommendations.

The scenario planning process involved analyzing historic land use and population trends at local, regional and national scales; gleaning insights about future land use and economic development plans from planner interviews and a review of local and regional planning documents; identifying a set of Key Drivers whose outcomes would significantly impact the Valley's future (climate change, politics, funding, historic trends, generational priorities, and global impacts); and developing four distinct scenarios that envision different outcomes based on movement within these six drivers. The resulting scenarios were used as a basis for developing four distinct network redesigns.

The SWOT analysis revealed opportunities for improving frequency and accessibility of service in EJCs, as well as in rural areas in the northern and southeastern portions of the valley. Likewise, improvement of bus shelters, communications (particularly in Spanish), and first/last mile connections were identified as focus areas for improvement. These findings were incorporated into the route redesign process, along with best practices extracted by analyzing network designs and transit concepts utilized by other RTAs. Key network redesign recommendations include expansion of Flex Service and Flex Zones; addition of new Express Routes and Park-and-Rides; and the diversification of the fleet to better match vehicle size to route demand.

Figure A. Service Area Basemap.jpg

REMIX Route Recommendations:

Valley Stasis- ***p.22***

New Small City- ***p.25***

Skilled Valley- ***p.28***

Higher Ground- ***p.31***

Introduction

Valley On Board Overview

Valley On Board is a project-based partnership between the PVTA and the UMass Amherst Department of Planning and Landscape Architecture. This report is the culmination of work performed by graduate students enrolled in the Regional Planning Fall 2021 Studio course.

The Fall 2021 Studio is part of a larger two-year partnership between PVTA and UMass, the goal of which is to redesign the regional transit network to better serve current and future riders into the next 20 years. The project will comprise four phases:

Phase I: SWOT analysis of the current network, scenario planning to envision future contexts, and design of proposed route alternatives to enhance transit service.

Phase II: UMass Amherst's Department of Civil and Environmental Engineering will conduct research into energy modeling, transit data and technology use, and fare and financing models.

Phase III: UMass Amherst's Fall 2022 Planning Studio will engage in a public participation process to get public feedback on the initial route recommendations in Phase I and make revisions accordingly.

Phase IV: PVTA will complete the review process and develop a finance and implementation plan.

Project Context

Prior to this project, the PVTA worked with the consulting firm, AECOM, to create a comprehensive plan in accordance with State planning requirements for all RTAs. The comprehensive plan was completed in 2020 and, as a 5-year plan, was limited in scope. Valley On Board expands the planning timeline to 20 years, to explore a more realistic context in which to implement changes that traditionally require longer timelines, such as new infrastructure and major fleet modifications.

Another key difference between the Valley on Board project and the AECOM comprehensive plan, is this study is specifically focused on using equity as a lens for analysis and recommendations. See FOCUS COMMUNITIES below.

An important contextual consideration for this study is the COVID-19 pandemic, which began in 2020 and triggered a dramatic decrease in ridership due to stay-at-home orders and a shift to remote work and schooling. Though some stabilization has occurred, the long term impacts of the pandemic are still yet unknown, creating an uncertain future in regard to transit demand and priority service areas.

Likewise, the impacts of climate change contribute many unknowns to the future within which the PVTA network must deliver service. The scenario planning process undertaken as part of this project envisioned a variety of outcomes driven by climate change, ranging from population and economic shifts to weather-related hazards.

Figure B. Project Timeline.PNG

Regional Context

The PVTA, established in 1974, is located in western Massachusetts with operations across 24 member communities in Hampden, and Hampshire Counties, making it the largest regional transit agency in the commonwealth. The PVTA was created by the state as a funding source and to provide oversight and coordination of public transportation within the Pioneer Valley region. Today, it serves a diverse community that includes a blend of urban, suburban and rural areas.

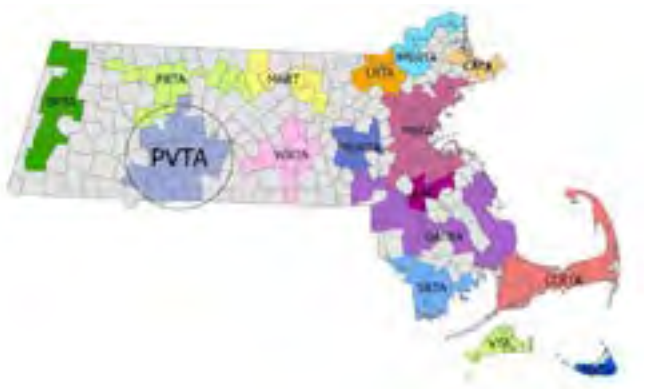
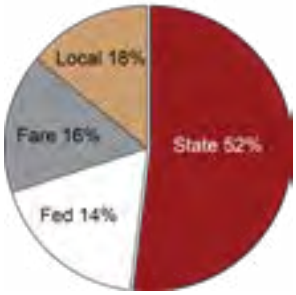


Figure C. Massachusetts RTAs.JPG

In addition to being the largest RTA spatially, the PVTA currently operates 45 bus routes, 36 of which are fixed routes serviced by 300 buses and vans. The organization's vision is to assist the Pioneer Valley in making these communities more livable through transportation services.

From an operations standpoint, the PVTA does not directly service its routes; rather, it contracts with three different local providers--the Springfield Area Transit Company, the Valley Area Transit Company, and UMass Transit--to both operate and maintain their large fleet. These three providers, whose garages are located in Springfield, Northampton, and on the UMass Amherst campus respectively, maintain separate fleets and staff. PVTA Funding comes partially from the 24 individual member communities that receive PVTA service through an assessment based on the number of fixed route miles and transit passengers served within that city or town. Federal and state funds also comprise a significant portion of the budget, with farebox revenues and grants making up the rest.



PVTA 2019 Funding Sources[1]

1 Altered from AECOM et al., "PVTA Bus Rapid Transit Alternatives Analysis."

Focus Communities

Valley On Board is part of a set of projects funded by a HOPE grant. The HOPE program commits federal dollars to Helping Obtain Prosperity for Everyone by improving public transit in areas of persistent poverty in the U.S.

To achieve the grant objectives, this study identified a set of focus communities wherein residents have the greatest stake in public transit. These communities, located throughout the Pioneer Valley but concentrated in the greater Springfield and Holyoke areas, meet the State's criteria for Environmental Justice Communities (EJCs). Some of the official criteria that define EJCs include lack of English-language proficiency, household incomes well below the median, and high percentage of minority population. These barriers inhibit people's ability to influence decisions about things affecting their own lives and communities, making them more vulnerable than other residents and warranting special consideration from a planning standpoint. Because of this vulnerability, and because residents of EJCs are also among the most transit-dependent members of our community, this study has deliberately elevated their place in the consideration set.

Figure D. EJ Map.jpg

Objectives & Metrics

Transit outcomes are typically assessed using the metrics of Ridership, Efficiency, and Farebox Revenues. For the purposes of this study, we have eliminated Farebox Revenues based on the assumption that farebox changes correlate with ridership changes. Therefore Ridership and Efficiency comprise the two standard metrics utilized in evaluating the current network and future route recommendations.

As noted previously, Valley On Board is part of a set of projects funded by a federal HOPE grant, the goal of which is Helping Obtain Prosperity for Everyone. According to the TransitCenter.org[2], a foundation that works to improve public transit across the US, public transportation can offer a "ladder of opportunity" by providing affordable and convenient connections to jobs, goods and services, medical care, and other essentials of daily life.

Valley On Board aims to strengthen this opportunity ladder by examining the PVTA network for opportunities to improve the standard measures of transit effectiveness. Therefore, this study utilizes a third metric in the evaluation process: **Access**, particularly for residents of EJCs.

Access in this study can be generally understood as the number of critical destinations (jobs, schools, recreational areas, shopping, medical facilities, etc.), that people can reach within 45 minutes. Access is further discussed and defined in the **Grading the System** section of this report.

2 https://dashboard.transitcenter.org/

Existing Conditions

Developing an understanding of existing conditions involved both primary and secondary research.

Site Visits

Primary research involved visiting two garages/service hubs operated by PVTA partners: the UMass garage, located at 185 Holdsworth Way in Amherst, and the new Springfield SATCO facility located slightly outside the city center. These site visits included informal discussions with drivers, service managers and mechanics, and offered insight into the complexity of PVTA's operations.

A key operations challenge identified during these site visits was a labor shortage amongst drivers and mechanics. Barriers to staffing include CDL license requirements for drivers, background checks, and technical knowledge, as well as generational differences between the previous and current labor pool and the ways in which workers view benefits, such as retirement funds and health insurance, versus hourly wages. This insight directly informed this report's Policy & Operations recommendations.

Route Rides

The study team also conducted route rides to glean firsthand insights into the rider experience. PVTA's 36 fixed route lines were divided into micro-regions and then assigned to a sub-team to study. Insights from the route rides informed the SWOT analysis, described in detail in the following pages.

Applied Literature Review

The study team reviewed current transit trends in formal academic literature, transit industry gray literature, and a review of area's regional planning documents.

The Transit Equity Dashboard (TED) figured prominently in shaping this project's approach to progressing equity-based consideration in the PVTA network. TED is a multi-layered transit study that analyzes the effectiveness of major transit systems' capacity to deliver services in an equitable manner.[3] TED scored transit systems in major metro areas such as Chicago, San Francisco and Washington D.C., measuring how well these transit networks connect people who've been marginalized within those metro areas to the jobs, services, and amenities they need to thrive. Using February 2020 as a baseline, this dashboard examines metrics like the number of jobs people can reach within a limited time-frame or budget, travel times to hospitals and grocery stores, and service frequency, and tracks how these measures have changed in each region. It illuminates existing disparities and tracks progress toward equity by measuring transit outcomes for Black people, other people of color, people living in poverty, and single mothers. This research helped inform the grading process applied to the route recommendations outlined in this report.

Another application of insights gleaned from the literature review was the establishment of route classifications, based on a framework posed in transit scholar Jarrett Walker's blog; the two classifications are Coverage and Patronage. According to Walker Patronage routes operate in the most densely populated locations and focus on generating revenue through direct farebox recovery, while Coverage models seek to cover the most space and are often associated with improving accessibility throughout a region as opposed to generating significant revenue.[4] Walker notes that patronage-based transit networks are based primarily on generating revenue. These patronage based models often conflict with coverage approaches, which seek to offer as much access to all areas as possible regardless of cost. Most systems are not one or the other, but rather a blend of coverage and patronage. Equity-based recommendations pull a network towards a coverage model, but these routes are generally poor revenue generators.

Applying Walker's analysis to PVTA routes revealed potential changes that could be made to enhance coverage, which would improve the route's access scores. Spatial analysis via Remix revealed that the PVTA network comprises 68.9% Patronage routes and 31.1% Coverage routes. Route descriptions versus population density were used to determine these classifications. PVTA has a greater portion of patronage routes, while a bulk of the region is spread across rural and suburban areas. This meant that when considering recommendations, special attention was needed to determine how best to service sparsely populated areas.

3 Klumpenhouwer et al., "A Comprehensive Transit Accessibility and Equity Dashboard."

4 Walker, "Purpose-Driven Public Transport."

Regional Plan Reviews

To establish an understanding of regional land use and economic development plans that would impact transit needs, regional planning documents (town-level and regional-level comprehensive and economic development plans) were reviewed. Additionally, email interviews were conducted with planners from the 24 member communities; this interview process is detailed below in this report.

Both the interviews and the planning documents review revealed a lack of regionalism and minimal integration of the transit authority across the valley.[5] A key insight was the understanding that municipalities receive intense pushback when presenting deviations from current land use norms, including implementing any significant change in the transit network. This challenge is exacerbated by the complexity of the review process required to approve network changes; a process which requires a minimum of 6 months of review, including a public participation component.

Spatial Analysis

The next step in gathering a rich understanding of the region was to conduct a spatial analysis of key destinations, job centers and land uses. A series of base maps were created by using Geographic Information Systems (GIS) and Remix softwares. GIS is a traditional planning tool used for visualizing data through maps. Remix is a state of the art transit engineering program that provides users with on the fly spatial analysis of preloaded bus routes and transit systems. The program also facilitates the creation of new lines while providing the associated statistics such as cost and expected ridership of these test routes. The PVTA granted VOB access to the Remix software and a significant portion of initial spatial analysis was gathered through the utilization of this tool. Remix was particularly crucial in the creation of our route recommendation models, which are discussed on pages . A curation of the base maps along with brief summaries of their findings are located in the ***Scenarios Defined & Route Designs*** section of the report.

The spatial analysis of the region uncovered that EJ communities comprise nearly 40% of the region's population at 248,000 residents spread across the valley. Housing and transportation costs do not exist in isolation. The region's EJCs frequently experience being burdened by their costs of living at rates greater than the remainder of the region. These communities that are cost burdened spend more than 30% of their income on housing alone. While the PVTA Service region sits at approximately 35% of households being cost burdened, nearly 45% of households in EJCs experience this challenge.[6] Providing a transit system that connects these individuals to further opportunities is absolutely critical. The route recommendations sought to address this inadequacy by focusing on improving accessibility within these communities. A goal was to offer recommendations for the system that would grant access to opportunities and connect to employment destinations.

Another issue that was uncovered was that EJCs often lack access to single occupancy vehicles and thus are more transit dependent. It is reported that 21% of EJ Households do not have a vehicle while only 3% non-EJ households [7]lack this same access. These EJ households are spread across two very distinct counties and in locations where access to public transit is limited. The differences between the counties present unique challenges that impact the formation of recommendations. For example, to lower overall emissions, it is crucial to phase out combustion engine vehicles. Unfortunately a one size fits all transit solution will not apply when considering the diversity of the region. Hampden county is home to a major urban core in Springfield and the most concentrated service network and population base. Hampshire is predominantly rural in nature and home to the 5 Colleges. The diversity demands different regional service solutions which were all considered within the route recommendations. Dynamic solutions were offered through utilizing flex routes and flex service zones that will be explored further in our route recommendations.

The preliminary analysis of the region established a deep understanding of the complexity of the current system, the role the PVTA played within its member communities and the ability to begin to consider recommendations that accomplish the predetermined goals of the project. Much of the work spent researching, analyzing and interviewing directly informed many of the final recommendations. The PVTA currently does an excellent job of providing robust service but there remains room for improvement particularly when considering the changes that will occur over the next 20 years. VOB was tasked with considering how and what the system of the future would look. The research conducted provided the necessary understanding of how the region functions that was critical for informing final recommendations.

5 See Planner Interviews Section for Additional Detail

6 "US Census Data Explorer."

7 "US Census Data Explorer."

SWOT Analysis

Referring to an analysis of the system's fundamental strengths, weaknesses, opportunities, and threats, a SWOT Analysis is a tool for examining relationships between internal and external factors which affect the system.[8] A full SWOT analysis is typically quite extensive; the following is a synopsis of the key takeaways for this initial portion of the project.

The SWOT analysis was a cumulative exercise that greatly influenced the scenario building process, and network redesign recommendations, while still meeting the outlined objectives and metrics around Access, Equity, and Efficiency. The process involved pooling observations from various sources of analysis, into these four overarching categories, from which the team used to make connections, and see how observations may be representative of system wide trends.

Well Connected Urban Core

Beginning with a strength, initial analysis observed that the current PVTA system readily connects people and essential destinations, within the urban cores of the network. Based on ArcGIS analysis, 44% of the service area's population, and 83% percent of critical destinations are located within a "walkable" distance. A "walkable" distance, for purposes of this report, is defined as a quarter mile buffer around at least one bus stop. While these "planner circles" or "walkshed", as a form of measurement, has its limitations, a quarter mile is considered convention.[9] Furthermore, our research revealed that the urbanized cores coincide with the region's Environmental Justices communities, which suggests that the current network serves transit dependent riders well.

Inefficiencies in Coverage Routes

The PVTA service area is typified by several urban cores, where developments and populations are clustered, and separated by large areas of rural, less densely populated spaces. The PVTA's current system exhibits a well connected series of urban cores- or nodes, but reveals a potential weakness in its connectivity to the more rural areas. The group found that coverage routes for rural areas characteristically have relatively low ridership and need to connect longer distances meaning they are high mileage routes. Combining low ridership with high mileage labels the route as inefficient. While we considered this a weakness, it's also an opportunity to explore more flex options for similar routes or for expanded service, through either a change in frequency or through diversification of the fleet itself- using smaller, more fuel efficient vehicles.

The group examined the current Ware-Palmer Flex Route, as a case study. In this example, the flex route provides service to rural communities through the use of smaller shuttle buses, runs on lower frequency, and offers the option for riders to call for a pick up at locations within ¾ mile of the fixed route. There are opportunities to expand this route format on similar, low-ridership/high-mileage route

Overall the group's goals, where to better match capacity with demand, in order to optimize efficiency, and reduce costs while still providing service to those outlying populations- especially thinking of elderly populations aging in place- who may not fall into the typical environmental justice demographic, but who we can use as a proxy for transit dependent riders outside specific EJ designated communities.

8 Uri Avin, "Using Scenarios to Make Urban Plans," in Engaging the Future: Forecasts, Scenarios, Plans, and Projects, ed. Lewis Hopkins and Marisa Zapata (Lincoln Institute of Land Policy, 2007).

9 Louis Merlin et al., "Redrawing the Planners' Circle: Analyzing Trip-Level Walk Distances Across Two National Surveys," Journal of the American Planning Association 87 (May 18, 2021): 1–14, https://doi.org/10.1080/01944363.2021.1877181.

Micro-mobility as First & Last Mile

As a strength and opportunity, we looked at how the current PVTA system connects with existing micro- transit systems. ValleyBike is a relatively new and growing bike share system with 72 stations across 8 membership communities. The majority of the stations are located within urban hubs, at critical destinations like medical centers, shopping malls, entertainment venues, as well as within the region's EJ communities. ValleyBike represents a unified micro-transit system, working in tandem with PVTA, providing affordable transportation options for the "first and last" mile of rider's trips.[10]

What the group identified as an opportunity was to strengthen the connection between ValleyBike and the PVAT. While several stations are also located near PVTA transit nodes, the two networks are not conjoined into a unified transit system. Also, the number of stations are not evenly distributed throughout the service area- with more stations in and around the colleges and universities in the northern section of the PVTA service area. Both programs would benefit from a comprehensive plan, or guiding framework, for citing new VAlleyBike stations near PVTA bus stops, and other transit nodes- such as Amtrak stations and interstate bus centers. This would create a more comprehensive transit system, and specifically support rider's with their "first and last" mile needs.

Efficiency Improvements: Express + Transit Priority

Two additional areas identified as both a strength and an opportunity revolve around the idea of implementing express routes and transit priority treatments. The group's research on express routes included ridership data for the P21E (Springfield/Holyoke) which saw a 12% ridership increase when it was brought online in 2016. Additionally, ridership numbers increased on all current express routes during the pandemic.[11] Group members also collected qualitative observations on route rides of the two new express routes, the B43E and G73E, which are implemented recommendations of the recent PVTA Comprehensive plan earlier this year.[12] The group analysis concluded that express routes are strengths of the current network. There is an opportunity to expand their use to improve system efficiency for regional connectivity, to improve access via lowered transit times, and to improve commuter ridership and fare-driven funding.

However, this topic was also considered a threat, since all routes, beyond highway applications, are heavily dependent on local traffic congestion. Transit priority treatments are a method for alleviating traffic congestion by prioritizing buses[13]. Implementing these treatment are beyond the sole jurisdiction of the PVTA, and require approval processes of the individual service communities; which can be complicated, but without which, could render

and future local and express routes ineffective. A BRT service has been proposed for State Street in Springfield, but concerns from the city have halted progress on this project[14]. The city should reconsider their stance on this in the future.

Integrate Land Use + Transit Planning

Another area that is both a strength but could also be considered a threat to the existing PVTA system is the process of integrating regional land-use and transit planning. Intermediate and long-term planning is crucial to understanding how land-use changes affect destinations and how the PVTA provides access by connecting riders with desired destinations. Optimally, the PVTA system would connect riders with destinations, and stops/ routes would be sited near nodes of activity- in accordance with an overarching regional development plan. In reality, each town has its own development priorities, and there is no overarching regional plan that is enforceable across town lines. This makes regional coordination extremely difficult across the service area, and thus, there is a disconnect, where PVTA services may not fully align with key land-uses, leading to a patchwork of connectivity as land-uses change. This threatens the overall system.

The opportunity is better coordination between the PVTA and its service communities, to operate services in conjunction with prioritized land-uses, and to use public transit as a catalyst for transit oriented development. Some of these opportunities also include the expansion of the park and ride network- currently there are 4 existing park and rides in the entire PVTA service area, and by citing route terminus points at major nodes of activity.[15]

10 "ValleyBike Share."
11 "FY 2014-2022 Monthly Ridership-Hours-Miles by Route - September 15, 5:40 PM."
12 Pioneer Valley Transit Authority, "Comprehensive Regional Transit Plan Update 2020."
13 Pioneer Valley Transit Authority, "PVTA Bus Rapid Transit Alternative Analysis."
14 AECOM et al., "PVTA Bus Rapid Transit Alternatives Analysis."
15 Macioszek and Kurek, "The Use of a Park and Ride System—A Case Study Based on the City of Cracow (Poland)."

EJ Communities & Poor Health Outcomes

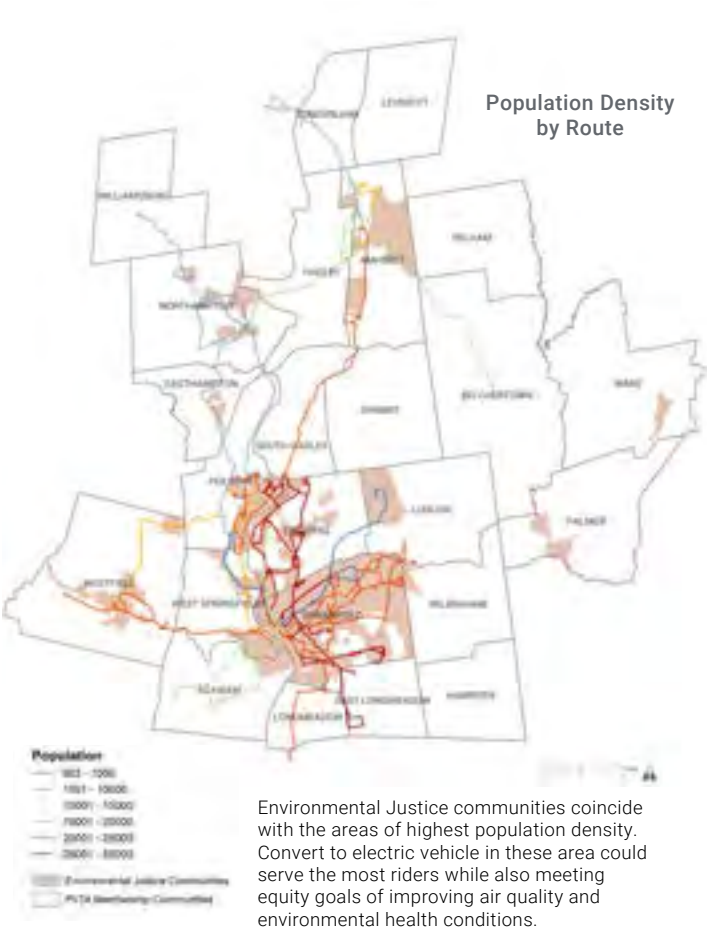
Another topic identified as both a threat and an opportunity is how PVTA transit services can impact health outcomes in their service area. As noted previously, there is an intersection between where PVTA currently provides expansive services- multiple routes serving the same community, and the region's identified Environmental Communities. In 2018 and 2019, Springfield earned the unfortunate title as the "Asthma Capital" of the nation.[16] Air pollutants- including those from diesel vehicles such as buses- negatively impact the air quality, particularly for those who are most vulnerable, and consequently for those same populations who might need public transit the most.[17] In a way, the public transportation offered is threatening to negatively influence poor health outcomes.[18]

This is also an opportunity for PVTA to expand its eclectic and hybrid bus fleet options, first prioritizing routes with high ridership, and multiple stops- patterns that negatively impact the overall efficiency of diesel- power buses, but where electric and hybrid buses excel. This would reduce emissions, and the negative contribution of these emissions, specifically where they are most likely to impact environmental justice communities.[19]

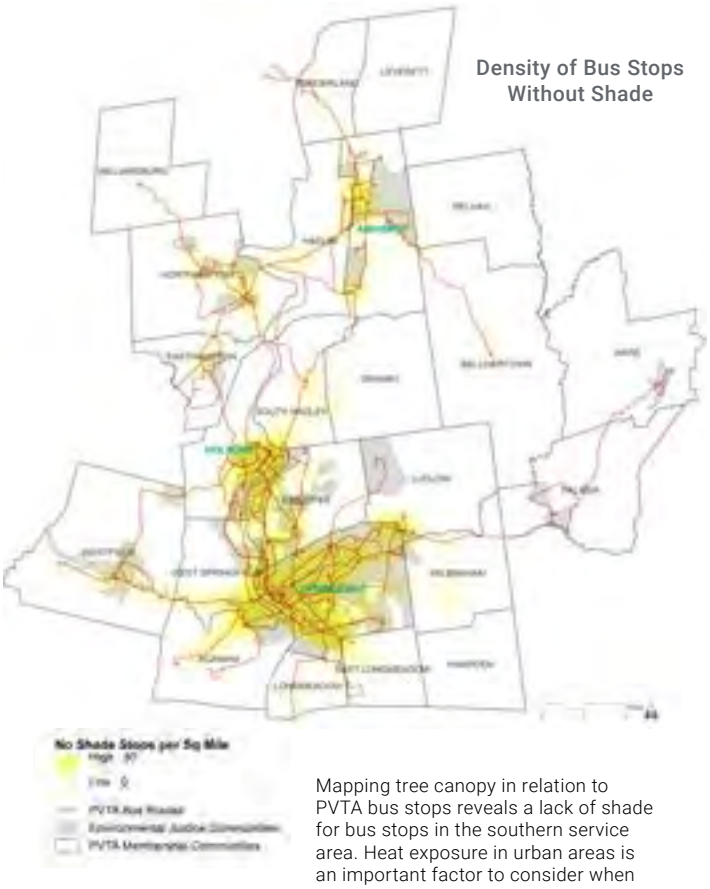
Lack of Bus Stop Amenities

The group identified the lack of bus stop amenities as both a weakness and threat to the overall system. Our research indicated that 66% of bus stops within the PVTA service area do not have shelters. Of those, the highest-ridership stops without shelters are located in the northern section of the service area. In these locations without shelters, we recommend a review as to whether the amenities are adequate, and recommend an expansion of bus shelter amenities to provide rider comfort and dignity for PVTA service users.

Another aspect to consider are the onsite constraints. There are on-site constraints where each proposed bus stop location is unique, limited by size and land ownership, as well as an uncertainty as to who maintains that infrastructure once it's installed. We concurred with the AECOM Comprehensive Plan, which recommended the need for a standardized process for installing bus shelters, especially given the challenges for the PVTA needing to work with individual municipalities to receive approval to install the infrastructure.[20]



Environmental Justice communities coincide with the areas of highest population density. Convert to electric vehicle in these area could serve the most riders while also meeting equity goals of improving air quality and environmental health conditions.



Mapping tree canopy in relation to PVTA bus stops reveals a lack of shade for bus stops in the southern service area. Heat exposure in urban areas is an important factor to consider when prioritizes bus stop amenities.

16 Williams, "At No. 12, Springfield No Longer Dubbed The Asthma Capital Of The United States."
17 Wang, Sun, and Ye, "On-Road Bus Emission Comparison for Diverse Locations and Fuel Types in Real-World Operation Conditions."
18 "Learn About Impacts of Diesel Exhaust and the Diesel Emissions Reduction Act (DERA)."
19 Moody, "A Scalable Model of All-Electric Fleets for Transportation"; "Is the US Ready for More Electric Buses?"
20 Pioneer Valley Transit Authority, "Comprehensive Regional Transit Plan Update 2020."

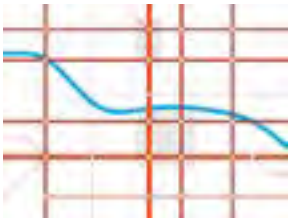
Case Studies & Transit Best Practices

Case Studies

A case study analysis was conducted to develop an understanding of best practices used by transit authorities across the United States. Ultimately, five transportation authorities were selected for in-depth analysis due to their use of practices relevant to the studies goals of improving access, equity, and efficiency and resemblance to conditions found in the PVTA system. Best practices resulting from this analysis were then integrated into the route redesigns and recommendations for the PVTA. Full case study analysis and comparative table are located in Appendix 1: Case Studies.

Best Practices: Network Design

GRID NETWORK



Grid Network which designs the bus routes as a grid so that most destinations can be reached from most origins with only one transfer. This is a good option for cities with distributed destinations such as downtowns and employment centers.

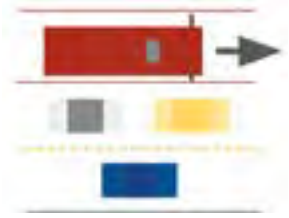
MULTI-HUB NETWORK

In a multi-hub network, routes start and end at prominent stations allowing for greater transfer opportunities. This form also reduces some rider experienced inefficiencies of intraregional travel inherent a single-hub system.

EXPRESS ROUTES

Express Routes are fast transit routes that are designed to get people between major stops (usually the two end points of the route) with limited stops in between. Designing these routes for commuting to major job centers is common.

DEDICATED BUS LANES



Dedicated bus lanes are parts or lanes of the road that are dedicated for the use of buses. These are often employed on popular routes that may experience high traffic congestion slowing service down without these lanes.

Best Practices: On Demand Transit

On-Demand Transit encompasses transit services that are available to people who aren't served well by traditional bus routes. On-Demand services can be useful to rural communities where traditional bus routes may not be feasible, and our population is increasingly aging. It should be noted, that On-Demand transit is not the same as para-transit, which are transit services dedicated for individuals with disabilities that prevent them from using most forms of transportation. On-Demand transit service is for everyone.

FLEX ROUTES

Flex routes provide scheduled service to fixed bus stops and allows the bus to travel closer to the passenger's starting and ending points, if requested in advance. Service occurs from stop to stop at the times listed in the schedule, but may be re-routed between stops as requested in order to pick-up/ drop-off passengers at locations not directly on the route. (ex ¾ mile radius of route, Existing PVTA Ware-Palmer service)

FLEX ZONES

Flex zones differ from flex routes as they provide curb-to-curb on demand service for entire predefined areas in a region. Flex zones are typically good for extending coverage into suburban and rural areas that are not well covered by traditional fixed route coverage.

MICROTRANSIT

Micro-Transit is small scale on demand transit services that can offer BOTH flex service and flex routes with on demand scheduling. The key difference here is the scale of the transit vehicle. This transit concept may also be referred to as fleet diversification.

Planner Interviews

To properly align future scenarios with local planning priorities, a series of questions were sent out to planners and economic development officials within the PVTA partner communities. Survey questions focused on regional development efforts, transit connectivity, zoning and projected trends, as well as reviewing the working relationship between the towns and the PVTA. (The full list of interview questions is provided within Appendix 1: Planner Interviews.)

Questions 1, 2, and 6 were designed to learn about current points of interest that required greater transit connectivity and could be integrated within the route recommendations.

Questions 3, 4, 5 and 9 were designed to see how decision makers within the area thought about PVTA as a regional transportation authority, regarding their ability to communicate effectively and instill positive change.

Questions 7, 8 and 10 were designed to provide insight into community goals, especially with respect to transit connectivity. Question 10 was especially important in terms of how much the chosen professionals were thinking about transportation and scenario planning.

Larger municipalities, such as the City of Springfield, which maintains a professional staff in both planning and economic development, were sent two surveys, while smaller communities such as the Town of Pelham, only had a contact listed for the chair of the Planning Board. Each official was contacted, and the survey responses were collected via zoom, phone, and email.

After receiving feedback from 11 PVTA partner communities, the qualitative data analysis software MAXQDA was used to explore the findings. Within MAXQDA, each interview answer was entered or "coded" into the software and assigned a "theme" based on its content. The answers were then organized in SWOT format. Instances where planners pointed out strengths and weaknesses of the PVTA's services and/or opportunities to improve amenities and relations with each respective town were noted. Association maps were then created to review the prominent takeaways and analyze responses side by side. (See Appendix 1 for MAXQDA maps.)

Dream Themes:

- *Fleet Electrification*
- *Fare-free system*
- *Varied-size fleet*
- *ValleyBike collaboration*
- *Westfield to Springfield to Worcester*

Results suggested there is an overwhelming interest in developing more coordination between member communities and the PVTA to match new municipal developments with bus service. While there were some differences between northern and southern communities, the driving force behind responses was more aligned with how connected the communities were by the PVTA. Communities that are less connected by PVTA expressed a primary desire to become more connected by having higher frequency and more stop locations. In more connected communities, planners described awareness of the PVTA in development planning and suggested improvements such as syncing stops with ValleyBike locations, providing better bus stop amenities, and fleet diversification. This suggests that less-connected communities are most interested in being serviced more by PVTA while more-connected communities have an interest in improving the services already provided.

Scenario-Driven Route Redesigns

Scenario planning is a long-term comprehensive planning strategy with roots in the military and business worlds. Over the last 30 years, this planning technique has been adapted to function in both regional and urban planning. A key component of using scenario planning is scenario development. Robust scenario development requires analyzing various trends and identifying potential uncertainties that may shape the future of the study region.

Identifying existing trends helps to establish a baseline scenario, often called Business As Usual, which a series of alternative scenarios can then be based upon. Together these scenarios, including the Business as Usual and alternatives, provide a vehicle for envisioning different ways the future could unfold beyond traditional forecasting techniques.

Scenario planning is therefore a strategy for *planning in uncertainty*, an especially important concept in a time of climate change, economic disruption due to global pandemics, and continued rapid technological advancement – all of which have significant implications for the transit industry. Scenarios grant planners the space to develop dynamic approaches to achieving a given set of goals under varying conditions.

The Valley on Board project decided early on scenario planning would be the ideal technique to create dynamic route recommendations that allow the PVTA to improve equitable and efficient service regardless of what the future has in store.

Through extensive research the team identified a series of drivers that were considered most impactful in shaping the future of the Pioneer Valley: *Climate Change, Global Impacts of Energy and Technology, Policy/Funding, Generational Values, and the Historical Legacy of the Pioneer Valley*. These drivers were then envisioned to interact and influence various outcomes that determined the scenarios. Ultimately, four different scenarios, discussed at length on the following pages, were created with a 20-year outlook for 2040. Individual route redesigns were then developed for each scenario in response to the changing demographic and economic landscapes imagined in each alternative future. To develop the scenarios and their accompanying route redesigns, the team performed extensive research to understand the PVTA's diverse service area:

Planner Interviews in Member Communities

Municipal officials from each of the PVTA member communities were sent a 10-question survey to provide a ground level review of how each municipality viewed the potential future of the valley and how it connects to the PVTA.

Comprehensive Planning Documents

Regional and municipal plans were reviewed to identify policy initiatives and recommendations relevant to development, economic, and transit trends. The next step was to consider a spectrum of *full* to *no adoption* of the recommendations and the potential implications of neglecting or pushing adoption would have on realistic futures.

Local and Global Trends Review

Global and local trends on housing, energy demand, climate change, generational cultural shifts, federal transportation policy and funding, and population forecasts for the valley were reviewed. Historic trends related to local economics, development practices, and socio-economic inequities of the Pioneer Valley were also considered.

Group Discussion and Internal Validity

Each scenario was internally reviewed to not only confirm its grounding in reality, but that each scenario offered substantial variation from one another and thereby would provide the PVTA with a useful array of potential futures.

Existing Conditions + SWOT

Current system configuration and metric-based analysis of the current PVTA system was organized to identify strengths, weaknesses, opportunities, and threats that could be integrated, aggravated, or alleviated within scenarios and their accompanying route redesign.

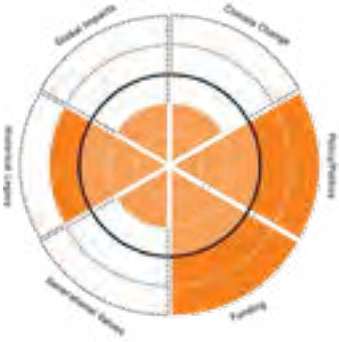
Transit Best Practices

Transit literature and case studies were reviewed to determine best practices that could be integrated into route redesigns. (Expanded description of case studies and best practices can be found in Appendix 2: Case Studies.)

Scenarios Defined & Route Redesigns

Valley Stasis (BAU)

Continued [muddled] approach to regional planning



New Small City

Holistic adoption of planning initiatives and regional collaboration

Skilled Valley

Community colleges and manufacturing fuel southern growth

Higher Ground

Climate migration and UMass expansion drive inequitable growth

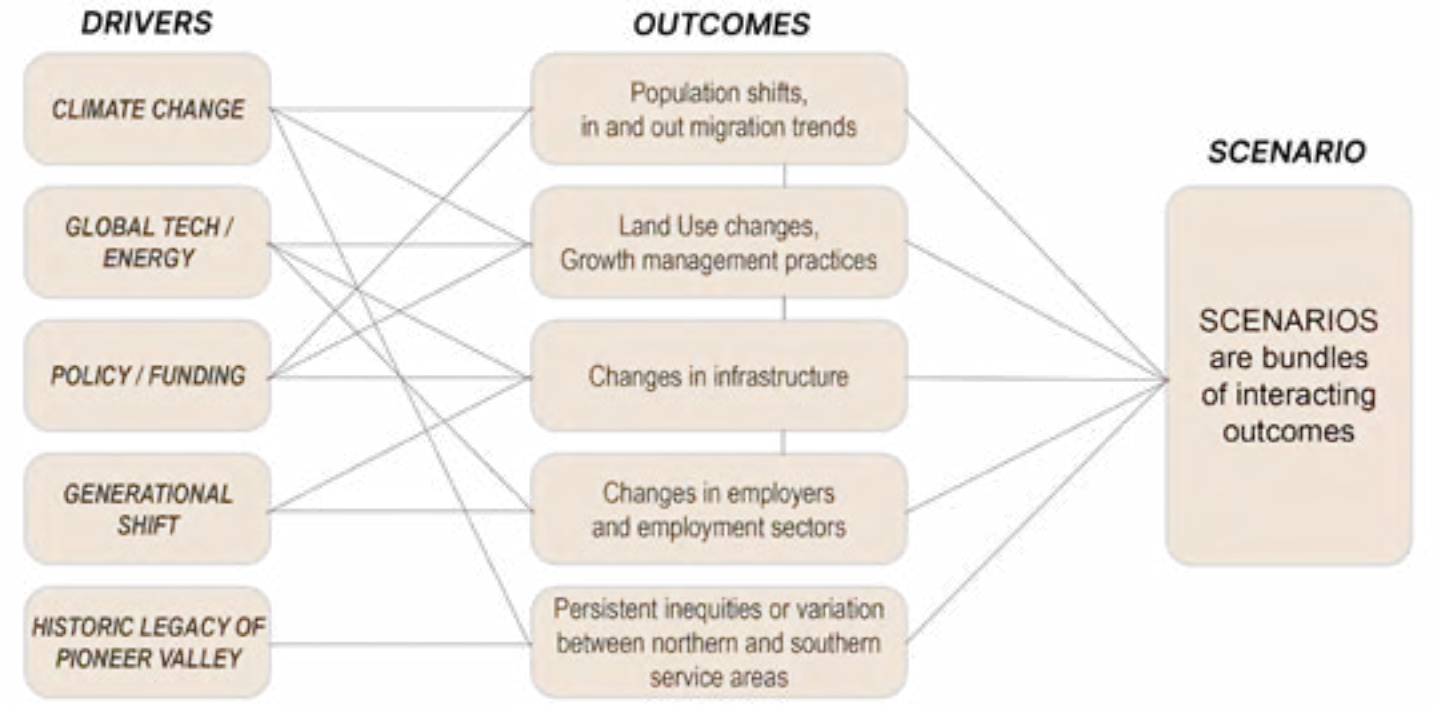


Figure E. BAU Driver Outcomes Explanation.png

Through extensive research the team identified a series of drivers that were considered most impactful in shaping the future of the Pioneer Valley: Climate Change, Global Impacts of Energy and Technology, Policy/Funding, Generational Values, and the Historical Legacy of the Pioneer Valley. These drivers were then envisioned to interact and influence various outcomes that determined the scenarios.

Valley Stasis (Business as Usual)

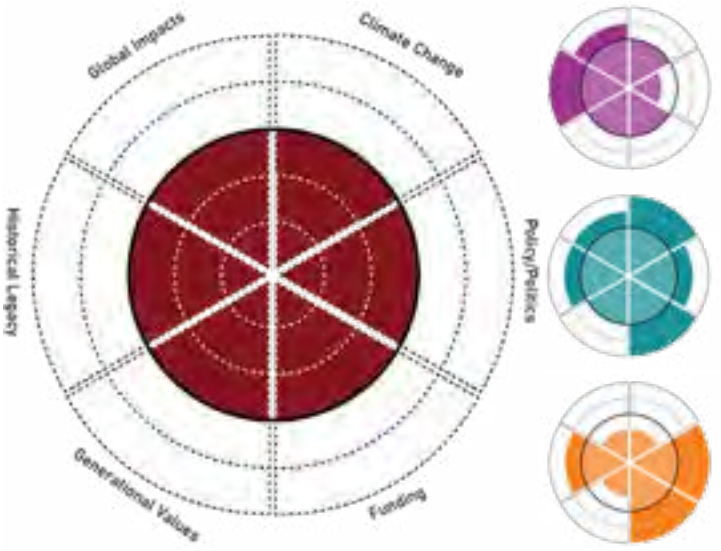
SCENARIO DESCRIPTION

This scenario assumes the projected climate change trends create more frequent and intense extreme weather events [1] that cause outdated infrastructure to fail and drive in-migration from the south of the country. More precisely, the Pioneer Valley is expected to experience increased annual temperatures and increased annual precipitation and flooding (specifically due to increased winter rain) [2]. Additionally, the fuel costs are projected to increase at a steady pace [3]. Electric cars… Agricultural and forested land is increasingly occupied by solar fields as a push for "green" energy and food production is focused on cash crops.

Generational Values are bringing shifts in lifestyle preferences, witnessing the transformation of American commuters and workers. Older generational (Baby Boomer, Gen X) values, attitudes and behaviors are less likely to change or remain flexible and in tune with technological advances [4]. Young Americans are more likely to prefer city living and walkable communities where driving is an option, not a necessity [5]. At the same time, they are "digital natives" who are more receptive to/ adoptive of technological advances [6]. Millennials are willing to give up their personal vehicles three times more than other generations, but they are more likely to drive more miles per person as they age than they do today [7]. The new generation is more likely to use transit and active transportation that is multimodal and colleges discourage vehicle ownership, resulting in lower vehicle miles traveled by young adults [8].

Related to the American worker, Americans are quitting their jobs at unprecedented rates, a sign that they're confident about finding new ones [9]. Millennials are more interested in job security and work¬ life balance than money and may desire more flexible working conditions and hours [10]. An aging population is not replenished by the younger generations at a proportionate rate and fewer young people buy homes or cars. These younger people live in transit-oriented areas while older people live in single family homes in the suburbs. Car ownership trends towards EV alternatives as technology becomes more accessible.

Lack of coordination of land use, housing, and climate planning in the Pioneer Valley Region leads to mixed outcomes and lack of meaningful regional planning and coordination. Urban areas and some towns promote transit investment, Transit Oriented Development, smart growth planning, and make significant efforts to adapt to climate change. Small agricultural towns continue to promote single family housing development, contain restrictive zoning, and limit multifamily housing and



certain commercial development, and do little to prepare for climate change's effects. Transportation Improvement Program (TIP) identifies priority projects, and the Valley Vision regional Smart Growth plan integrates transportation, land use, and housing [11].

Employment is still predominantly concentrated around the Education and Medical industries ("Eds and Meds") with a shift to hybrid remote work becoming more prevalent. Large manufacturing moves out of the region and these areas are redeveloped through adaptive reuse.

Unreliable funding sources moving forward will require more creative approaches/solutions. Funding sourced local assessments from municipalities relatively stagnate and are capped at the 2.5% annual increase [12]. Fare prices remain consistent and proportional to natural inflation and funding from partnerships (ex: UMass) remains constant [13].

[1] Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee. (2011). Massachusetts Climate Change Adaptation Report. https://www.mass.gov/files/documents/2017/11/29/Full%20report.pdf; [2] Pioneer Valley Planning Commission. (2014). Pioneer Valley Climate Action and Clean Energy Plan. http://www.pvpc.org/sites/default/files/PVPC%20Climate%20Action%20Clean%20Energy%20Plan%20FINAL%2002-18-14.pdf; [3] U.S. Energy Information Administration. (n.d.). Annual Energy Outlook 2021 Table: Table 12. Petroleum and Other Liquids Prices. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=12-AEO2021&region=0-0&cases=ref2021&start=2019&end=2050&f=A&linechart=ref2021-d113020a.3-12-AEO2021&chartindexed=0&sourcekey=0 (5) (6) Calvo-Porral, C. and Pesqueira-Sanchez, R. (2020), "Generational differences in technology behaviour: comparing millennials and Generation X", Kybernetes, Vol. 49 No. 11, pp. 2755-2772. https://doi.org/10.1108/K-09-2019-0598; (7), (8) - https://uspirg.org/sites/pirg/files/reports/Millennials%20in%20Motion%20USPIRG.pdf; (9) - https://fred.stlouisfed.org/series/JTSQUR; (10) - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2868990/; (11) - Pioneer Valley Planning Commission. (2020). Regional Transportation Plan for the Pioneer Valley Metropolitan Planning Organization. http://www.pvpc.org/sites/default/files/%E2%80%8CFinal%20RTP-Full%20Document.pdf; (12) , (13) - AECOM. (2021). Comprehensive Regional Plan Update 2020. Pioneer Valley Transit Authority. http://www.pvta.com/documents/crtpu/CRTPU%20Jan%202021.pd

Valley Stasis
(Business as Usual)

ROUTE REDESIGN SUMMARY

The Valley Stasis Route Redesign focuses on increasing coverage to the southeast region of the service area, rural connections, and transit access to EJCs. The transit dream of an East-West high-speed rail between Boston and Springfield does not come into fruition within the 20-year outlook. Longer distant express routes become an intermediary solution for mass transit connecting to Worcester and Boston. Most fixed routes of the PVTA's current system remain and inter-regional express routes are expanded.

A prime example of this, is better connectivity to the new B79 intercity route to Worcester, which increases the ability to access other major economic and educational hubs such as Metro-Boston. These routes, while providing connections to Worcester, also provide some fixed route service to Wilbraham, Palmer, and Ware.

Small changes to routes south of Springfield in Longmeadow better connect riders to employment centers in these locations.

In the north, the 31 is extended seasonally to provide recreational access to Mount Sugarloaf. Low frequency fixed routes create better connect between South Hadley, Granby, Chicopee and Springfield.

Figure F. BAU Scenario Route Recommendation.jpg

Remix Mapping Link

https://platform.remix.com/map/512b0ede?latlng=42.24784,-72.44971,9.5&public=true

Figure G. BAU Express and Flex.jpg

Figure H. BAU HEADWAYS.jpg

Existing express routes are retained as they meet the needs of the stable population.

New low-frequency routes improve coverage by extending service to rural area in the East and West. An example of this is the new low-frequency route connecting the PVTA service region with Worcester through a new hub in Ware.

Valley Stasis (Business as Usual)

ROUTE SPECIFIC RECOMMENDATIONS TABLE

Category	Route	Major Stops	Frequency	Metric	Time Frame
New / Express Routes	G5 (changes)	Union Station, Longmeadow, East Longmeadow	No change	Efficiency	Short
	31 (changes)	Amherst Center, UMass, Sunderland Center,	No change	Access	Short
Flex Routes/ Zones	Granby	N/A	No change	Access/Equity	Medium
	Ludlow	N/A	No change	Access/Equity	Medium
	Belchertown	N/A	No change	Access/Equity	Medium
Low-Frequency Routes	South Hadley/Granby/Holyoke	Mount Holyoke College, Granby Center, HTC	80 mins	Access/Equity	Medium
	Springfield/Ware	Union Station, Wilbraham Center, Ware Center	120 mins	Access/Equity	Medium
Infrastructure	Park and Rides	Priority Northern Service area	No change	Access	Short
	Small Transit Hub Amenities	Ware	No change	Access/ Efficiency	Medium

Figure I. BAU Route Recommendation Table.PNG

New Small City

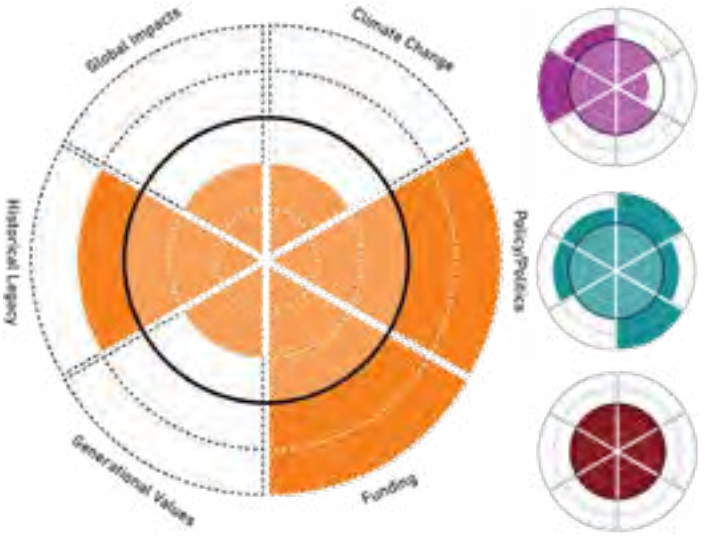
SCENARIO DESCRIPTION

New Small City is considered the best-case scenario where a revitalization of the major urban centers in Hampden and Hampshire Counties is driven by significant federal and state investments in regional transportation infrastructure projects. Rail projects connecting New York City, Connecticut, Springfield, Albany, and Boston are completed by way of regional collaboration and an infusion of capital from the passage of the federal Infrastructure Bill. Downtown Springfield becomes reinvigorated as it morphs into a major transit hub along the Northeast corridor. As Springfield flourishes, smaller neighboring urban centers such as Northampton experience concentrated urban growth.

For this scenario to become the future of the region, current regional planning initiatives must be adopted and serve as the new road map for the region's expansion. The New Small City would require a significant shift away from the valley's historical approach of growth management at municipal level. The team acknowledges that this divergence from traditional planning and growth management is a heavy lift for a region so accustomed to the home rule approach. Nevertheless, the team felt it was crucial that we offer a scenario that would consider all the implications of a truly regional approach to planning.

The passage of President Biden's Infrastructure Investment and Jobs Act in November of 2021 provided the foundation for developing this scenario. The bill contained the necessary language and set aside capital that supports this vision of a rail connected Northeast corridor. Section 22301 of the bill explicitly outlines Northeast rail expansion as being prioritized. This scenario leans into projects such as the Hartford Line, Metro-North and the North Atlantic Rail being completed. The rail expansion would position Springfield as a potential centerpiece of the regional corridor and related transit-oriented development (TOD) would occur.

Infrastructure alone will not drive the revitalization of Springfield. Policy recommendations laid out by Pioneer Valley Planning Commission's Vision for the Valley 4 must be used as the guide for growth management. This plan envisions prioritizing the Springfield area for further development and would represent the necessary shift in current land use practices. The valley would move from current practices of suburban sprawl and single-family home development to supporting the TOD in urban centers. Expanding affordable housing and multifamily developments that accommodate a potential in-migration from growth, rural depopulation, and climate related shifts in population will be seen.



Climate change mitigation is prioritized as the expansion of urban centers force policy makers to address air quality concerns from transportation emissions. This forces a wide scale adoption of Battery Electric Buses (BEB) within the PVTA network to meet the state's carbon emission reduction goals for the future. BEB adoption alone will not mitigate the impacts of climate change and the state must expand current investments in offshore wind generation to support new concentrated urban growth. This clean energy transition will provide the necessary power for supporting passenger electric vehicles, BEBs and expanding home energy demands of a growing region

New Small City

ROUTE REDESIGN SUMMARY

New Small City's Route Redesign builds support for rapid growth in Springfield, Northampton and Amherst. The PVTA remains focused on providing a comprehensive service network in these three nodes. A grid network is established within Springfield to facilitate frequent service and interurban express routes, which are critical for connecting the main service areas.

This system reconfiguration focuses on strategic frequency and scheule improvments to the existing interurban system in area of concentrated urban population growth. These areas are anticipated to have the greatest ridership numbers and function as a more reliable fare recovery mechanism. Modification of the network in these high populationdensity nodes improves access for all via overall transit efficiency. Significant funding increases from the state and federal government envisioned in this scenario support an expansion of transit operations and allow for the necessary frequency improvements. Transit priority treatments including transit signal priority and transit lanes are also considered as the region remains focused on improving overall access and efficiency.

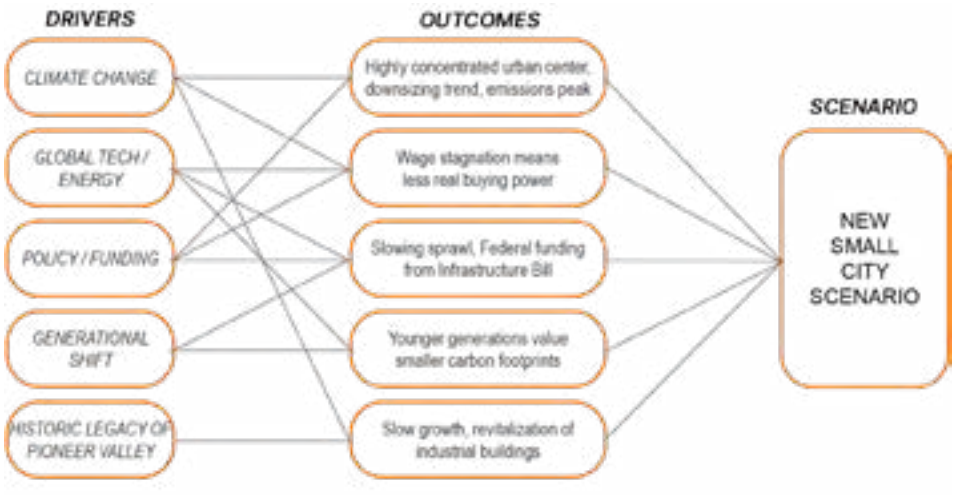


Figure J. New Small City Driver Outcomes.png

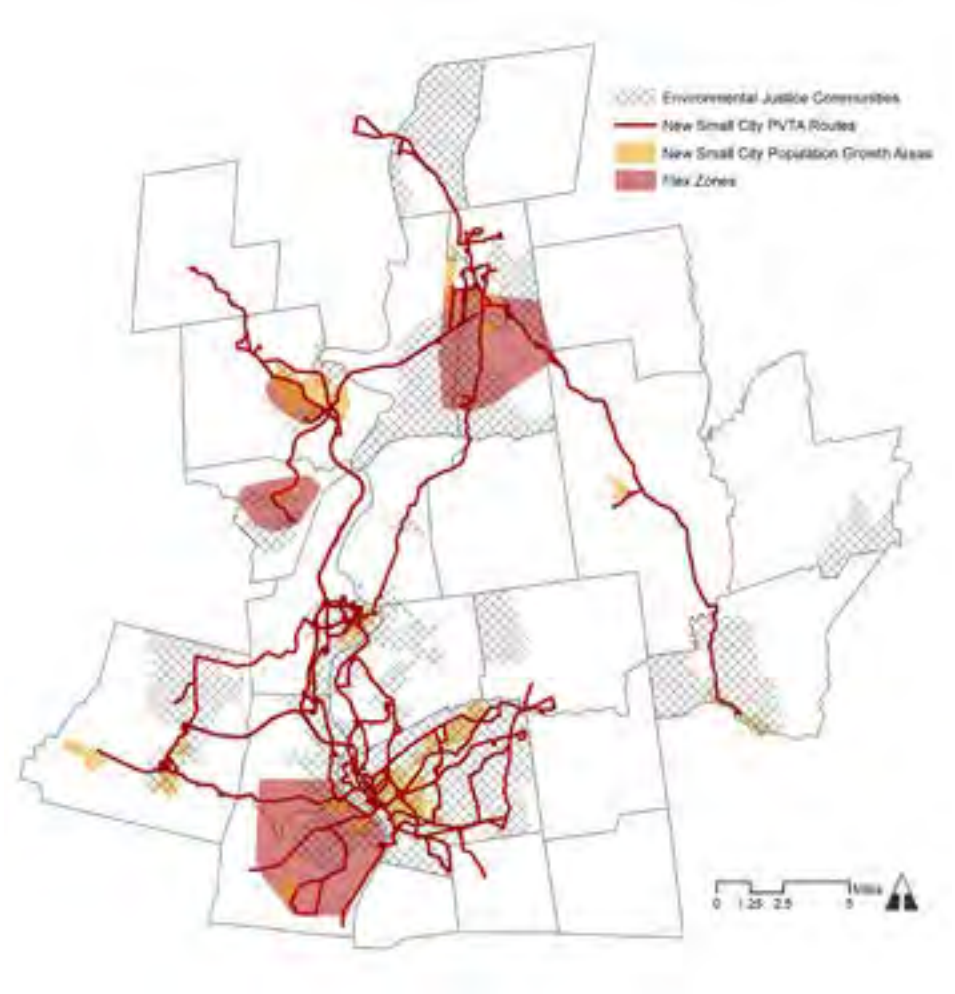


Figure K. New Small City Route Recommendation.jpg

Remix Mapping Link

https://platform.remix.com/map/20f45358?latlng=42.25762,-72.59567,10.5

Figure L. New Small City Express and Flex.jpg

Figure M. New Small City Headways.jpg

Frequent express routes between Springfield, Northampton, and Amherst create a well connected Valley. Development of a grid network in Springfield will improve transit access for all Springfield residents in a cost-neutral manner.

A grid network in Springfield, interurban express routes, and transit priority treatments create frequent services with connection between main service areas at critical transfer points. This requires all routes to operate with headways between 15 to 20 minutes.

New Small City

ROUTE SPECIFIC RECOMMENDATIONS TABLE

Category	Route	Major Stops	Frequency	Metric	Time Frame
New / Express Routes	Grid Network in Springfield	Wherever two routes intersect	15 minutes	Access/Equity	Medium
	G73E	Union Station, HTC, Academy of Music	15 minutes	All	Short
	R29E	Union Station, HTC, UMass Haigis Mall	15 minutes	All	Short
	B43E	Academy of Music, UMass Haigis Mall	15 minutes	All	Short
Flex Zones	West Springfield, Agawam	Connection to Union Station	N/A	Access	Medium
	Easthampton	N/A	N/A	Access	Medium
	South Northampton	Connection to Academy of Music	N/A	Access	Medium
	South Amherst, Pelham	N/A	N/A	Access	Medium
Infrastructure	Bus Lanes	Main St Springfield; State St Springfield; Dwight St Holyoke (one lane); Maple St Holyoke (one lane); North Pleasant St Amherst (through UMass Campus)	N/A	All	Long
	Park and Rides	Eastfield Mall, Ludlow near I-90, 3900 Cooley St Springfield, 65 Main St Springfield)	N/A	All	Long

Figure N. New Small City Recommedation.PNG

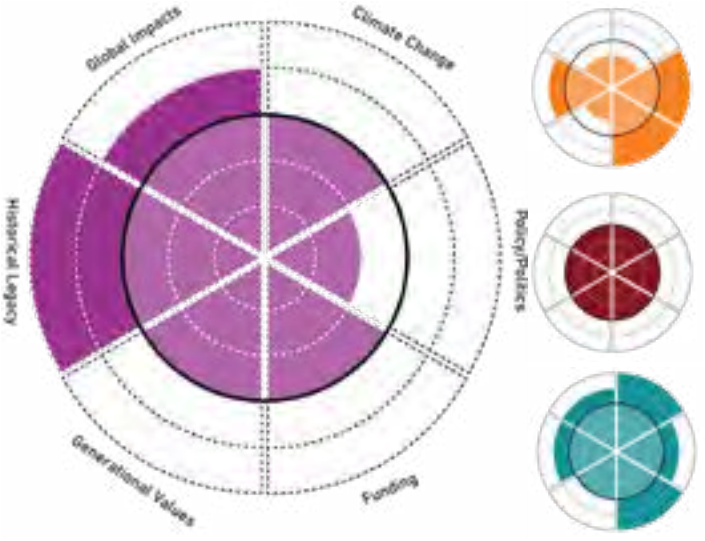
Skilled Valley

SCENARIO DESCRIPTION

The Skilled Valley scenario envisions shift in higher education enrollment shifting the major employment centers throughout the Valley. Enrollment decreases at traditional four-year colleges throughout the Valley, while federal funding for free community college greatly increases enrollment at area trade and two-year colleges. UMass will matriculate many of these students initially, however in future years, students who may have attended those schools choose other universities outside the service area. Overlaid on all of the drivers are the distinct values of a new generation who care deeply about preserving the environment, supporting local food production, and avoiding student debt.

The historic industrial trends that follow the North-South divide of PV, commonly identified by the Hampshire-Hampden County line, become more apparent in the Skilled Valley scenario. In the North, which has a long agrarian history, the environment heats up, causing the growing season to extend and expand agricultural opportunities. This driver leads to exponential growth of agricultural jobs, supported by existing educational infrastructure, including UMass' Stockbridge School, ranked 1st in the country for agricultural universities, as well as programs at Springfield Technical Community College and Holyoke Community College. As the agrarian sector picks up in the North, many students who would have enrolled in traditional four-year degree programs in the service area choose programs within the aforementioned schools in preparation for agricultural work, or choose universities outside the service area, leading to a decline in student, faculty, and supporting staff populations. This decline affects all the industries that have historically supported the universities including restaurants and local shops that employ a variety of workers. The outflow of money will cause EJ communities in the North to grow as the key-stone industry shifts away from education, which supports more varied job needs, and towards agriculture.

The generational interest in avoiding student debt is the leading driver for an increase in trade school matriculation in South PV. In Massachusetts, the average community college tuition is $6,380 versus nearly $52,000 for Massachusetts based four-year private universities, a number set to grow according to national tuition trends that have experienced a 24% increase between 2006-2016. In this scenario climate migration from the Southern US and territories also drive an increase in trade school enrollment. A recent report assessing Holyoke's response to the influx of those displaced after Hurricane Maria in Puerto Rico noted that the overwhelming concern of



recent migrants was having a steady income. The report also found that refugees were most likely to seek support from relatives living in or near poverty, putting an undue burden on EJ communities. In the Skilled Valley scenario, these drivers lead local communities to provide services that help refugees, and their relatives enroll in trade schools in order to be more financially stable. In time this shrinks the EJ communities of the South. Recent policy initiatives such as the proposal to include free two-year community college for qualifying students in Biden's original American Families Plan, indicate the likelihood that federally funded community college will be enacted in the coming decades and support a growing interest in the trades which has ballooned from 9.6 million in 1999 to 16 million in 2014.

Most trade school alumni remain within their school's county or neighboring county. This suggests that those graduating from trade schools in the South will likely work in Hampden County. Its historic manufacturing legacy will support this trend and industry will grow exponentially, providing ample jobs for graduates. Reflecting its historic draw, the Skilled Valley will also attract neighboring trade professionals, increasing population numbers in the South.

This return to historic industries in both the North and South will result in a need for PVTA to consider an alternative service model. In the North, the PVTA will need to adjust service options, including financial restructuring. These options may include more flex services, fleet diversification, and increased connectivity to the South for employment opportunities. In the South, the PVTA will need to support the growth in industry and trade-school enrollment through options such as developing more express routes, increased frequency, and partnerships with key industry employers.

Skilled Valley

ROUTE REDESIGN SUMMARY

The system is reconfigured into a dual-hub-and spoke design revolving equally around Union Station in Springfield and the Holyoke Transportation Center. This allows for connectivity between Union Station, job training and work opportunities, and other central destinations in the South with high frequency circulator routes around Holyoke Community College and Springfield Technical Community College.

From the hubs, routes extend East and West to Westfield, Agawam and Ludlow to serve communities of anticipated growth from climate migrants seeking to connect with existing kin networks in the Pioneer Valley. In the major urban centers of Holyoke, Springfield, and Chicopee, the frequency of routes is increased to better accommodate a variety of work schedules, including increasing evening and night service to support employers and employees who operate outside the bounds of a traditional 9am-5pm workday.

While the University of Massachusetts has been a focus for the PVTA in the past, this alternative decreases the frequency and number of routes in the North, specifically those that act as shuttle services for UMass students, faculty, and staff. In response to the loss of UMass employment center, the Skilled Valley redesign focuses on improving connectivity for residents in the North with increased employment opportunities in the South via express routes. Along with the decline of the presence of UMass, is a decline in the availability of student drivers to operate the Amherst routes. This driver shortage combined with the decrease in student, faculty, and staff presence corroborates

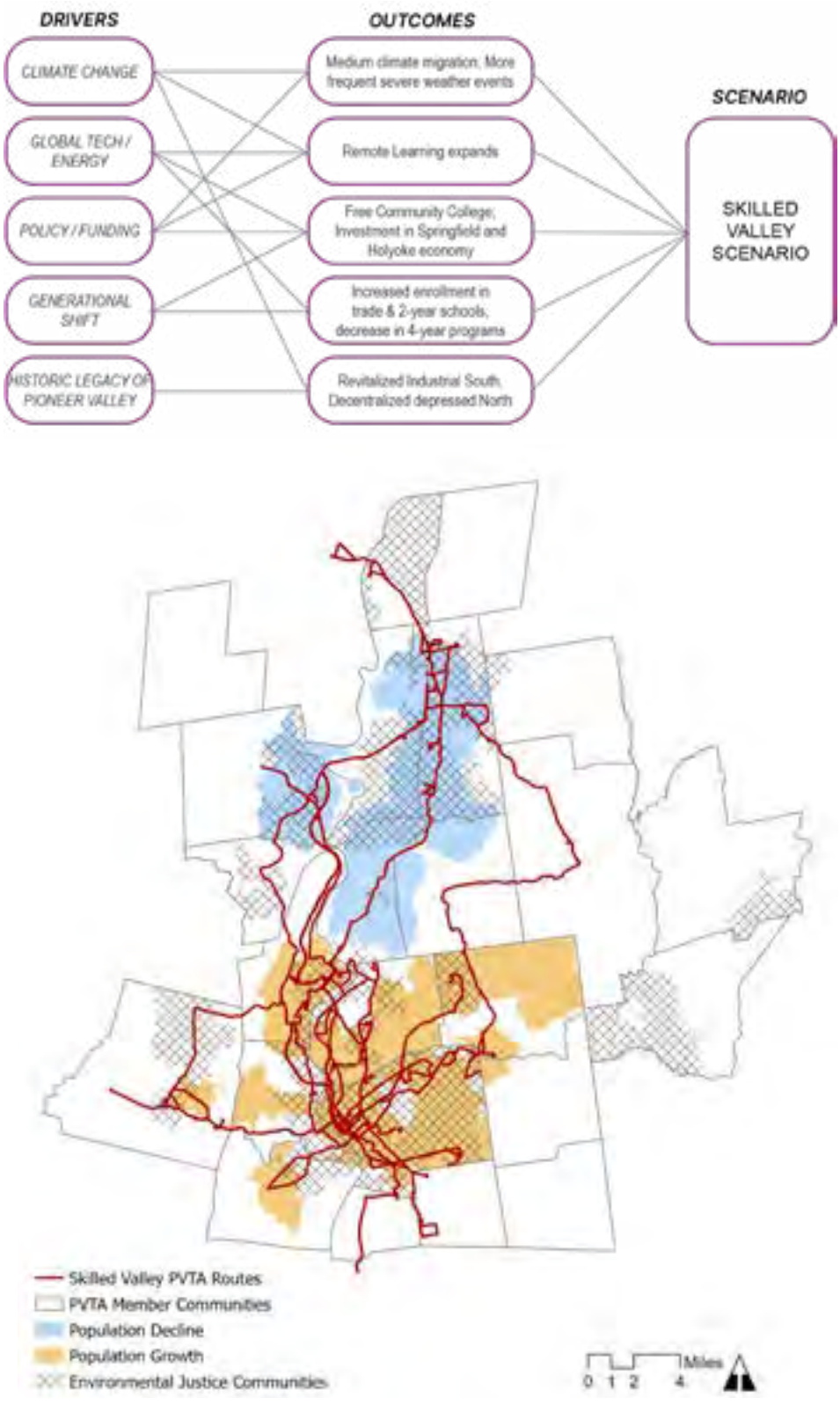


Figure 0. Skilled Valley Route Recommendation.jpg

Remix Mapping Link

https://platform.remix.com/map/512b0ede?latlng=42.24784,-72.44971,9.5

Figure P. Skilled Valley Express and Flex.jpg

Figure Q. Skilled Valley Headways.jpg

New Northampton to Holyoke Express via I-91 connects northern residents with HTC, here a hub for high frequency routes. New Belchertown to Eastfield Mall Express connects the rural areas of Belchertown, Granby, and Ludlow with Springfield.

As northern service is reduced, Union Station and HTC become main hubs with increased frequency in south. New routes improve connections between North/South via major roadways especially in access to community colleges and manufacturing employers.

Skilled Valley

ROUTE SPECIFIC RECOMMENDATIONS TABLE

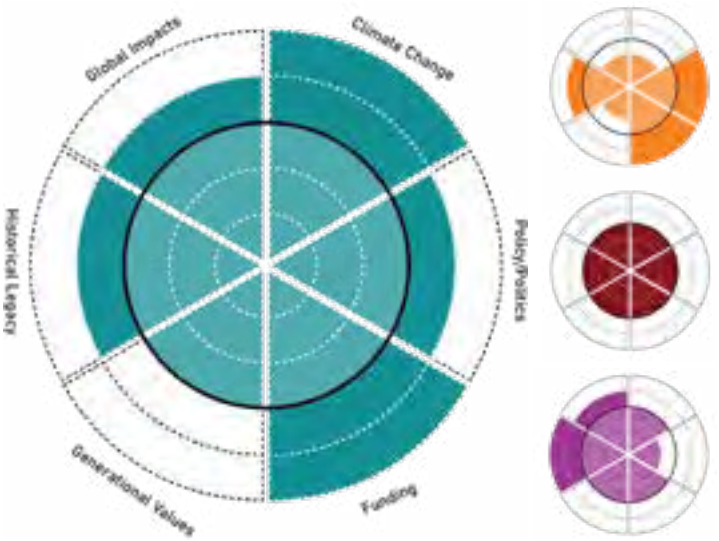
Category	Route	Major Stops	Frequency	Metric	Time Frame
New / Express Routes	B47	Academy of Music, HTC	30 minutes	Efficiency	Medium
	Belchertown to Eastfield Mall	Belchertown Center, Eastfield Mall	60 minutes	Access/Equity	Long
	Florence Connector	Florence Main St, Academy of Music	15-30 minutes	Efficiency	Short
	HCC Circulator	Holyoke Community College, HTC	15-30 minutes	All	Short
	STCC Circulator	Springfield Technical Community College, Union Station	15 minutes	All	Short
Flex Zones/ Routes	No Flex routes or Zones were created, though if shrinking populations in the North shift to smaller, more diffuse town centers, flex routes may be more appropriate than expanded fixed route service				
Low-Frequency Routes	No new low-frequency routes were created.				
Infrastructure	Park and Rides	Eastfield Mall; Belchertown Stop & Shop; East Longmeadow Stop & Shop/Big Y; Ludlow Big Y Plaza	N/A	Access/Equity	Long

Higher Ground

SCENARIO DESCRIPTION

Global economic powers are unable to resolve commitments to a green future with national industries historically tied to fossil-fuels, resulting in a global high-emissions climate change scenario.[1] As climate change effects become increasingly tangible, state and federal funding for climate change mitigation and adaptation increases and stabilizes.[2] In response to the need for climate adaptation and fueled by increased state funding, UMass greatly expands research investments in climate adaptation agriculture, clean energy transition, stormwater management, and vast workforce retraining and development.[3] These investments lead to job growth in the agriculture and energy sectors, attracting more young professionals to northern university hubs. Simultaneously, as remote options untether workers from commute-based decision making, university students increasingly stay in the Valley post-graduation, slowing the brain drain.[4] Together these two groups greatly increase the population of the northern service area, continuing current trends of infilling suburban areas and spreading out in the rural periphery.[5]

A high-emission climate change scenario also drives population increase across the Pioneer Valley as southern and coastal populations move to northern cities in search of a safe areas with available housing and jobs.[6] In-coming migrants are diverse across all demographics and resettlement patterns align with social-economic status and existing cultural social networks.[7] However, municipal-level response to climate change and reception to in-migrants varies due to increasingly polarized political beliefs.[8]



Progressive northern municipalities collaborate in response to the need for more housing due to migrants, in-coming professionals, and the retention of recent graduates. Northampton, Hadley, Amherst and their rural neighbors adapt zoning regulations to allow more market-rate infill and apply new federal funds to increase affordable housing.[9,10] Conversely, southern municipalities, such as Springfield, Holyoke, and Chicopee, remain politically divided and lack a coordinated response, leading to poor growth management.[11] More conservative-trending rural southern towns implement prohibitive policies that further confine new communities.[12] As low-income migrants move in, resource competition increases in these southern urban hubs. Existing environmental justice communities expand in footprint and housing shortages prevail. Some new low-income residents adapt through multi-generational housing. Others are forced into existing housing stock in high-risk floodplain areas, made available by the flight of more affluent and mobile residents.[13]

1 Sixth Assessment Report (ipcc.ch)
2 https://www.whitehouse.gov/briefing-room/statements-releases/2021/06/24/fact-sheet-president-biden-announces-support-for-the-bipartisan-infrastructure-framework/
3 https://www.umass.edu/research/centers-and-institutes
4 https://www.zillowgroup.com/news/mover-report/
5 https://www.jchs.harvard.edu/blog/are-millennials-leaving-cities-yes-young-adults-are-not
6 https://www-nature-com.silk.library.umass.edu/articles/nclimate3271
7 https://www.mass.gov/doc/final-study-0/download
8 https://www.pewresearch.org/science/2016/10/04/the-politics-of-climate/
9 https://www.gazettenet.com/Warren-criticizes-8939473
10 www.bbc.com/news/world-us-canada-59081791
11 https://www.nepm.org/post/springfield-mass-mayor-sarno-intends-block-further-refugee-resettlement#stream/0
12 https://www.wbur.org/news/2020/11/03/2020-massachusetts-election-map
13 https://www.mass.gov/doc/2017-2018-mvp-planning-grant-report-springfield/download

Higher Ground

ROUTE REDESIGN SUMMARY

The PVTA network converts to a multi-hub design in response to both the rapidly growing population throughout the Valley, need for improved access to expanding job opportunities in the north, and greater climate resilience. Throughout the valley, aging mall parking lots (Eastfield, Holyoke, Hampshire) see adaptive reuse into park & ride facilities with stops at these locations prioritized as transfer nodes. Express routes are expanded to improve efficiency of north/south connectivity. The Hampshire Mall stop in Hadley is envisioned as the new hub northeast of I-91, creating more transfer options off of the UMass campus as the demographics of northern ridership diversify beyond students.

Further north, a new Sunderland express route connects to flex routes that serve the dispersed agricultural employment and open space destinations. The timing and frequency of expanded northern service adjusts to agricultural laborers' early morning hours, then tapers to hourly schedules. As more of the population works remotely, service is also adjusting to focus more on equitable access to non-work destinations such as recreational and entertainment destinations throughout the valley. Service is enhanced with greater evening and weekend frequency. Inter-regional connections are strengthened, including a low-frequency route between Northampton to Pittsfield (BRTA) with limited weekend-only service.

In the south, the PVTA focuses on building emergency resiliency to the threat of flooding, especially in areas of vulnerable EJCs living within the floodplain. A flood response shuttle is established in downtown Springfield connecting flood-vulnerable stops (see Appendix 5: Flood Resilience) with Holyoke Transit Center.

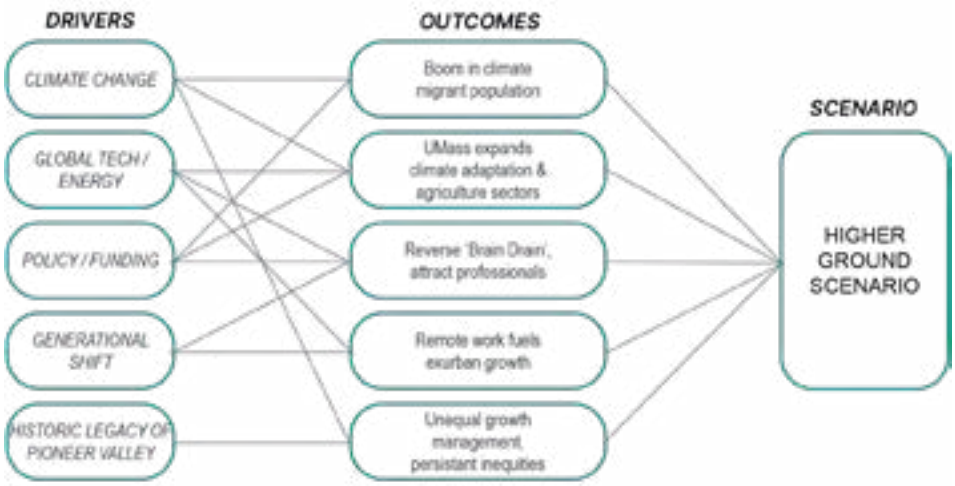


Figure R. Higher Ground Driver Outcomes.png

Figure S. Higher Ground Route Recommendation.jpg

Remix Mapping Link

https://platform.remix.com/map/b7da20e7?latlng=42.36838,-72.88893,9.5&public=true

Figure T. Higher Ground Express and Flex.jpg

Figure U. Higher Ground Headways.jpg

Springfield to Sunderland Express via I-91 with early morning service for agricultural workers. B7E to shuttle commuters from Eastfield Mall Park & Ride to downtown Springfield. G73E expanded to Hadley hub. R42 and northern 31 convert to flex.

New low frequency route from Northampton to Pittsfield runs 3x day on weekends. 45E from Hadley to Belchertown to Palmer Rail Connection runs in alignment with train schedule. Most new routes have high frequency for morning commutes then taper to hourly headways due to increase remote work.

Higher Ground

ROUTE SPECIFIC RECOMMENDATIONS TABLE

Category	Route	Major Stops	Frequency	Metric	Time Frame
Fixed / Express Routes	33E Sunderland Express	Union Station, Holyoke Mall, HTC, Sunderland Park Ride	20 minutes AM, hourly	Access/Equity	Short
	G73E	Union Station, Holyoke Mall, Academy of Music, Hampshire Mall	30 minutes	All	Short
	B7E	Eastfield Mall, Union Station	15-30 minutes	Efficiency	Short
	Flood Response Shuttle	Downtown Springfield	As needed	All	Medium
	Belchertown-Holyoke	HTC, Granby, Belchertown, Quabbin Visitors Center	15-30 minutes	All	Medium
Flex Routes	31 northern section	Hampshire Mall, UMass Farms, Sunderland Park Ride	N/A		Long
	R42	N/A	N/A	Access/Equity	Long
Low Frequency Routes	Pittsfield Connector	Academy of Music, Pittsfield	3x/day weekends only		
	45E	Hadley, Belchertown, Palmer	With train schedule	Efficiency	Medium
Infrastructure	Park and Rides	Hampshire Mall, Holyoke Mall, Eastfield Mall	N/A	All	Long

Grading the Route Redesigns

The purpose of scenario planning is not to predict the future, but to strategize how to achieve a set of given goals amid varying conditions. While it is unlikely that any one scenario outlined in this report will unfold exactly as envisioned, the future may hold a combination of elements from each. Accordingly, parts of each scenario's redesign may be useful in the PVTA's future. With this in mind, each route redesign was tested against each scenario based on the categories of access, equity, and efficiency. Each scenario represents a different pattern of future population, housing, and economic projections. Evaluating each route redesign against each scenario, provides insight into which elements of the redesign may be universally successfully and thus allow the PVTA to improve access, equity, and efficiency no matter how the future evolves.

To accurately measure the strength of each route redesign across the scenarios, a set of standardized metrics and methods were developed (Table X; additionally further descriptions of metrics and scoring workflow are provided in Appendix X).

For **Access**, a collection of potential destinations including work destination, non-work destinations, and intermodal connections were compiled. Scoring for access depended on how many destinations a rider could get to based on a quarter mile buffer around designed bus routes.

Equity was measured by how many environmental justice communities were serviced by a given route redesign.

Efficiency scoring incorporated a measure of overall ridership capture within a quarter mile buffer of routes and flex zones, the cost of the system per rider, and average minimum headway of all routes.

The scoring process was developed using geographic information systems and the transit mapping software Remix. Each route redesign (RR) was essentially overlaid on each scenario maps including destinations, projected changes to environmental justice communities, and population projections. A score of how each route redesign performed per metric within each scenario's envisioned development patterns was recorded and reviewed in comparison to one another. The results of the scoring process are provided on the following page.

CATEGORY	METRIC	METHOD	DATA
Access	% Work Destinations	Within ¼ mile buffer of proposed route redesigns*	Major Employers (source: LMI)
	% Non-Work Destinations		Food Retailers, SNAP, Hospitals, Pharmacies, Entertainment Venues, Public Open Space, Affordable Housing, Nursing Homes
	% Intermodal Connections		Rail hubs, ValleyBike share stations
Equity	% EJ Blocks		EJ expansion developed per scenario
Efficiency	Ridership	% Population capture within buffer and flex zone)**	% Population increase/decrease projections developed per scenario
	Cost/Rider	Cost of Route Redesign divided by ridership capture	Cost of System determined in Remix. Population projections developed in GIS
	Frequency	Average of minimum headways of all routes in redesign	Headway data derived/developed within Remix

Figure V. Route Metrics.png

* With respect to the quarter mile buffer, we recognize that research over the last 5-10 years has shown the importance of accounting for land use factors (i.e. topography, development density, sidewalk access) as well as equity-based factors such as universal accessibility and age that influence 'walking' time from stops to final destinations. However, given the scope of the project and time limitations, the approximation of a ¼-mile buffer was used as a proxy for walkable distance to conduct the 'scoring' of the alternative route designs. Recommendations for more fine-grained analysis are included in the "Next Steps" section of the report.

** To normalize differences to changes in population across scenarios, metrics were measured as a percentage of total (Ex: % capture of population within buffer as compared to total projected population PVTA service area).

Grading Results

Each route redesign (RR) was overlaid on each scenario map of projected changes and scores were recorded for each developed metric. Grading results were recorded both in individual "scorecards" per route redesign (shown on the following page) and comparatively, resulting in the Highest Score table seen below.

The **Route Redesign developed for the Higher Ground** performed highest in *access* and equity metrics across all scenarios, with the exception of its own scenario in which the Route Redesign developed for Valley Stasis performed equally well in access. This means that the Route Redesign developed for the Higher Ground provides service to the most destinations and EJCs throughout all envisioned scenarios. This is likely because the route redesign increased coverage routes broadly throughout the service area in effort to provide access to projected populations in both urban and town centers, recreational open space destinations, and northern agricultural areas. The conversion of more flex routes with potential capture areas of 3/4 mile buffer (similar to the existing Ware-Palmer route) also increase this redesign's performance in access. Full description of route specific recommendations for this redesign can be found on p. 32.

The **Route Redesign developed for the Valley Stasis** performed highest in *efficiency* across all scenarios. This means when comparing the cost of the system relative to the potential ridership capture of the designed network it performed as most cost efficient. This is likely due to the use of strategic, smaller adjustment to the current system through extending existing routes and schedule improvements that increased ridership and EJCs capture without dramatically increasing the system cost. If flex routes or flex zones were incorporated into this redesign, it would likely score equally well in access and equity metrics due to its strong coverage. Full description of route specific recommendations for this redesign can be found on p. 23.

The **Route Redesign developed for the New Small City** performed highest in *frequency* across all scenarios. This means that the Route Redesign developed for the New Small City has the shortest average headways for all routes in its system. Efficiency is built into this redesign multi ways including the integration of a triangular express network between major urban hubs, the development of a grid network in Springfield, and the conversion of major urban roadways to dedicated bus lanes (full or half road. Full description of route specific recommendations for this redesign can be found on p.26.

Highest Route Redesign (RR) Scores per Scenario

	VALLEY STATIS	NEW SMALL CITY	SKILL VALLEY	HIGHER GROUND
ACCESS	RR Higher Ground			
EQUITY	RR Higher Ground	RR Higher Ground	RR Valley Stasis RR Higher Ground	RR Higher Ground
EFFICIENCY	RR Valley Stasis			
FREQUENCY	RR New Small City			

Figure W. higgest_remake1.PNG

CATEGORY	METRIC	DIS-AGGREGATED	VALLEY STASIS	NEW SMALL CITY	SKILLED VALLEY	HIGHER GROUND
Access	To Work	Major Employers				
	To Non-Work	Schools				
		Affordable, Senior Housing		80%		
		Entertainment Venues				
		Places of Worship		80%		
		Medical Centers		91%		
		Food Retailers		88%		
	Intermodal Connections			97%		
	Recreation			46%		
Equity	Service to EJCs					
Efficiency	Ridership		60%	60%	51%	61%
	Cost of System			$16.6 million		
	Cost/Rider		$44.73	$46.15	$47.41	$43.65
Frequency	Average Minimum Headways			2.69 average score		

CATEGORY	METRIC	DIS-AGGREGATED	VALLEY STASIS	NEW SMALL CITY	SKILLED VALLEY	HIGHER GROUND
Access	To Work	Major Employers				
	To Non-Work	Schools				
		Affordable, Senior Housing				
		Entertainment Venues		87%		
		Places of Worship				
		Medical Centers		81%		
		Food Retailers		81%		
	Intermodal Connections			98%		
	Recreation			45%		
Equity	Service to EJCs					
Efficiency	Ridership		58%	58%	58%	58%
	Cost of System			$22.7 million		
	Cost/Rider		$64.14	$66.57	$68.20	$62.73
Frequency	Average Minimum Headways			3.57 average score		

CATEGORY	METRIC	DIS-AGGREGATED	VALLEY STASIS	NEW SMALL CITY	SKILLED VALLEY	HIGHER GROUND
Access	To Work	Major Employers	82%			
	To Non-Work	Schools	54%			
		Affordable, Senior Housing	[illegible]			
		Entertainment Venues	87%			
		Places of Worship	[illegible]			
		Medical Centers	[illegible]			
		Food Retailers	[illegible]			
	Intermodal Connections		[illegible]			
	Recreation		35%			
Equity	Service to EJCs		[illegible]	[illegible]	[illegible]	[illegible]
Efficiency	Ridership		51%	51%	43%	52%
	Cost of System		$18.9 million			
	Cost/Rider		$60.57	$62.37	$64.35	$59.01
Frequency	Average Minimum Headways		3.2 average score			

CATEGORY	METRIC	DIS-AGGREGATED	VALLEY STASIS	NEW SMALL CITY	SKILLED VALLEY	HIGHER GROUND
Access	To Work	Major Employers	97%			
	To Non-Work	Schools	[illegible]			
		Affordable, Senior Housing	87%			
		Entertainment Venues	87%			
		Places of Worship	81%			
		Medical Centers	94%			
		Food Retailers	80%			
	Intermodal Connections		92%			
	Recreation		51%			
Equity	Service to EJCs		83%	83%	84%	83%
Efficiency	Ridership		[illegible]	[illegible]	[illegible]	[illegible]
	Cost of System		$19.9 million			
	Cost/Rider		$49.62	$51.18	$52.35	$48.49
Frequency	Average Minimum Headways		2.95 average score			

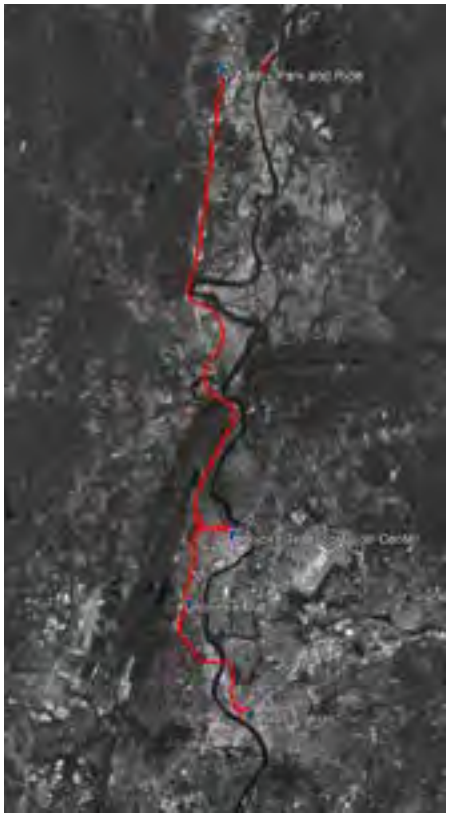
Overall Transit Recommendations

Increase Express Routes Between Hubs

A key recommendation throughout the redesigns is increasing express routes to create an interconnected valley. Most new express routes would connect the major urban areas with frequencies between 15 to 30 minutes. The primary cities and towns to connect via an express system are Springfield, Holyoke, Northampton, Amherst, and Westfield with varying degrees of demand based on how the scenario envision development and economic changes in the Valley over the next 20 years.

The PVTA already has an effective basic route structure to support this modification, so existing lines such as the R10, the R29, the B43, and the G73E will function as the foundation for implementing the triangle connection approach in the region. The three main points of the grid network should be Springfield, Northampton, and Amherst. Three direct express routes should connect them and thus improve how the PVTA's interurban routes function. This will enable residents of the Valley's growing cities to access jobs and amenities in the sibling cities. In this scenario, jobs and amenities would be distributed across the small urban centers

The Higher Ground Route Redesign includes a non-interurban express route between Springfield and Sunderland via I-91 that could better serve Deerfield and connect to the FRTA.



Implement Flex Zones and/or Routes in Low-Density Service Areas

Flex zones are an efficient way to bring people living in lower density residential zones to fixed routes. They act as designated areas with boundaries in which transit is flexible. This is similar to a flex route in terms of the allowance of riders to communicate with drivers in advance about where to be picked up. A flex zone, on the other hand, is not confined with a buffer to a specific route corridor, but instead there may be multiple vehicles operating in the zone. Flex zones work well in bringing residents in lower density areas to hubs that may be in or near higher density areas, such as cities or other mass retail areas. The New Small City Route Redesign incorporates 4 flex zones in areas with these characteristics close to fixed routes operating in higher density areas or fixed routes that serve as regional connections. For example, a flex zone in the suburbs of West Springfield and Agawam provides flexibility for residents to access fixed routes in or near Springfield. This can be an efficient way to maximize coverage without creating several underused fixed routes.

Overall Transit Recommendations Continued

Add Transit Priority Treatments and more park-and-ride locations

Regardless of scenario, automobile traffic will cause delays for the PVTA's vehicles. To mitigate this threat, it is strongly recommended that the PVTA work with member cities to implement dedicated bus lanes and busways. We recommend putting these bus lanes with the highest-density portions of the PVTA's service area, such as Springfield, Holyoke, and Amherst. We recognize that some municipal officials in the Valley are skeptical of dedicating limited roadway space to transit. The goal of bus lanes is to speed up buses which improves the service for riders and makes them more cost-efficient to run. The Massachusetts Bay Transportation Authority has seen great success with partnering with municipalities to build bus lanes. The PVTA should explore something similar if this alternative is selected. An important fact to keep in mind is that the MBTA's service area has even greater restricted roadway space to dedicate to transit than the Pioneer Valley and their success is despite this. The benefits of faster transit service for riders and cheaper service for the PVTA give municipalities a convincing reason to consider bus lanes.

Regardless of scenario, we anticipate that there will still be some suburban and or rural development in the valley. For this reason, we suggest that more park-and-ride locations be built so that more residents can access the PVTA's fixed-route bus network. These new facilities should be placed in Hampden County because there are currently no park-and-rides there.

Overall Policy Recommendations

Coordinate with ValleyBike

ValleyBike is an important local micro mobility company with bike stations located across the Valley. The PVTA can better coordinate with ValleyBike in order to provide services that assist riders in first and last mile access by linking multimodal transportation systems. Several of the planners interviewed also recommended closer collaboration between the PVTA and ValleyBike for similar reasons.

Improve Bus Stop Amenities + Communications

The PVTA is aware of its inconsistent bus stop amenities available across the service area, and limitations due to land use and municipal coordination. Based on feedback received from planner interviews, there appears to be a desire to work on improving these amenities. Using a phased approach is recommended, beginning with improvements that would ease access to riding the bus. This includes providing more English as a Second Language options on buses and at bus stops, online, and through the app. Another high priority recommendation is to provide route maps at all bus stops and on all buses. This reduces the barrier for new riders to use the PVTA's services, and allows riders to better schedule their trips to meet their needs. We also suggest strategically installing more bus stop shelters at highly used stops through coordination with municipalities. In the future, installing real-time signs that offer information on bus arrival times and delays, first at major hubs and later at intermediately used stops would keep riders up to date and ease service use. Real time schedule communications may be especially useful in flooding response situations or other climate-related weather events that may affect normal service.

Solar bus lighting/off grid solutions

RIPTA bus shelter analysis

Brasco

LANTA Solar Bus Bench Light

Engo Planet

Urban Solar

Incentivize bus commute by forming public-private partnerships with local companies

In a ***Boston pilot program***, there was increased ridership when fare was subsidized for employees of local businesses in comparison with those with standard fare. This also lessens the congestion on main streets, thus enhancing the transit system overall. This reduced or free ride model can be combined with ValleyBike to assist with connecting the first and last miles.

CDL Staffing improvements

The DRIVE-Safe Act was included in the recently passed infrastructure bill. This Act reduces the age requirement for obtaining a CDL license from 21 to 18. This presents an opportunity for the PVTA to attract young workers and start them on a lifelong career with the company, addressing the issue of staffing shortages from the bottom up. UMass Transit and SATCO are different garages that require different approaches to maximize this new opportunity.

The PVTA currently offers CDL training to student drivers at UMass, and has a close partnership with the Transit Operations certificate program. For drivers already working for the PVTA, it is recommend that the PVTA offers attractive starting packages upon graduation for bus drivers who have been with the company during their tenure at UMass. To attract new employees from the UMass applicant pool, the PVTA may reconsider the policy of "all employees must be able to drive a bus." This would allow desk-related jobs such as radio operators and transit planning analysts to join the ranks, reducing the risk of burnout and allowing employees to have set tasks. Additionally, it might be prudent to place the transit planning analysts under the auspices of the PVTA's Manager of Transit Planning and have that employee make those hiring decisions. The PVTA may also consider advertising job openings to non-UMass students, exploring opportunities to hire from other nearby colleges.

The SATCO garage recently brought back CDL training, which is likely to improve retainment of new employees. In addition, the PVTA can partner with local CDL training companies like Tri-State in Springfield to attract people already interested in this career path to finish the program and start their new career at the PVTA. Local tech high school graduates are another large pool of potential employees that the PVTA can attract by inviting them to train at the SATCO garage, or help subsidize licensure through a local training company. In addition, PVTA may consider targeted advertising to community college students who may be interested in the opportunity to work for a local company as a mechanic or driver.

UMass Transit also sees a regular lack of drivers. Although they have an entirely different situation from the other garages, there may be novel solutions for this operator.

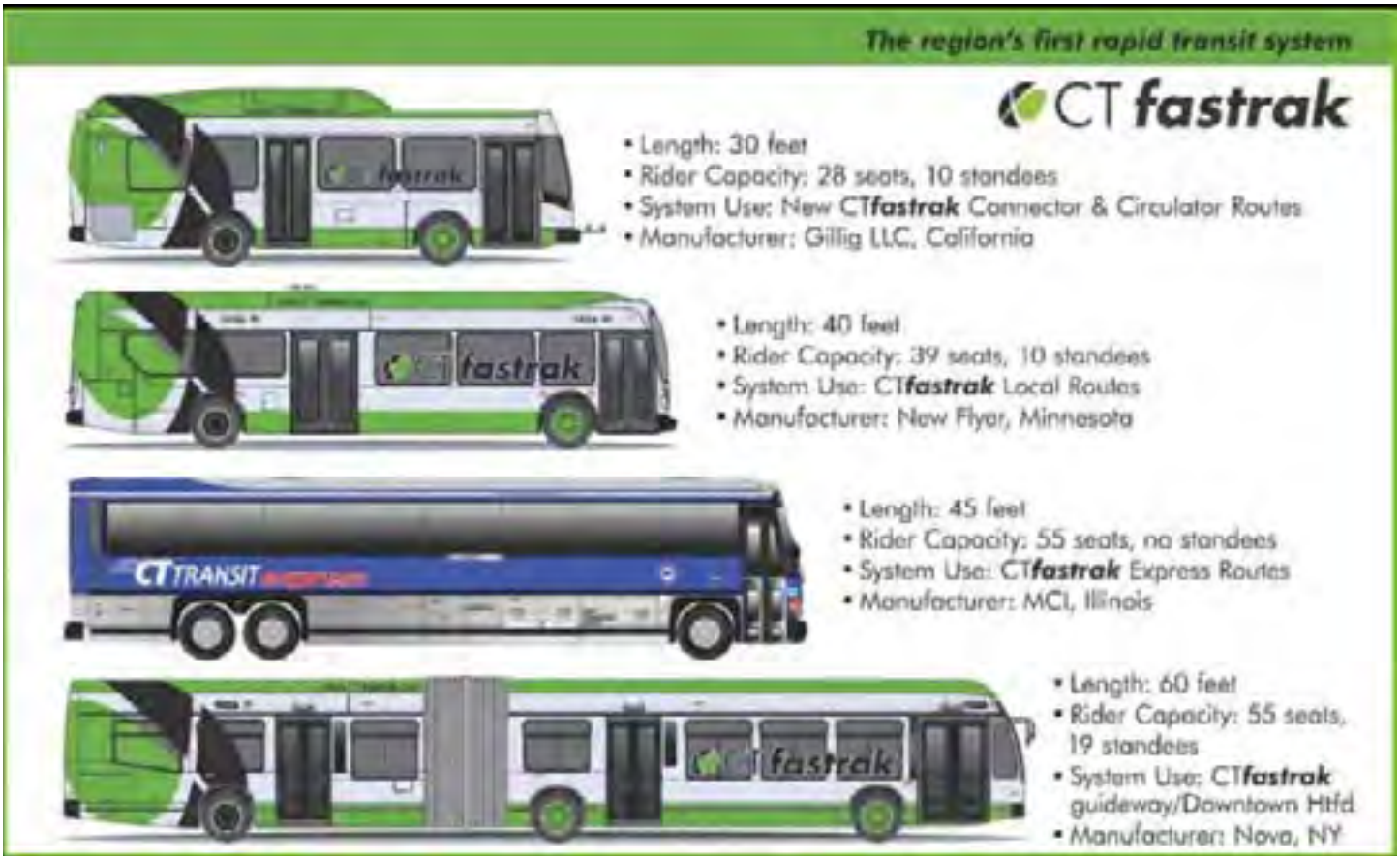
All of that said, we are not management or staffing experts. The PVTA might take their concerns about staffing to a management consultant who could make more detailed recommendations.

Fleet diversification

Many redesigns incorporated flex route and zones, with fleet diversification being a necessary component to make those strategies effectve. This includes purchasing vans for the flex zones and shorter, regular buses for low-ridership coverage routes. An example of a high-quality shorter bus is the battery-electric Low-Floor Plus version of Gillig's 29' model. For vehicles in flex zones, the van vehicle suite from ARBOC Specialty Vehicles is recommended for enhanced equity for people with mobility disabilities.

It will also be critical to expand the battery electric bus fleet and related charging infrastructure. The PVTA is already aware that the chief BEB manufacturers in the United States are Proterra and New Flyer; they already have buses from both. New Flyer's BEB is the Xcelsior CHARGE NG and Proterra's top model is the ZX5 MAX Electric Transit Bus. Both have proven technology, even by the PVTA itself, and both can expect to see significant growth in battery range in the coming years. New Flyer may have a slight advantage because they have been building buses longer and the CHARGE NG comes in 35', 40', and 60' lengths. Proterras only come in 35' and 40'. Moreover, some Proterra buses in Philadelphia and other transit systems have had to be taken out of service because of poor build quality. No such reports exist for the CHARGE NG's that this study is aware of.

The build out of electric charging infrastructure will have to happen before full or large scale BEB transition occurs. The PVTA will need to install enough BEB chargers at all three garages to be able to convert the full bus fleet to battery electric. The PVTA does currently have some chargers, however they need to obtain many more for full BEB operation. Research from UMass Amherst's Civil Engineering Department has shown that conductive (overhead) chargers are the most efficient. Therefore, it is recommended that the PVTA should primarily procure conducive charging equipment. The MBTA is undertaking a twenty year process to improve its garages to allow for full BEB conversion. The PVTA should start by doing a similar garage infrastructure planning process.



GRANT OPPORTUNITIES

What are TIPs

Pioneer Valley Planning Commission (PVPC) maintains the creation of a Transportation Improvement Program (TIP) every four years as per 49 U.S.C. 5303(j). With cooperation from Federal, State, and Public Transportation organizations, PVPC is required to create a comprehensive plan for capital and non-capital surface transportation projects, bicycle, and pedestrian facilities and other transportation enhancements. TIP includes regionally significant projects receiving Federal funding. Where non-federal funds are not utilized, fiscal constrained projects are required.

In conjunction with Regional Transportation Plans, these two critical guiding documents are the basis for the future. Alike Master Plans for municipalities, outline goals and respective objectives to complete along the path. These documents work to solidify needs of the given entity and formulate the blueprint for the path into the future. These opportunities for improvements within the surface infrastructure with consideration afford PVTA a chance to incorporate modernizations that are beneficial to respective infrastructure use cases. PVTA does not have an unlimited budget and will need to seek outside funding assistance, thus grant opportunities are critical for advancing initiatives both within and outside of PVTA.

Grant Opportunities Available to PVTA

Grant opportunities available for PVTA are ample, but require preparation in synchrony with stakeholders. Discretionary, Formula, Loan Financing, Performance based, and Public-Private Partnerships make up the broad categories of grant opportunities available for PVTA. TIP specific funding mechanisms under the Federal support (shown in the table below) typically fall under the 80% Federal and 20% State breakdown with some exceptions. State funding follows a similar structure to the Federal level, yet with the added stakeholder of municipal level buy-in on given projects. Non-Profit organizations including the Barr Foundation or Tasks for Transit provide local funding opportunities for transit specific projects. Additionally, a 'meals tax' could be considered such as in Acton where this was implemented to support a fixed route shuttle operating on a circulator route. These opportunities are numerous and still fall on the shoulders of PVTA to create a more attractive mode choice over single occupancy vehicles.

How do these projects affect PVTA? How can PVTA be incorporated in planning of said projects? Turn projects into opportunities for PVTA -How can PVTA sell the bus service to more individuals?

The recent bill signed by Governor Baker for Climate Policy in conjunction with the 2050 Decarbonization Roadmap and Clean Energy and Climate Plan for 2030 give guidance on the State Level to the future RTAs will be operating in. The support of Federal, State, and Local sources within the TIP projects that are aligned with the RTP, and State level emission goals are critical for PVTA to continue improving service within the member communities. Assistance from PVPC as well as further coordination between member communities moving forward must be strengthened. Many municipalities are limited in funding for transit and pooling resources between entities could provide regionalized opportunities to join forces on similar goals. With mixed support from various stakeholders, results will be lacking the depth that is needed to truly make meaningful changes.

		Description	Funding Split
Federal Grants	HSIP	Highway Safety Improvement Program- Reduce traffic fatalities & injuries	Federal 90% - State 10%/ Federal 90% - State 10%
	CMAQ	Congestion Mitigation and Air Quality Improvement Program - Reducing transportation emissions contributing to supporting Clean Air Act & National Ambient Air Quality Standards	Federal 80% - State 20%
	TAP	Transportation Alternatives Program - Focus on pedestrian and bicycle, non-driver access to public transportation	Federal 80% - State 20%
	TIFIA	Transportation Infrastructure Finance and Innovation Act credit program. Includes Direct Loans, Guarantee, Standby Credit,	Federal Credit cannot exceed 33% of anticipated costs
	AIM	Accelerating Innovative Mobility program to advance innovation in transit.	Federal share is limited to 80% with local match
	NSP	High Priority Project Grant to augment motor carrier safety, advance technological applications for commerical motor vehicle specific network	Federal 80% - State 20%
	STBGP	Surface Transportation Block Grant Program - Flexible Funding for any Federal Project	Federal 80% - State 20%
	Section: 115, 117, 125, & 129	Congressional earmarks, each year earmarks are given designated funding category	Federal 100% - State 0%
	Section: 5307	Grants for Urbanized Areas (UZA) for transportation capital, planning, job access, reverse commute projects, and operating expenses.	Federal Share is 80% for Capital Assistance, 50% for Operatings, and 80% for (ADA) no-fixed-route paratransit service, using up to 10% of a recipient's apportionment. *
	Section: 5309	Capital Investment Grant (Discretionary) for rail and bus rapid transit	Federal share is up to 50% of project
	Section: 5310	Funding for meeting needs of elderly and disabled to improve mobility for capital items.	Funding is allocated at State level in MA. by MassDOT for Non-profits under Mobility Assistance Program (MAP) program
	Section: 5311	Formula Grants for rural Areas	the federal share is 80 % for capital projects, 50 % for operating assistance, and 80 % for (ADA)
	Section: 5320	Capital assistance for new or existing alternative transit systems	Federal up to 100% of project capital or planning costs
	Section: 5337	Capital assistance for maintenance, placement, and rehab of projects (transit agencies specific)	Federal 80% of eligible capital costs
	Section: 5339	Capital funding for replacement, rehab, and purchases of buses and related equipment including related facilities.	Federal 80% - State 20%

	Description		Funding
State Grants	Community Transit Grant	Distributes Federal & State Funds to expand services for older adults & disabilities. Includes Section 531	Federal 80% - State 20%
	Efficiency and Regionalization Grant Program	Funding for effort to regionalize services	Municipal/Technical Asst. Focused, could be opportunity for partnership
	MA Community Health and Healthy Aging Funds	Dept. of Public Health funds to improve health through sustainable approaches	Partnership with PVPC
	Community Development Block Grant	Funding for public social services to offer free or reduced rides	Municipal Focused, could be opportunity for partnership

Next Steps (participation):

This report is a collection of work completed in the first phase of a four phase process conducted over the span of two years. In spring 2022, Phase 2 will be picked up by the UMass Engineering School where students will run energy models, propose new finance and fare restructuring options, and conduct further data and technology research. Phase 3 will begin in fall 2022 with the next Regional Planning studio. An extensive engagement process will be designed and conducted with the public in order to receive feedback on the proposed route recommendations of this report. Based on public knowledge and experience collected during that process, more specific metrics will be created and applied to the route recommendations. These updated recommendations will then be provided to the PVTA, along with a final report that will be reviewed during Phase 4. In this final phase, the PVTA will collect more public feedback on the proposed route recommendations, as well as input from the Board before adopting the initial recommendations.

Appendices

Appendix 1: Case Studies

A case study analysis was conducted to develop an understanding of best practices used by transit authorities across the United States. Ultimately, five transportation authorities were selected for in-depth analysis due to their use of practices relevant to the studies goals of improving access, equity, and efficiency in the PVTA system. Best practices resulting from this analysis were then integrated into the route redesigns and recommendations for the PVTA.

ABQ RIDE

Location: Albuquerque, NM

Service Population: 1 million

Service Summary: 26 fixed routes, 13 commuter routes, three dedicated bus rapid transit lines, and on-demand paratransit service (Sun Van)[1]

The agency was chosen due to its similarity to the PVTA service model, dedication to public accessibility, and innovations in rider equity. Recently, Albuquerque has implemented several policies to become a more inclusive and equitable city. Improving public transportation has been critical to achieving those goals. Albuquerque has undertaken numerous projects to increase public accessibility, reduce carbon emissions, and eliminate traffic deaths and serious injuries. By 2030, the city intends to be entirely sustained by renewable energy.[2,3] In 2021, the agency introduced their first fully electric bus into service, with plans to add five more by the end of the year. The agency's sustainable fleet also includes compressed natural gas (CNG), hybrid, and diesel buses.

A recent priority initiative of ABQ RIDE is a one-year pilot program offering fare-free ridership for all bus routes beginning in 2022.[4] Until this program goes into effect, the agency is operating with a modified fare-free zone serving the downtown area and offers zero-fares for all students and seniors.[5] Seeking to encourage ridership amongst daily commuters and reduce car dependency, ABQ RIDE has utilized multiple strategies to promote the viability of public transportation. Using the "Metro Savings Calculator" potential riders can easily measure the financial impact of commuting via bus or car.[6] To incentivize ridership for commuters who could use public transportation regularly, ABQ RIDE has adopted the Guaranteed Ride Home (GRH)

program, offering insurance to public transit commuters by ensuring on-demand transit will be available to their destination in the event of an emergency.[7] By reducing or eliminating the barriers of fares, accessibility, and efficiency, ABQ RIDE is able to more effectively encourage public use without restrictions.

In tandem with the numerous city initiatives designed to address social and environmental justice, there are multiple measures taken by ABQ RIDE to promote public equity. Starting in 2006, more than 100,000 books have been placed on city buses as a catalyst for community building, promoting early childhood literacy, and expanding access to public education.[8] As QR-codes and more technological methods become the norm for public dissemination of information, the service of "TEXT2RIDE" allows riders to receive route schedules via text message, available to every mobile device.[9]

1 "Routes & Schedules." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/transit/routes-and-schedules.
2 "Vision Zero." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/vision-zero.
3 "ABQ RIDE Debuts Electric Bus January 30, 2021." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/transit/news/abq-ride-debuts-electric-bus-january-30-2021-1.
4 "Zero Fares, Coming 2022." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/transit/tickets-passes/zero-fares.
5 "ABQ RIDE Free Fares for Seniors, Students Start March 1." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/transit/news/abq-ride-free-fares-for-seniors-students-start-march-1.
6 "Metro Savings Calculator." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/transit/metro-savings-calculator.
7 "Guaranteed Ride Home." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/transit/transit-programs-projects/guaranteed-ride-home.
8 "Discover a Book on ABQ RIDE." City of Albuquerque. Accessed December 8, 2021. https://www.cabq.gov/transit/transit-programs-projects/discover-a-book.
9 "TEXT2RIDE."City of Albuquerque. Accessed December 8, 2021." https://www.cabq.gov/transit/mobile-tools/text-2-ride.

Clemson Area Transit (CATbus)

Clemson Area Transit (CATbus) serves three counties, four universities, and five municipalities in South Carolina. However, Clemson University is a major influence in the region, and is the centerpiece of the CATbus system. The project team drew parallels between the relationships between Clemson University and CATbus, and UMass Amherst and the PVTA: both universities are major drivers of transit ridership and important drivers of economic vitality in their respective areas. Further, the presence of smaller universities and municipalities in the Clemson area is also reminiscent of the Five Colleges area. Although students comprise the majority of CATbus' ridership, a 2019 survey revealed that, over a ten-day period, 53% of riders used the bus for job access.[1]

Clemson Area Transit's fleet is constantly being modernized and kept up-to-date with transit trends; the agency was the first in South Carolina to operate articulated buses and first to install bike racks on all buses.[2] Sustainability efforts have been a major focus for the transit agency: in addition to the six electric buses already in their fleet, CATbus used a $4 million Federal Transit Authority "Low or No Emission Bus" Grant to purchase an additional ten electric buses in 2016, working toward their goal of achieving a 100% electric fleet by 2025.[3] With vastly higher miles per gallon and lower costs per mile, the change from diesel to electric buses has been economically beneficial to the agency while making significant progress in their push for a more environmentally friendly system.[4]

The entire fixed route system, which comprises 13 routes, is fare-free for all riders.[5] To improve accessibility within this network, CATbus has innovated with flexible methods, allowing for buses to deviate up to three-quarters of a mile from an established route in order to pick up riders (however, this service must be requested a minimum 24-hours in advance).

CTtransit

Owned and operated by the Connecticut Department of Transportation, CTtransit is the largest public transportation system in Connecticut. Serving a mix of riders from rural, urban, and metro areas, CTtransit can be compared to the PVTA in this regard, though it is far more expansive in its coverage of the 1,450 square miles of the state. CTtransit operations are divided into eight divisions serving different metropolitan areas of the state, centered around Hartford, New Haven, Stamford, Waterbury, New Britain, Bristol, Meriden, and Wallingford. Connections are also available between CTtransit divisions, and to various other transit options, which include other state-owned and subsidized buses, Peter Pan buses, and rail services. By delegating divisions to different private contractors to provide service, CTtransit has an operational fleet of over 800 buses and 400 paratransit vans, and provides passengers access to numerous transit options.[6]

In addition to traditional and express routes, some of the more unique transit services offered by CTtransit include connector bus routes, flyer bus routes, shuttle bus routes, and bus rapid transit. Connector bus routes provide peak-hour weekday bus service connecting rail stations to central business areas. Flyer bus routes are limited-stop local routes that provide faster service than traditional routes via use of highways, HOV lanes, or busways. Shuttle bus routes provide no-fare short-distance services in downtown areas, designed to bring riders closer to their destinations.[7] The agency's bus rapid transit service, known as CTfastrak, is fully integrated with the CTtransit system, and provides a no-transfer ride to many major regional employment, shopping, and healthcare destinations.[8]

By offering a variety of transportation options, CTtransit is most effectively able to provide service based on the needs of a particular area. Having developed an intricate network of 55 park and ride locations throughout the state, CTtransit is able to accommodate commuters traveling from suburbs and rural areas into denser communities.[9] In addition to these unique services, CTtransit offers a single fare "Two-Hour Pass" at $1.75 (an unlimited amount of local service transfers). In contrast, most traditional fare systems for transit authorities (such as PVTA) use single ride fares which require riders to purchase transfers at an additional cost.[10]

1 "Clemson Area Transit Ada Plan - Catbus." Accessed December 8, 2021. https://www.catbus.com/Portals/7/Documents/ADA-plan-2018.pdf.
2 "Clemson Area Transit Ada Plan - Catbus." Accessed December 8, 2021. https://www.catbus.com/Portals/7/Documents/ADA-plan-2018.pdf.
3 Mitchell, Anna B. "Clemson Transit Gives Nod to Proterra for 11 New Buses." The Greenville News. The Greenville News, August 10, 2017. https://www.greenvilleonline.com/story/news/2017/08/09/clemson-transit-gives-nod-proterra-11-new-buses/552414001.
4 Moody, Keith W. "A Scalable Model of All-Electric Fleets for Transportation." Clemson Area Transit. Clemson Area Transit, South Carolina, 2019. https://static1.squarespace.com/static/584598d4d1758ec839a47bab/t/5d66d9592d18f0000123aae5/1567021410821/3C_MoodyKeith_ClemsonTransit.pdf.
5 "CATBus." Ride Systems Live Tracker. Accessed December 8, 2021. https://catbus.ridesystems.net/routes.
6 CTDOT. "Connecticut Statewide Bus Study Final Report," 2.1.9 - Fleet Characteristics, February 23, 2018, https://portal.ct.gov/-/media/DOT/PLNG_STUDIES/CT_STATEWIDE_BUS/CT-StatewideBusStudyFinalReportFebruary2018v2pdf.pdf.
7 "Service Types," CTtransit, Accessed December 8, 2021. https://www.cttransit.com/services.
8 "CTfastrak," CTtransit, Accessed December 8, 2021. https://www.cttransit.com/services/ctfastrak.
9 "Park & Ride System," CTtransit, Accessed December 8, 2021. https://www.cttransit.com/services/park-ride-system.
10 "Fares," CTtransit, Accessed December 8, 2021.https://www.cttransit.com/fares.

GoTriangle

Providing urban and rural connections across Wake, Durham, and Orange counties in North Carolina, GoTriangle is responsible for linking the major cities of Chapel Hill, Durham, and Raleigh as well as their anchor research universities. With a combined service area population of over two million people, their annual ridership is indicative of a well-used transit system.[11] GOTriangle was selected for examination as a case study due to its many similarities with the PVTA, including similar size and coverage area; highly seasonal student populations from Duke University, North Carolina State University, and UNC-Chapel Hill, which are all reliant on GoTriangle for their transportation needs; and a pronounced divide between the transit needs of rural and urban populations across several different regions. In order to provide more tailored service within the three distinct counties, administrative micro-regional subdivisions are utilized so that each region acts as its own unit under the "GO" brand, with GoTriangle specifically focusing on facilitating regional connections.

In an effort to provide more flexible and reliable service in rural areas, GoTriangle operates on-demand shuttle service in a growing number of small towns in Wake County. This allows riders to order a shuttle online to transport them to and from select locations within the designated town "flex-zone" which includes connections to the greater regional fixed bus route network.[12] Additionally, these shuttles are fare-free for users to access, incentivizing higher ridership.

Along the same effort of increasing transit access, GoTriangle has a zero-fare program in place for youth riders ages 13 to 18 who register for the "Go-Pass" program. GoTriangle also collaborates with a variety of major regional employers to offer exclusive benefits to commuters by using their employee ID as a pass. Further, to counteract reduced ridership and ease difficult economic conditions for residents, GoTriangle has been fare-free for the duration of the pandemic, which has been funded by Federal financial assistance. The agency has plans to return to collecting fares in July of 2022.[13] GoTriangle has been able to support all of its fare-free services through its unique funding structure which involves receiving over 89% of its annual funding from state vehicle registration, vehicle rental, and sales taxes, resulting in minimal reliance on fares to provide consistent service.[14]

Lehigh and Northampton Transportation Authority (LANta)

The Lehigh and Northampton Transportation Authority (LANta) serves the cities of Allentown, Bethlehem, and Easton in Pennsylvania's Lehigh Valley region. LANta's mission is to "provide access and mobility designed to enhance the quality of life within the region," which it achieves through provision of a mix of transit services.[15]

LANtaBus is the company's fixed-route service consisting of 35 fixed routes and concentrated mainly within the urbanized areas of the cities, and their surrounding boroughs and townships. LANtaFlex, the company's most innovative service offering, is a reservation-based, curb-to-curb, shared-ride service designed to meet mobility needs in the more suburban areas of the Lehigh Valley. LANtaFlex allows riders to travel within seven pre-defined geographic areas, called "Flex Zones," which also offer opportunities to transfer to the LANtaBus fixed service at connection points. LANtaVan is a special door-to-door paratransit service for qualifying riders with disabilities or elderly riders who cannot access the regular LANtaBus system.

According to a recent rider survey, nearly all (96%) of LANta's ridership is considered low-income by the U.S. Department of Housing and Urban Development's definition of low income.[16] Recognizing the socio-economic needs of residents, and in order to keep pace with population growth across the Lehigh Valley, numerous initiatives have been launched over the past decade to address public needs. In 2001, LANta launched a pilot program to expand weekend and nighttime services in an effort to meet the needs of night-shift workers and welfare-to-work program employees.[17] In 2010, the company launched the *Moving LANta Forward* plan with the goals of 1) addressing unmet public transportation needs due to population growth; 2) expanding mobility and access to employment opportunities; and 3) increasing the visibility and convenience of public transportation.[18] In 2019, LANta reacted to the emergence of a "food desert" by launching a new bus route to assist the low-income and elderly residents affected by the closure of the community's only fresh food market.[19]

11 "Go Forward." GoTriangle Short Range Transit Plan. GoTriangle. Accessed December 6, 2021. https://goforwardnc.org/wp-content/uploads/2018/11/GoTriangle-Short-Range-Transit-Plan-FINAL-Nov-2018-Web.pdf

12 "Town of Morrisville, NC." Morrisville Smart Shuttle. Town of Morrisville, NC. Accessed December 6, 2021. https://www.townofmorrisville.org/residents/morrisville-smart-shuttle.

13 "Transit Agencies Suspend Bus Fares through June 30, 2022." GoTriangle. Accessed December 6, 2021. https://gotriangle.org/news/transit-agencies-suspend-bus-fares-through-june-30-2022.

14 "GoTriangle Annual Report FY2019." GoTriangle Annual Report. GoTriangle. Accessed December 6, 2021. https://gotriangle.org/sites/default/files/publications/gotriangle_2019_annual_report_web.pdf.

15 "About Us," LANta, accessed October 24, 2021, https://www.lantabus.com/about-us/.

16 "Public Notices," LANta, accessed October 24, 2021, https://www.lantabus.com/public-notices/.

17 Matt Assad, "LANTA to add services that help working poor: Possibilities include Sunday and night runs, mini systems, partnerships," The Morning Call, April 19, 2001, https://www.mcall.com/news/mc-xpm-2001-04-19-3361432-story.html.

18 LANta, Transit Supportive Land Use for the Lehigh Valley, accessed October 24, 2021, http://www.lantabus.com/wp-content/uploads/2014/01/LANTA-Transit-Supportive-Design-for-the-LV-FINAL-V3.pdf.

19 Christina Tatu, "LANta to launch new bus service in Slate Belt food desert after 'devastating' store closure," The Morning Call, September 4, 2019, https://www.mcall.com/news/local/nazareth/mc-nws-bangor-main-street-market-lanta-20190904-ee2g55a5mnaybnouuwwrxzt7mi-story.html.

LANta was selected as a case study due to its similarity in service area size and population to the PVTA (324 square miles and 533,100 people,[20] compared to 302 square miles and 551,543 people,[21] respectively). Comparisons were also drawn between both transit authorities' regional service provision; the inclusion of urban, suburban, and rural communities within the respective service areas; and the presence of numerous institutions of higher education within the service areas. Despite its broad similarities with the PVTA, however, the best practice gleaned from LANta was the ultimate reason for its selection as a case study. LANta's unique and innovative offering of a flexible service based on geographic Flex Zones provides a solution to serving suburban and rural communities in the most efficient manner.

The case studies covered here provided context from practice of actual strategies in use by transportation authorities around the United States. Transit best practices have informed the route design recommendations for PVTA, found later in this document, with the aim of improving transit access, equity, and efficiency across the Pioneer Valley.

Comparison of Transit Authority Metrics

	Pioneer Valley Transit Authority	ABQ RIDE	Clemson Area Transit	CT Transit	GoTriangle	Lehigh and Northampton Transportation Authority	Worcester Regional Transit Authority	Houston METRO	Niagara Frontier Transportation Authority	Rhode Island Public Transit Authority
Service Area (square miles)	302	251	320	1,450	1,519	324	866	1,303	380	1,436
Ridership (Annual Unlinked Trips)										
FY15	12,242,638	12,360,445	1,742,463	31,263,710	1,843,735	4,933,486	3,814,451	86,089,171	21,714,180	18,074,129
FY16	13,050,725	11,422,932	1,550,292	31,523,205	2,086,000	4,923,795	4,049,499	89,970,895	22,680,510	17,813,105
FY17	11,466,707	10,251,314	1,754,013	29,542,743	1,925,839	4,664,755	3,599,241	88,129,126	21,602,535	16,239,062
FY18	10,931,237	9,659,576	1,603,468	29,625,167	1,890,411	4,495,258	3,131,083	90,300,174	20,434,993	16,339,054
FY19	10,120,344	9,159,709	899,385	26,444,084	1,883,926	4,373,035	3,013,268	89,951,217	19,282,797	16,029,388
Vehicle Revenue Miles (VRM) (FY19)	7,638,088	7,430,079	718,817	17,612,217	4,083,434	5,440,743	3,045,919	76,665,799	8,432,832	8,922,598
Operating Expense per VRM (FY19)	$8.04	$8.32	$4.70	$10.14*	$7.26	$8.75	$10.68	$10.05	$12.57	$11.41
Annual Vehicle Revenue Hours										
FY15	368,159	401,311	47,595	1,221,621	179,701	224,132	165,847	4,500,013	787,970	658,893
FY16	392,667	403,901	38,717	1,400,169	188,863	226,265	172,013	4,865,487	786,100	673,407
FY17	389,593	403,646	53,736	1,412,276	187,298	227,344	172,635	4,798,694	774,635	672,788
FY18	383,227	403,598	61,573	1,427,825	192,401	230,307	162,278	4,931,237	767,163	678,887
FY19	369,630	404,246	52,087	1,445,498	191,760	242,508	161,086	5,000,218	773,382	671,155
Fares										
Basic - Single Ride	$1.50	$1.00	Free	$1.75	$2.25	$2.00	$1.75	$1.25	$2.00	$2.00
Basic - All Day Pass	$3.50	$2.00	N/A	$3.50	$4.50	$4.00	$4.50	$3.00	$5.00	N/A
Senior - Single Ride	$0.75	Free	N/A	$0.85	Free	Free	$0.85	$0.75	$1.00	$1.00
Senior - All Day Pass	N/A	N/A	N/A	$1.70	Free	N/A	$2.25	$1.50	$2.50	N/A

*Average across all company divisions:
Hartford: $10.13
New Britain: $6.18
New Haven: $11.88
Stamford: $10.98
Waterbury: $11.55

20 Federal Transit Administration, Lehigh and Northampton Transportation Authority: 2019 Annual Agency Profile, https://www7.fta.dot.gov/sites/fta.dot.gov/files/transit_agency_profile_doc/2019/30010.pdf.

21 Federal Transit Administration, Pioneer Valley Transit Authority: 2019 Annual Agency Profile, https://www7.fta.dot.gov/sites/fta.dot.gov/files/transit_agency_profile_doc/2019/10008.pdf.

Appendix 2: Planner Interviews

Interview Questions

1. Do you have any current development projects (1-5yrs) that would benefit from greater transit connectivity? (specifically economic development, park and ride locations and housing development projects)

2. Do you have any long term development plans (5-10yrs) that would benefit from greater transit connectivity? (specifically economic development, park and ride locations and housing development projects)

3. How do you view the process for getting a transit route or stop approved/ added/ changed in your community (ie: easy, straight forward, difficult)

4. How do you see PVTA supporting your work? Are there opportunities to align PVTA's long-range planning with your community's long-range planning?

5. In your opinion, generally, what are 3 weaknesses and 3 strengths of the PVTA in your community?

6. Do you frequently have community events (concerts, fairs, etc) that would benefit from dedicated transit service?

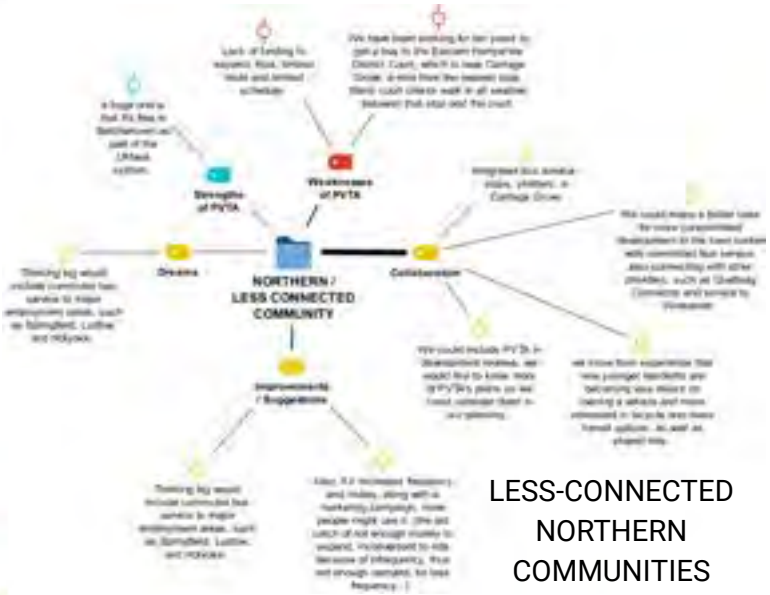
7. What are some transit priority treatments (e.g. dedicated bus lanes, transit signal priority) that your community would be interested and able to implement?

8. Do you have any reflections on past comprehensive/ development planning projects as it relates to transit?

9. How could collaboration between your town/ city and the PVTA be improved to be more productive?

10. The PVTA has challenged our studio to think big, and to consider some options that may be extraordinary or outside the realm of practicality in implementing. Do you have any thoughts on a "dream" project that could potentially solve many issues within moving residents in a more sustainable way

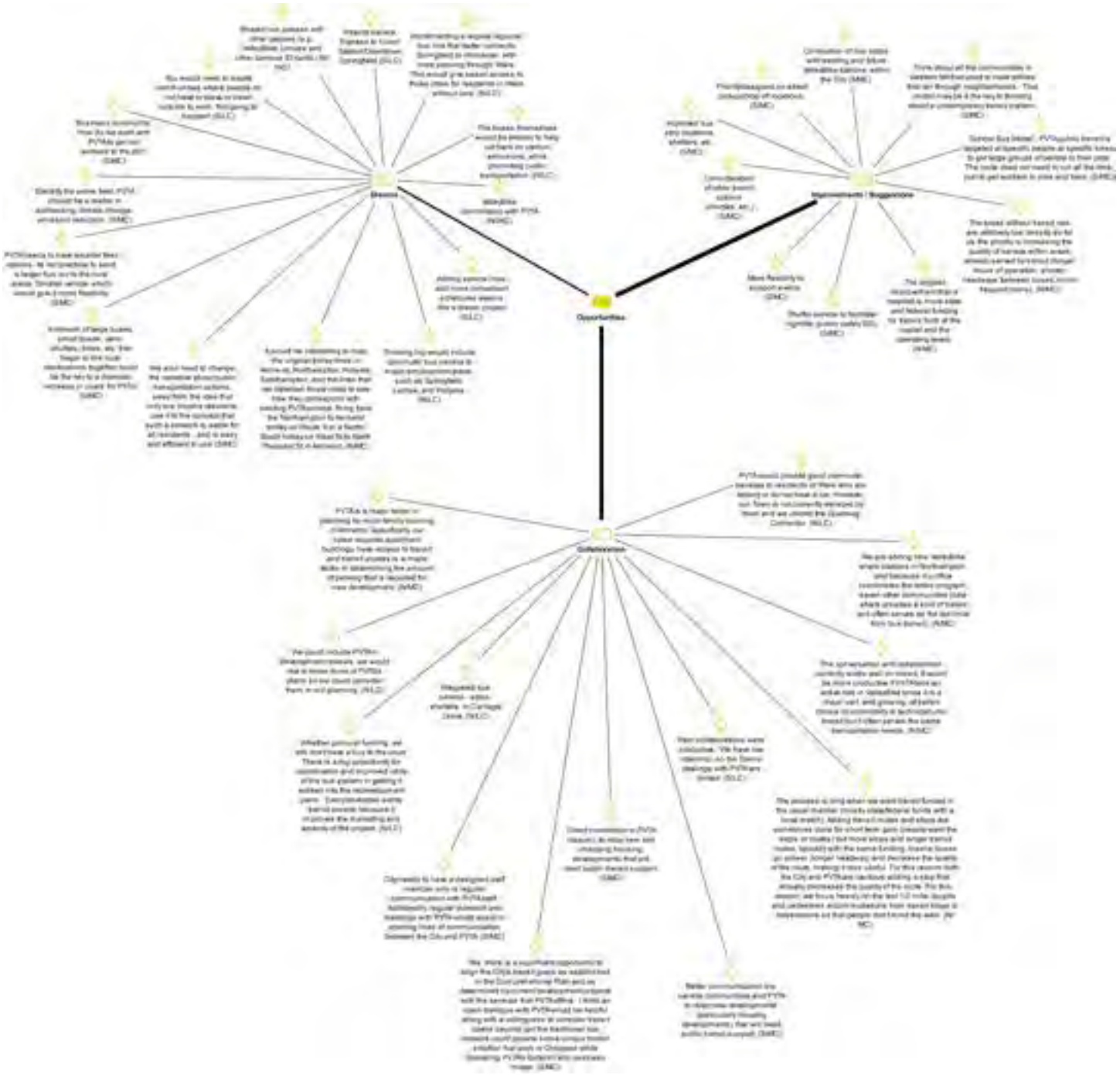
WELL-CONNECTED
NORTHERN COMMUNITIES



LESS-CONNECTED
NORTHERN
COMMUNITIES

WELL-CONNECTED
NORTHERN
COMMUNITIES

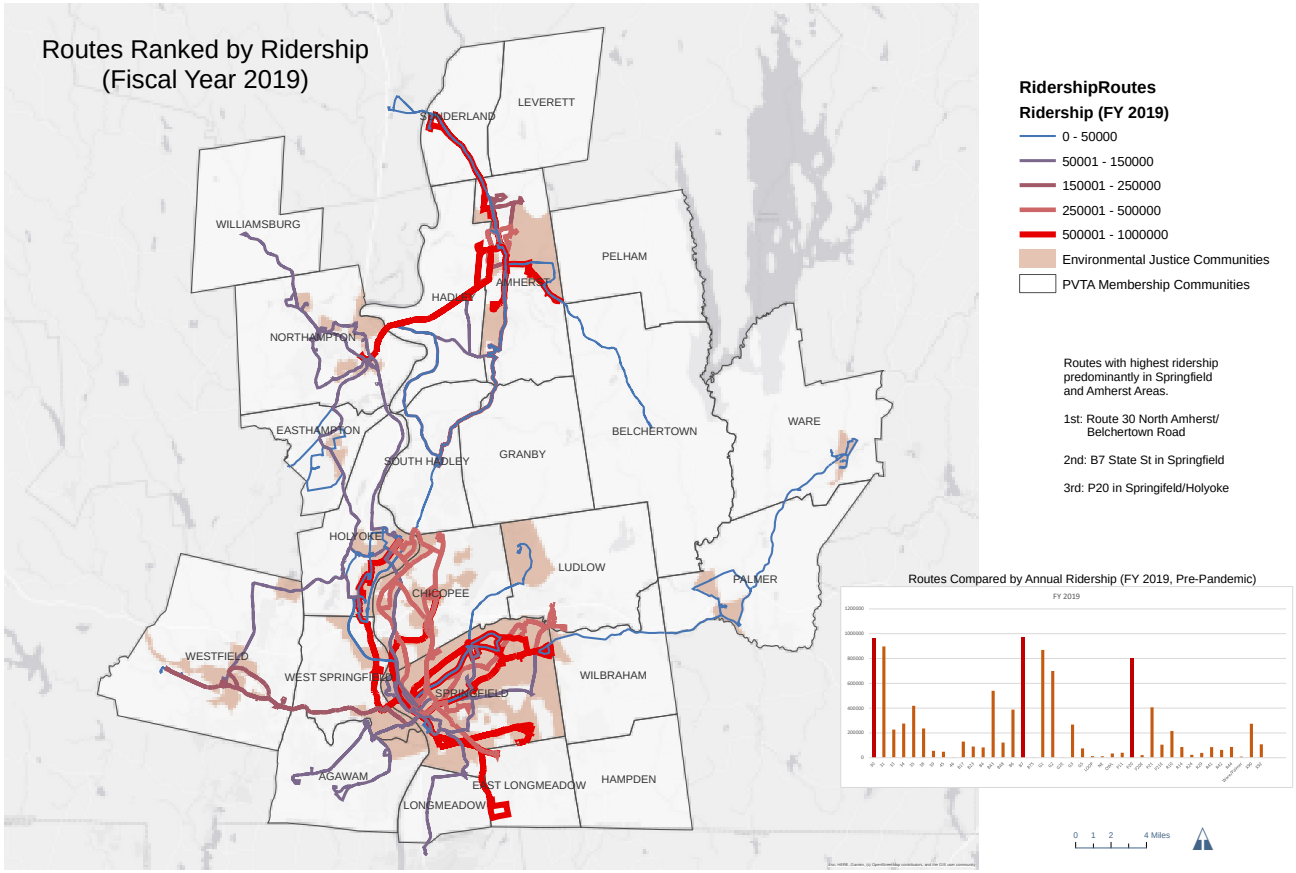
LESS-CONNECTED
SOUTHERN COMMUNITIES


Opportunities
Improvements | Suggestions
Collaboration

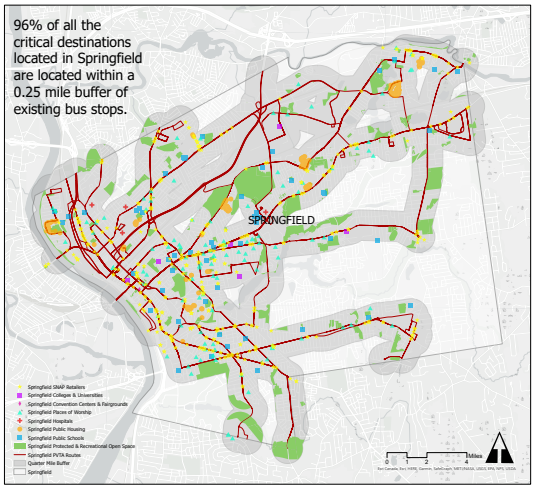

Over Transit Pavilion route junction; Connection to Westfield State University; Connections to Holyoke and Union Station (S/LC)
appropriate route locations/ destinations, new(er) downtown terminal (S/LC
Dedication to transit dependent riders within the limit of their resources (N/MC)
Strong political support locally even if not with state funding decision makers (N/MC)
I see PVTAbeing an important part of the community's approach and planning for affordable housing. (S/MC)
Strengths of PVTA
clean buses, reliable service, abundance of routes (N/MC)
PVTAis an established regional transit system which can provide Chicopee residents with regional access. (S/MC)
a huge one is that it's free in Belchertown as part of the UMass system. (N/LC)
New bus terminal on Maple Street (approx. 10 yrs ago)- Transportation Overlay District. Connected local bus service, train station, and education (adult basic ed). Intersection between workforce, education, transportation. Agreat success and a model. (S/MC)
PVTAhas some multi-modal connections (i.e. Union Station in Springfield for rail service). (S/MC)


Weaknesses of PVTA

Appendix 3: Additional Maps



Critical Destinations within a 0.25 mile Buffer of Existing Bus Stops



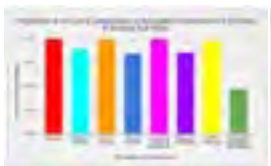


Figure 1: Figure 1 shows the percentage of all the critical destinations located in Springfield that are located within a 0.25 mile buffer of existing PVTA bus stops.

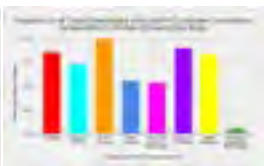
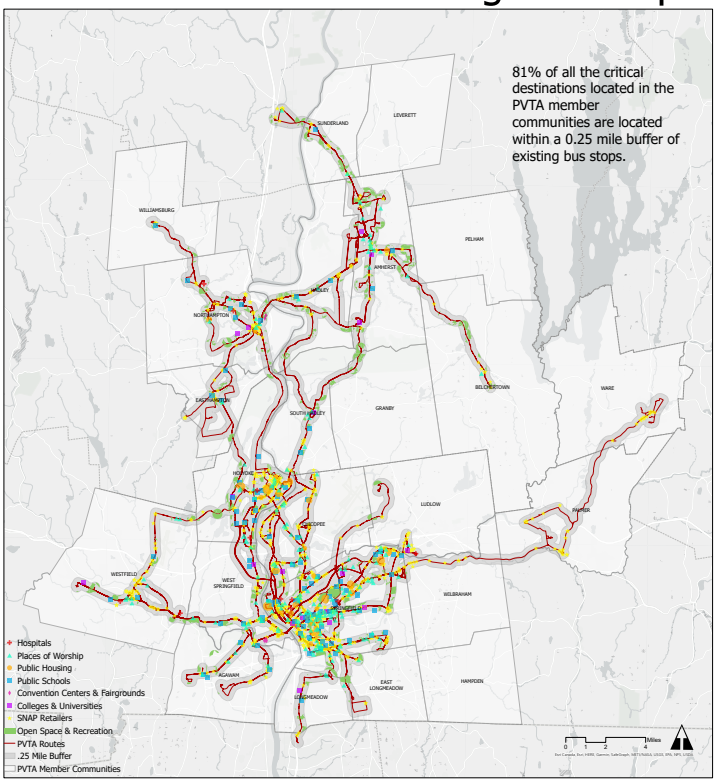
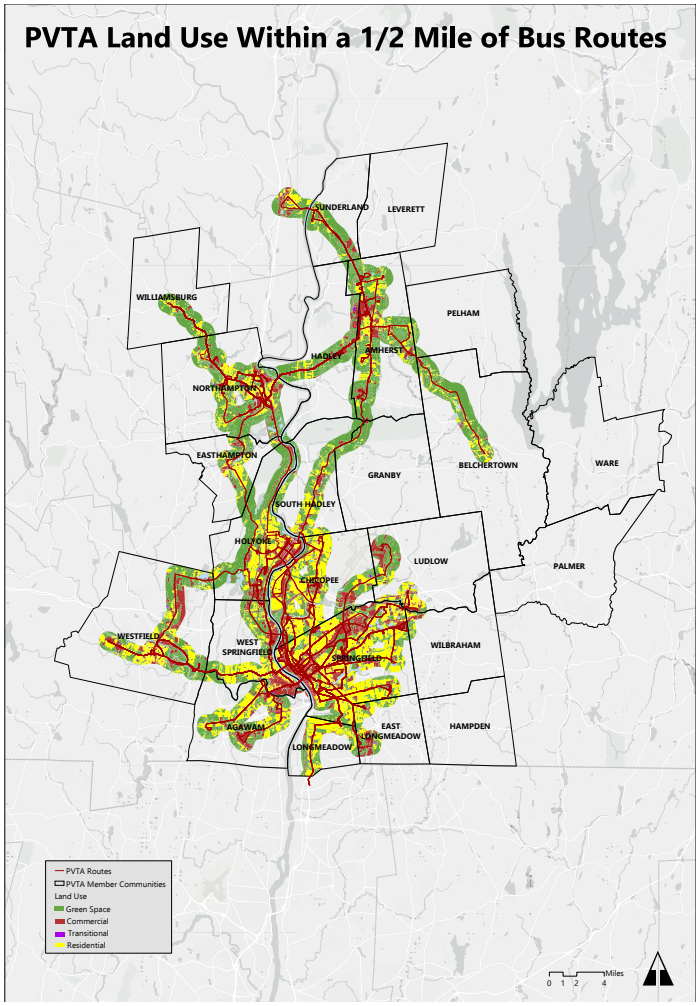
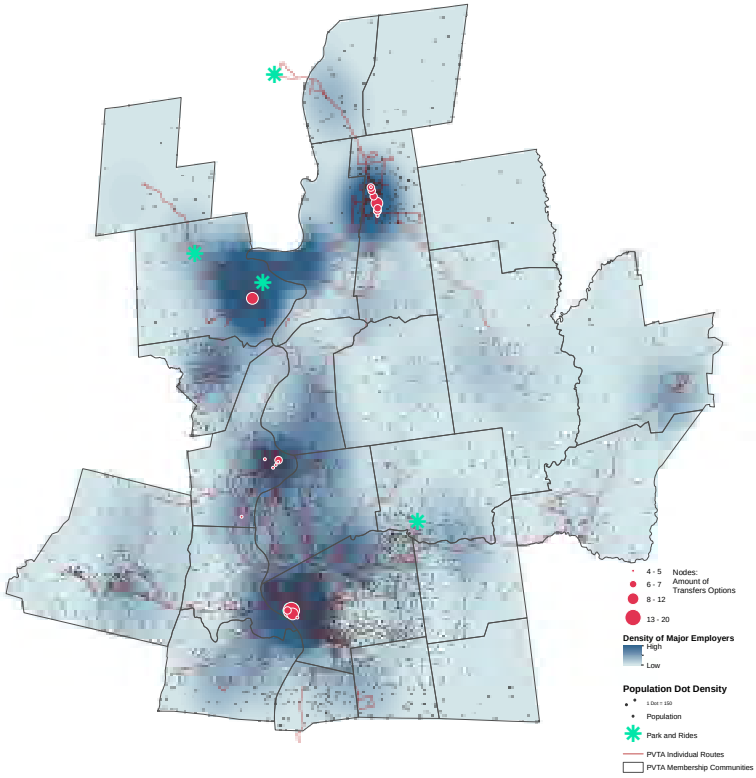


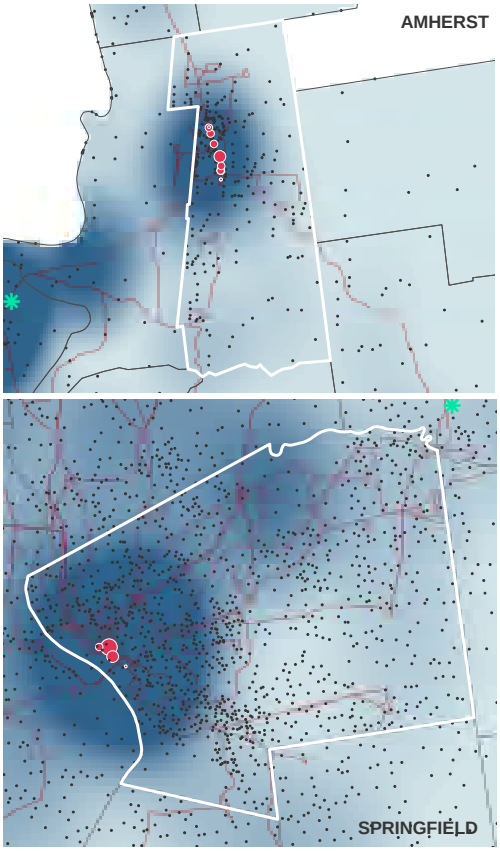
Figure 2: Figure 2 shows the percentage of all critical destinations located in the PVTA member communities that are located within a 0.25 mile buffer of existing PVTA bus stops.





Access to Work:
Population, Major Employers, Park & Rides, Transfer Nodes





Appendix 4: Geospatial Appendix

GIS Data Library with sources and links to data share can be found here

GEOSPATIAL SCENARIO DEVELOPMENT

Scenario Environmental Justice Block Growth

For the Skilled Valley Scenario

The reduction of UMass population creates more housing availability within the Northern service area, yet loss of jobs leads to lowered income levels causing an increase of EJ communities in the North. Lower-income existing residents and/or new residents from South may move into areas of existing student apartments and multi-family housing within northern downtowns.

1. Individually Clip MassGIS LandCover/LandUse to municipalities of Amherst, Hadley, Northampton.

2. Per municipality, Select by Attribute "Multi-Family Housing", create new layer from selection.

3. Select by Location, Census Blocks as source layer, intersect new layer of multi-family housing, create new layer from selection such as CensusBl_MFH_Amherst.

4. Clip MassGIS 2020 Environmental Justice Blocks to municipalities, ex: 2020EJ_Amherst

5. Select by Location, CensusBl_MFH_Amherst as source layer, "share a side with" 2020EJ_Amherst, create new layer from selection. The result is census blocks containing multi-family housing that are most adjacent to existing environmental justice communities within that given municipality.

For the Higher Ground Scenario

Politics inhibits regional planning efforts to adequately address in-migration and climate adaptation needs in the south. Low income incoming climate migrants move into existing multi-family housing areas within southern municipalities that have existing immigrant populations, relatively lower real estate values, and democratic-leaning voting patterns in the 2020 presidential election. Northern municipalities coordinate to use new federal funds to create more affordable housing within this scenario, preventing the growth of environmental justice blocks in the northern service area.

Same process as above, but for the municipalities of Springfield, Holyoke, Chicopee, South Hadley.

Scenario Population Projection Workflow

Scenario	Description	Pop Growth %	Where
Valley Stasis (BAU)	Moderate growth across PVTA	5.7%	All PVTA
New Small City	Concentrated growth in urban areas, moderate growth throughout PVTA	20% 3.4%	Urban Areas (based on TOD and planner interviews) Non-Urban Areas
Skilled Valley	Concentrated growth in South, Population Decline in North	South +19.12%, North -8.57%	Decline in 5 college area, growth in proximity to major employers and opportunity zones
Higher Ground	Concentrated high growth throughout PVTA	25%	Expanded EJ blocks (2020 EJ + multi-family housing zones for Springfield, Holyoke, Chicopee, South Hadley. TOD identified by PVPC in Northern PVTA)

Areas of population growth or decline were determined within each scenario (see above).

1. Run Select by Location, CensusBlock clipped to PVTA service area, aka "CensusB2010_PVTA" as "target layer" and scenario's pop growth areas as "source layer" using "have their centroid in the source layer feature", create new layer from selection called "CBPVTA_ScenarioGr"

2. Open that new layer's attribute table, create new field as small integer named "SK_PCYN" (ex: Skilled Valley Population Change Yes or No) and use field calculator to input "1" for that field

3. Run Spatial Join on CensusB2010_PVTA to connect CBPVTA_ ScenarioGr back to original CB layer, name output "Scenario_ PopChangeBlcks"

4. If there are different population increase/decrease percentages such as in Skilled Valley Scenario, clip the Scenario_PopChangeBlcks to the north and southern halves of the PVTA service area, perform steps 5-7 for each half then rejoin. If there is one consistent percent population increase, there is no need to clip the CB layer in halves. Follow instructions below.

5. Open one of the halves, ex: North. Create a new field, use double, name "SK_PPrInc" (i.e. Skilled Valley Pop Percent Increase) and use Field Calculator to input the percent increase or decrease in population (ex: 0.09)

6. Create another new field, short integer, SKN_PCh ("Skilled Valley North Population Change") this field will be the amount to be added or subtracted from original population. Use Field Calc SKN_PCh = POP100_ RE * SK_PPrInc * SK_PCYN. The equation = existing population times the percent population change times 0 or 1 depending on if the block is marked for population change or not. The 0 ensures that the equation will result in 0 population change when the block is not marked for change.

7. Create another new field, short integer, SK_PopN (Skilled Valley Population New), use Field Calculator to add or subtract the results of SKN_PCh depending on if it is an area of population growth or decline. Ex of the north, SK_PopN = POP100_RE - SKN_PCh.

8. Once then new population field is calculated, run statistics to determine the sum and manually input it into scoring spreadsheets.

Appendix 4: Geospatial Appendix

GEOSPATIAL SCORING PROCESS

Access Scoring Process

The buffer of each route redesign was run through the access scoring process below to determine percentages of destinations accessible per redesign. Destinations did not change per scenarios.

1. Use the Master Destinations file (available within data transfer) and quarter-mile buffer for Route Redesign.

2. Clip the master destinations layer (input features) to a given Route Redesign buffer layer (clip features).

3. Run Table to Excel on the resulting layer. Copy and paste the exported table into the prepared excel spreadsheet. A spreadsheet was prepared with to total the sums of 1 or 0 given to each disaggregated destination type. Sum of clipped destinations are divided by the total potential destinations to automatically generate precentages.

Preparing Master Destinations Shapefile

1. Batch Clip destinations layers to dissolved PVTA service area.

2. Reproject layers to consistent coordinate system as necessary. (WGS_1984_Web_Mercator_Auxiliary_Sphere)

2. Run Batch "Add XY Coordinates (Data Mgmt)" to individual clipped destination layers.

3. Run "Table to Excel" for each destination layer now containing XY data.

4. In excel, edit and combine destination layers. Maintain Point-X and Point-Y as individual X,Y coordinate fields. Maintain original object id's as individual fields but change name to more descriptive (ex: "OBJECTID_PbS" for public schools) in case need to rejoin features to original destination layer. Add fields for destination type (Dest_Type, ex: Public Schools), disaggregated metrics (Disag_Metrics, ex: Schools), metric (Metric, ex: NonWork), metric category (Metric_Cat, ex: Access). Create a new field for each disag metric and fill with 1 or 0 for binary yes or no. (Master File is available in data transfer for further review)

5. Bring condensed "MasterDestinations" spreadsheet back into ArcGIS by saving spreadsheet as .cvs. In ArcGIS, File > Add Data > Add XY Data. Use Point-X as X field, Point-Y as Y field, Projected Coordinate System: WGS_1984_Web_Mercator_Auxiliary_Sphere

EJ Capture Scoring Process

1. Use MassGIS 2020 EJ layer for Valley Stasis and New Small City which did not project additional EJ growth. For Skilled Valley and Higher Ground, use the scenario's new EJ expansion layer.

2. To determine total number of EJ blocks for the scenario, create a new field using short integer, named "Scenario_EJ" then use field calculator Scenario_EJ = "1". Run Statistics on that field to determine the sum and manually input into EJ scoring spreadsheet.

3. To determine total number of EJ blocks the the Route Redesign services in that scenario, Run Select by Location, for EJ layer (target layer) intersected by the scenario's route redesign's buffer (source layer). Create new layer from selection. Within attribute of this new layer, create new field, set at short integer, named "ScenarioNameEJ" and run Field Calculator to population with binary 1 for yes/0 for no ie ExEJ_T# = "1"

4. Run Statistics on that field to determine the sum of yeses (1's) and manually input into EJ scoring spreadsheet.

Population Interpolation Scoring Process

The buffer of each route redesign was run through this interpolation process using the projection population layer of each scenario. This determined the "total potential population capture" of that redesign in each scenario. These "total potential population capture" or "potential **ridership**" were then compared as part of the efficiency metric.

1. Begin a given scenario's population projection per census block layer and the quarter-mile buffer on all routes of Redesign. Merge flex zones or 3/4 mile flex routes buffers if present.

2. Open population layer's attribute table, create a new field set to Double called "Area_SqFt", calculate geometry in state plane.

3. Clip population layer to buffer layer.

4. Open the resulting clipped layer's attribute table, create another new field set to Double called "ArSqFt_New", calculate geometry as square feet in MA state plane again.

5. To calculate the new population, create a new field set to double named "New_TPop", use "field calculator" to divide the new area by the old area and multiple the original total population by the resulting fraction. i.e. New_Tpop = (ArSqFt_New/Area_SqFt) * Total Population

Thank You