



PRINCETON TRANSITWAY STUDY

# PRELIMINARY CONCEPT ANALYSIS

11.21.2022



**PRINCETON  
STATION**

**PRINCETON  
JUNCTION STATION**



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# EXECUTIVE SUMMARY

NJ TRANSIT's Princeton Branch, affectionately known as the Dinky, is a 2.7-mile electrified commuter rail line running between Princeton Junction (in West Windsor) and Princeton. For over 150 years, the Princeton Branch has been a vital connection between Princeton and the Northeast Corridor (NEC). NJ TRANSIT recognizes the importance of both maintaining this connection and of developing new approaches to mobility in the corridor due to a variety of factors including aging rail vehicles, declining ridership, and new demands for travel following the COVID-19 pandemic. Therefore, NJ TRANSIT undertook the Princeton Transitway Study, a concept-level review of the Princeton Branch, to begin to guide the future of this important corridor.

This study is the first step in the project delivery process. It identifies and assesses existing and future needs, evaluates opportunities to utilize the corridor as a multi-modal backbone for mobility in the Princeton and West Windsor area, and

recommends concept alternatives to advance to a future preliminary design phase. The Princeton Transitway Study envisions a multi-modal Transitway with frequent and reliable direct service between major origins and destinations in Princeton and West Windsor on modern and accessible vehicles, considering the following goals:

- **Improve the quality, reliability, and frequency of service** on the Princeton Branch to make the service more accessible for all travelers, thereby increasing ridership and reducing single occupancy vehicle trips.
- **Enhance connections** to surrounding communities, the University, and the region by identifying opportunities to incorporate other modes of transportation on or adjacent to the Princeton Branch, including bus, microtransit, pedestrians, bicyclists, and other forms of micromobility

- **Utilize new technology** to enhance the service for riders while lowering operational and maintenance costs and reducing greenhouse gas emissions.
- **Provide a flexible and scalable system** that can respond to changing demand that results from events, as well as from short-term and long-term travel trends.

Considering the project vision, goals, needs, and opportunities, three preliminary concept Build alternatives and one No Build alternative were developed and evaluated. These concept alternatives include the following:

- **Alternative 1:** Dedicated Transit Roadway with Embedded Light Rail
- **Alternative 2:** Light Rail with Parallel Dedicated Transit Roadway
- **Alternative 3:** Dedicated Transit Roadway
- **Alternative 4:** No Build

Several features are common to each of the concept Build alternatives, including a parallel pedestrian/bicycle pathway, potential new stations, potential extensions into Princeton and West Windsor, service branding, electric vehicles with attractive, modern concept designs, and the potential for future automated operations.

To evaluate the concept alternatives and select which should be advanced for further assessment, the project team conducted a preliminary assessment of factors such as service frequency,

community connections, equity, access, potential ROW and environmental impacts, cost and stakeholder/community input. The results of assessment indicated that, while all three concept Build alternatives would meet the vision and goals of the study, potential impacts and stakeholder and community feedback resulted in the removal of **Alternatives 2 and 3** from further consideration. Thus, only **Alternative 1** and the **No Build Alternative** were advanced for further assessment.

Because **Alternative 1** represents a significant potential change to the corridor, it was evaluated in more detail based on several key factors including environment, structures, historical and cultural resources, stormwater management, ROW and land use, potential transit operations, and cost. Based on this evaluation, **Alternative 1** is recommended to be advanced as the initially preferred concept alternative. **Alternative 1** would substantially enhance mobility and access to transit in Princeton and West Windsor, increase ridership, enhance active modes, and would minimize negative impacts to ROW, the environment, and historical and cultural resources. While the timing of subsequent study phases is not known at this time, the next step would be to advance **Alternative 1** to preliminary design and complete the required environmental documentation, either an Environmental Assessment or Environmental Impact Statement.



**ALTERNATIVE 1 (CONCEPTUAL RENDER)**

# REVIEW OF EXISTING CONDITIONS

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# ABOUT THE PRINCETON TRANSITWAY STUDY

NJ TRANSIT's Princeton Branch, affectionately known as the Dinky, is a **2.7-mile electrified commuter rail line** running between the Branch's two stations, **Princeton Junction (in West Windsor) and Princeton**. For over 150 years, the Princeton Branch has been a vital connection between Princeton and the Northeast Corridor (NEC). Today it provides connectivity to **NJ TRANSIT's NEC rail service** to **New York City, Newark, and Trenton**, as well as to **Amtrak regional and national rail services**.

NJ TRANSIT recognizes the importance of both maintaining this connection and developing new approaches to mobility in the corridor, due to a variety of factors including **aging rail vehicles, declining ridership, and new demands for travel following the COVID-19 pandemic**. Therefore, NJ TRANSIT undertook the Princeton Transitway Study to begin to guide the future of the Princeton Branch.



FIGURE 1-1  
PRINCETON STATION TODAY WITH THE DINKY COMING IN

# PROJECT OVERVIEW

## WHAT IS THE PRINCETON TRANSITWAY STUDY?

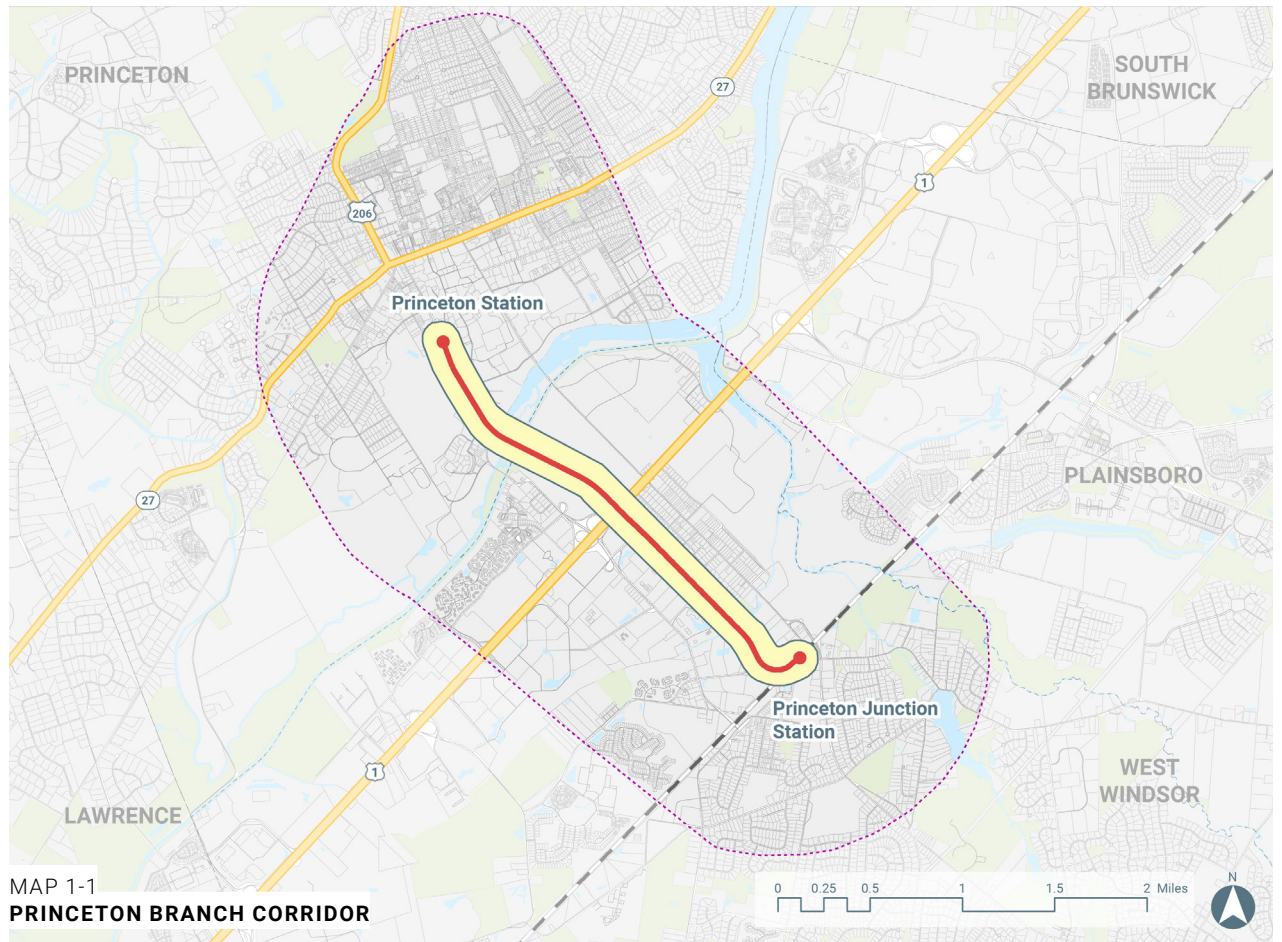
The Princeton Transitway Study is a **concept-level review of the Princeton Branch to define the future of transit service on the Princeton Branch**. This study is the first step in NJ TRANSIT's project delivery process. It identifies and assesses existing and future needs, evaluates opportunities to utilize the corridor as **a multi-modal backbone for improved mobility in the Princeton and West Windsor area**, and recommends concept alternatives to advance to a future preliminary design phase.

### LEGEND

- PRINCETON BRANCH CORRIDOR
- CONCEPT STUDY AREA
- MULTI-MODAL CONNECTIVITY STUDY AREA

**Concept Study Area:** Princeton Branch corridor between Princeton and Princeton Junction - focus of alternatives analysis.

**Multi-Modal Connectivity Study Area:** Evaluate ways to enhance connectivity to the corridor for transit, pedestrians, bicyclists, scooters, TNCs and others.





**1. EXISTING CONDITIONS AND CONSTRAINTS ANALYSIS:**

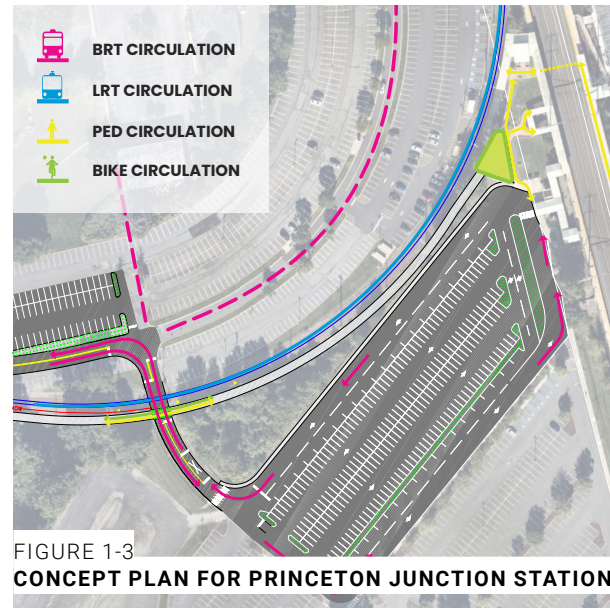
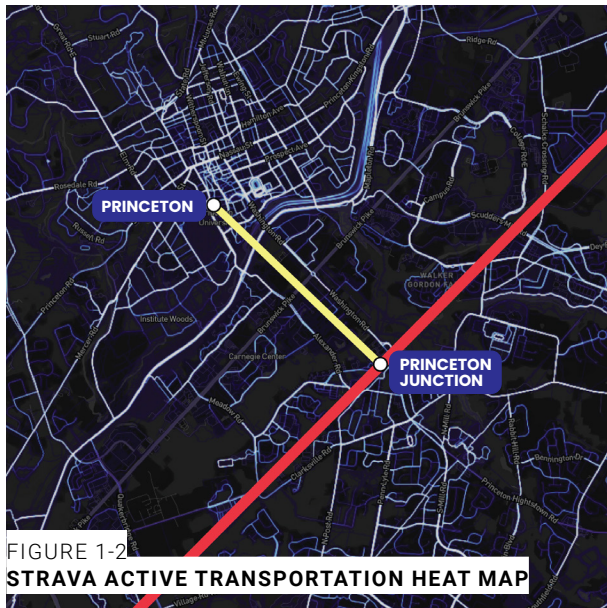
Establishes an existing condition baseline for the corridor and identifies current and future needs and opportunities.

**2. DEVELOPMENT OF PRELIMINARY CONCEPT ALTERNATIVES:**

Includes the development and preliminary evaluation of three concept Build alternatives and one No Build alternative. Based on the evaluation in this stage, one concept Build alternative and the No Build alternative were advanced to Stage 3.

**3. REFINEMENT AND EVALUATION OF SELECTED CONCEPT ALTERNATIVES:**

Selected concept alternatives from Stage 2 were refined based on stakeholder and community feedback and factors such as right-of-way (ROW), environmental impacts, structures, storm water management, etc. were quantified.



## WHY IS IT NEEDED NOW?

NJ TRANSIT has reached an important crossroads for service on the Princeton Branch that has resulted from variety of factors:

### 1. AGING RAIL VEHICLES

NJ TRANSIT's **Arrow III fleet is 45 years old, and in need of retirement due to increasing maintenance costs and the difficulty in obtaining replacement parts.** New rail vehicles that will be replacing the Arrow III systemwide would present significant operational and efficiency challenges on the short Princeton Branch. The Multilevel Rail Cars require a minimum of **426 seats, which present an inefficient and extremely costly operation, with additional platforming challenges due to the station platform geometry.**



FIGURE 1-6  
RIDING THE DINKY, CIRCA 1900 (PRINCETON UNIVERSITY LIBRARY ARCHIVES)



FIGURE 1-7  
PRINCETON STATION, 1988 (PRINCETON UNIVERSITY LIBRARY ARCHIVES)



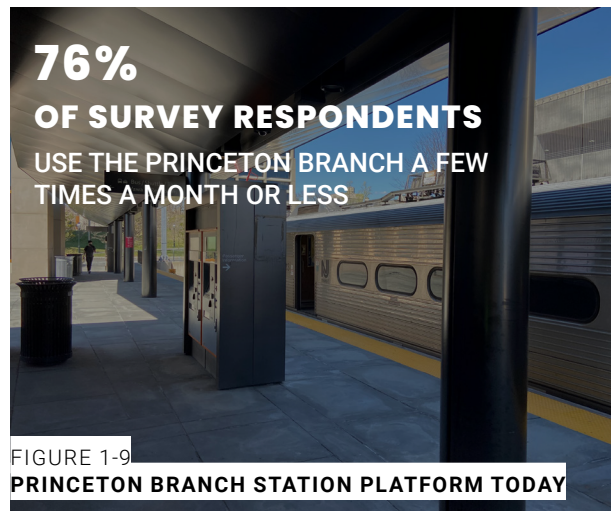
FIGURE 1-5  
PRINCETON STATION TODAY



FIGURE 1-8  
ARROW III TRAIN (WIKIMEDIA COMMONS, 2021)

## 2. DECLINING RIDERSHIP

Operational constraints and staffing requirements for heavy rail vehicles like the Arrow III on a single unsignalized track results in **headways of approximately 30 minutes** which does not coincide well with the approximately 10-minute peak headways on the NEC. **These inefficient headways, combined with the location of the Princeton station outside of a typical walking distance from Downtown** and most residential neighborhoods, and parking expansion at the Princeton Junction station, have **resulted in a ridership decline since 2013**.



## 3. ANTICIPATED LAND USE CHANGES ALONG THE CORRIDOR

Planned growth along the Princeton Branch, including **Princeton University's planned expansion to the east of Carnegie Lake**, as well as the planned **West Windsor transit-oriented development (TOD)** will increase demand for transit services along the corridor throughout the day, **not just during the typical AM and PM commuter peak periods**.



## 4. CHANGES IN MOBILITY DEMANDS AND EXPECTATIONS

Recent advancements in transportation technology and trends, as well as the COVID-19 pandemic, have begun to **change how and when people want to travel**. People are looking for options that are **flexible and frequent, particularly for short trips**. NJ TRANSIT must plan to respond to emergent needs now and into the future and **ensure a more robust and flexible system that can be scaled to meet changing demands**.

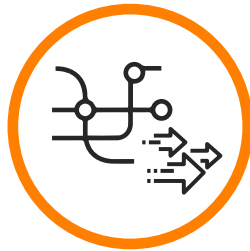


## WHAT ARE THE VISION AND GOALS OF THE STUDY?

The Princeton Transitway Study **envisions a multi-modal Transitway with frequent and reliable direct service** between major origins and destinations in Princeton and West Windsor on modern and accessible vehicles (See **Figure 1-12**).

This study resulted in a concept-level plan that directs the future of service on the Princeton Branch, considering the following goals:

- **Improve the quality, reliability, and frequency of service** on the Princeton Branch to make the service more accessible for all travelers, thereby increasing ridership and reducing single occupancy vehicle trips.
- **Enhance connections** to surrounding communities, the University, and the region by identifying opportunities to incorporate other modes of transportation on or adjacent to the Princeton Branch, including bus, microtransit, pedestrians, bicyclists, and other forms of micromobility.



**IMPROVE THE SERVICE**



**ENHANCE CONNECTIVITY**



**INCORPORATE TECHNOLOGY TO REDUCE EMISSIONS**



**PROVIDE FLEXIBILITY**

FIGURE 1-12  
**PRINCETON TRANSITWAY STUDY OVERVIEW: PROJECT GOALS**

- **Utilize new and emerging transportation technology** to enhance the service for riders while lowering operational and maintenance costs and reducing greenhouse gas emissions.
- **Provide a flexible and scalable system** that can respond to changing demand that results from events, as well as from short-term and long-term travel trends.



FIGURE 1-13  
**EXISTING STATION INFRASTRUCTURE (2022)**

# WHO WAS INVOLVED?

The NJ TRANSIT study team was supported throughout the project by an outreach program that consisted of the following components:

- Stakeholder Committee:** A stakeholder committee was established to provide input and guidance during each step of the process depicted in **Figure 1-14**. The committee included representatives from State and local government, the municipalities of **Princeton** and **West Windsor, Mercer County**, the **North Jersey Transportation Planning Authority (NJTPA)**, the **Delaware Valley Regional Planning Commission (DVRPC)**, **Greater Mercer TMA**, and other interested transportation parties. The stakeholder committee was engaged via virtual meetings at each stage of the project during three meetings (See **Figure 1-14**).

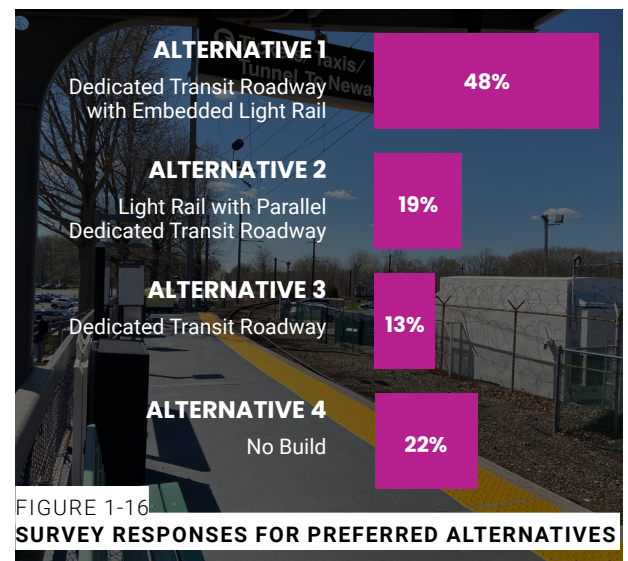


FIGURE 1-14  
PROJECT TIMELINE AND SCHEDULE

- Study Website (<https://www.njtransit.com/princetontransitway/>):** A study website was hosted by NJ TRANSIT and utilized to provide basic information regarding the study and contained links to presentation materials, surveys, and a comment form. Comments that were submitted via the website were documented, categorized, and answered. Answers to recurring questions were provided on a frequently asked questions (FAQ) page (See **Figure 1-15**).
- Surveys:** NJ TRANSIT conducted two surveys during the study. The first survey was distributed in April/May 2021 via e-mail and weblink to NJ TRANSIT customers and study stakeholders who had ridden the Dinky prior to the pandemic. The purpose of the survey was to understand pre-pandemic ridership patterns, the intent to use the Dinky in the future, and perceived challenges and opportunities for the Dinky. A second survey was conducted in December 2021 and was made available through e-mail and web-link to NJ TRANSIT customers and study

stakeholders. Respondents were asked to view a brief presentation regarding the preliminary concept alternatives and then respond to survey questions that were intended to understand which alternative was preferred, the reason for the preference, and concerns regarding the future of the Dinky (See **Figure 1-16**).

- Virtual Public Meetings:** The NJ TRANSIT project team was hosted by the Princeton Public Transit Advisory Committee during a special session on April 26, 2022, and by West Windsor Township Department of Community Development on May 24, 2022. During both meetings, the project team presented the study background, preliminary concept alternatives, and the recommended concept alternatives. A question-and-answer period followed each of the presentations which provided the opportunity for members of the public to ask questions regarding the study.



## WHAT DID WE LEARN?

The Existing Conditions and Constraints Analysis as well as stakeholder and public comments/feedback resulted in the following key takeaways:

- Key Finding #1:** Downward trends in Dinky ridership can be attributed to the following factors: relocation of the Princeton station further east of Downtown and residential areas, operational constraints that result in service that does not line up with the arrival and departure of trains on the NEC, and the opening of additional parking at the Princeton Junction station in 2013. Furthermore, survey responses show that approximately 76% of riders were using the Dinky a few times a month or less.

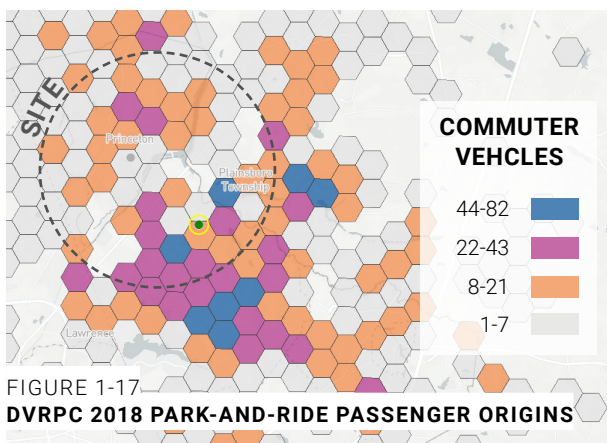


FIGURE 1-17  
DVRPC 2018 PARK-AND-RIDE PASSENGER ORIGINS

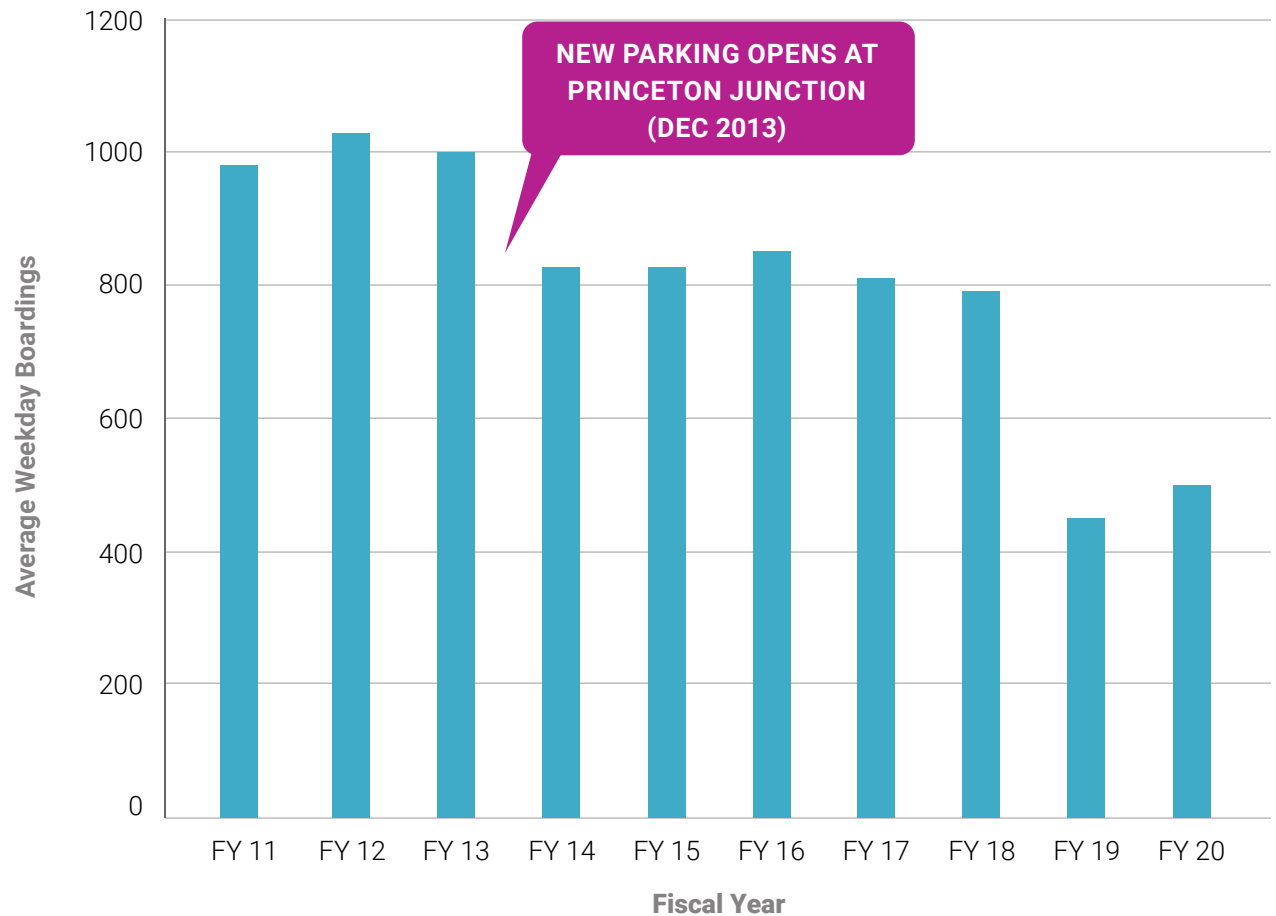


FIGURE 1-18  
DINKY RIDERSHIP TREND IN RECENT YEARS

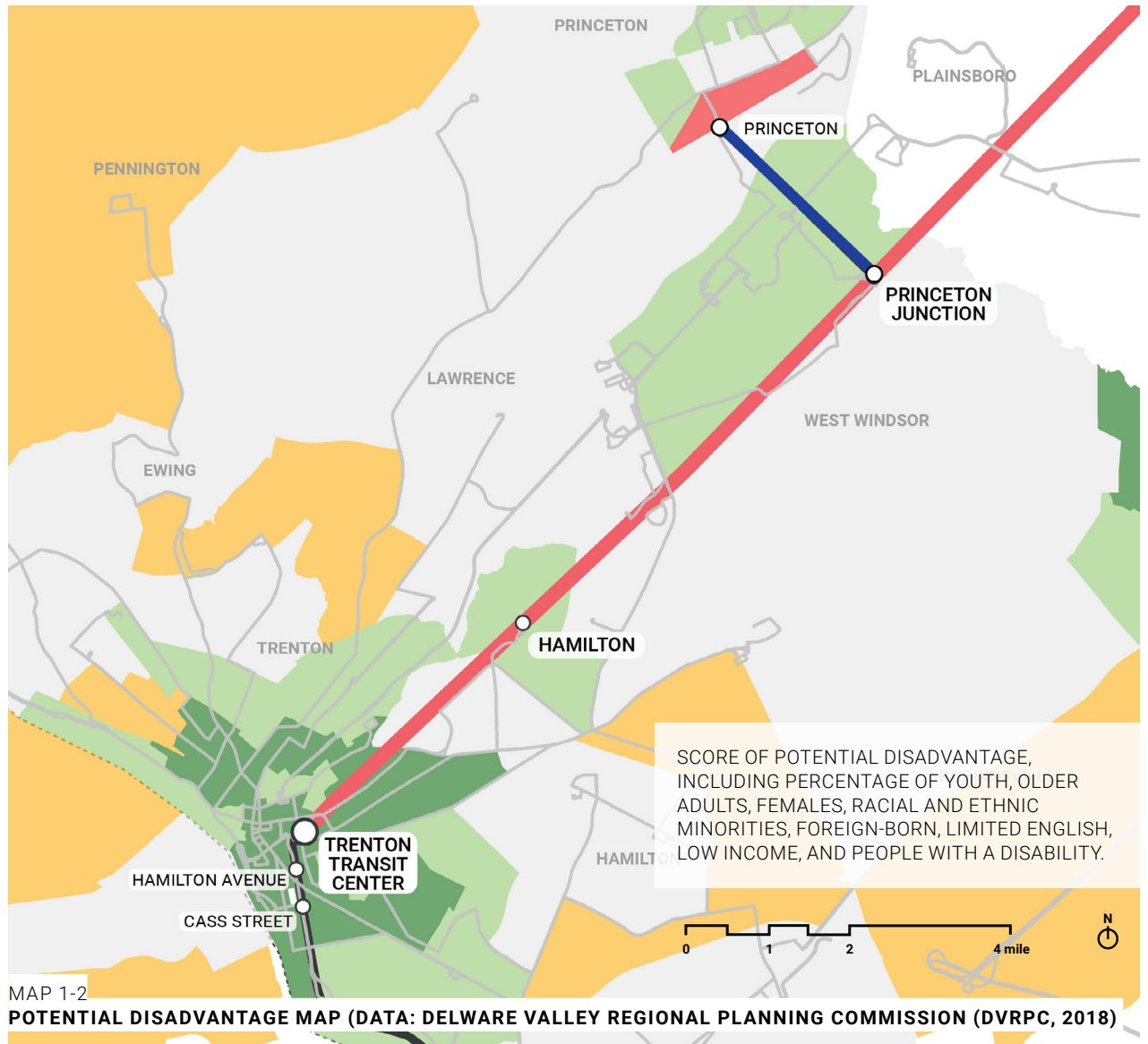
- Key Finding #2:** Areas along the Princeton Branch route, as well as to the north and west of Downtown Princeton were ranked “above average” for potential disadvantage, indicating that a revised routing with additional stops could enhance equitable access to transportation in the area. Planned affordable and senior housing developments within the area of the Princeton Shopping Center will create additional demand for equitable mobility options in areas already ranked “above average” for potential disadvantage (See **Map 1-2**).

**NJ TRANSIT**

- NORTHEAST CORRIDOR (TRAIN)
- PRINCETON BRANCH
- LIGHT RAIL ROUTE
- BUS ROUTE
- TRANSFER STATION
- STATION

**POTENTIAL DISADVANTAGE**

- WELL ABOVE AVERAGE
- ABOVE AVERAGE
- AVERAGE
- BELOW AVERAGE
- WELL BELOW AVERAGE





- Key Finding #3:** Dinky riders listed service frequency/hours, reliability, and access to Downtown Princeton and other residential areas as the most significant challenges for the future for the service and thus were ranked as some of the most important opportunities by riders (See **Figure 1-19**).
- Key Finding #4:** In addition to the aging rail vehicle fleet, substantial investment would be required in the future to repair and/or replace the aging bridge structures over Bear Brook, the D&R Canal, and Stony Brook to continue supporting heavy rail operations.
- Key Finding #5:** Planned development, such as the West Windsor TOD and the expansion of the Princeton University Campus, as well as potential future infill development along Alexander Road would create new demand along the corridor for more frequent service throughout the day.

**Respondents Importance Rating of Opportunities for the Dinky**

(Rated on a scale between 0- Not Important and 5- Very Important)

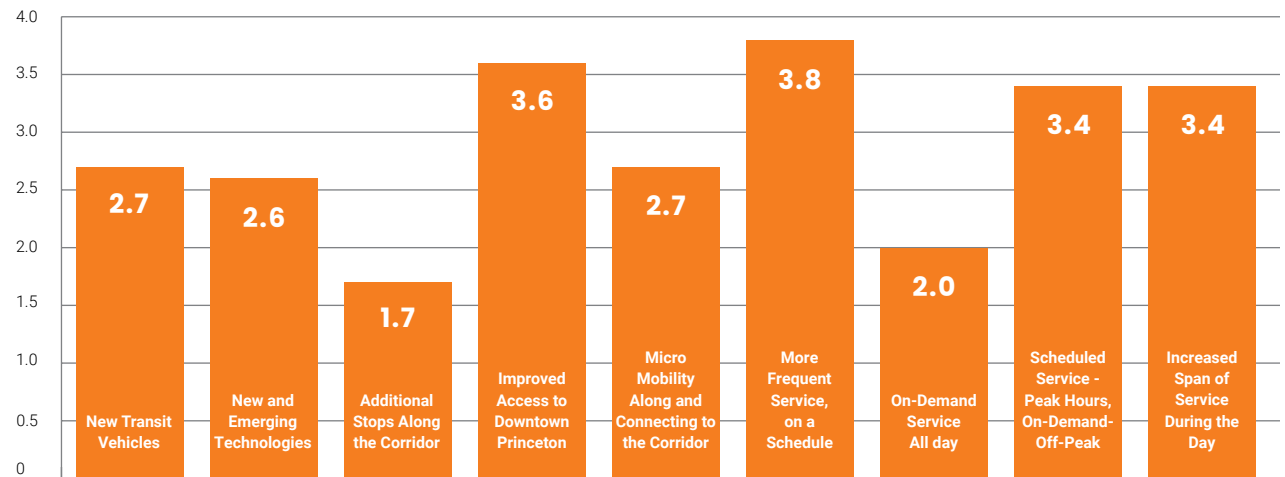


FIGURE 1-19  
**SURVEY RESULTS FOR OPPORTUNITIES FOR THE DINKY**



FIGURE 1-20  
**EXISTING INFRASTRUCTURE ON PRINCETON STATION PLATFORM TODAY**



FIGURE 1-21  
**CONCEPT FOR DEVELOPMENT ON EASTERN CAMPUS OF PRINCETON UNIVERSITY (WALKABLE PRINCETON)**

As a result of the key findings above, the following needs and opportunities were identified:

- **Enhance frequency, operating hours, and reliability of service** on the Princeton Branch to improve mobility for all users throughout the day.
- **Extend high-quality transit services** from the Princeton Branch corridor into Downtown Princeton and residential areas in Princeton and West Windsor to enhance overall mobility.
- **Provide high-quality transit services to areas with higher densities** as well as areas with lower income, minority, student, and senior populations that tend to have lower rates of auto ownership.
- **Identify opportunities to incorporate other modes of transportation** on or adjacent to the Princeton Branch, including bus, microtransit, pedestrians, bicyclists, and other forms of micromobility.
- **Support potential development** along the Princeton Branch corridor.

- **Utilize new and emerging transportation technology** to enhance the service for riders while lowering operational and maintenance costs, and reduce greenhouse gas emissions.
- **Provide a flexible and scalable system** that can respond to changing demand that results from events on the University campus or within Princeton, as well as from short-term and long-term travel trends.
- **Explore opportunities to allow other transit services**, including Tiger Transit and FreeB to utilize the Princeton Branch corridor to enhance connections to the Princeton Junction station and other planned or potential future development along the corridor.



FIGURE 1-22  
**EXAMPLE OF OTHER MODES OF TRANSPORTATION RUNNING ALONG A PUBLIC TRANSIT LINE**



FIGURE 1-23  
**EXAMPLE OF DEVELOPMENT IN A MID-DENSITY CONTEXT**



# PRELIMINARY CONCEPT ALTERNATIVES

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# TRANSITWAY CONCEPTS

## PRELIMINARY CONCEPT ALTERNATIVES

Considering the project vision, goals, needs, and opportunities, three preliminary concept Build alternatives were developed and evaluated. These alternatives include the following:

- **Alternative 1:** Dedicated Transit Roadway with Embedded Light Rail
- **Alternative 2:** Light Rail with Parallel Dedicated Transit Roadway
- **Alternative 3:** Dedicated Transit Roadway

In addition to the three above listed concept Build alternatives, **Alternative 4: No Build** was also considered in this analysis. A No Build condition is required as part of any alternatives analysis to compare the benefits and impacts of each alternative to maintaining an existing condition. The No Build condition also identifies what improvements may need to be made to the existing infrastructure for long-term operations in the future.



FIGURE 2-1  
POTENTIAL VEHICLE TYPES

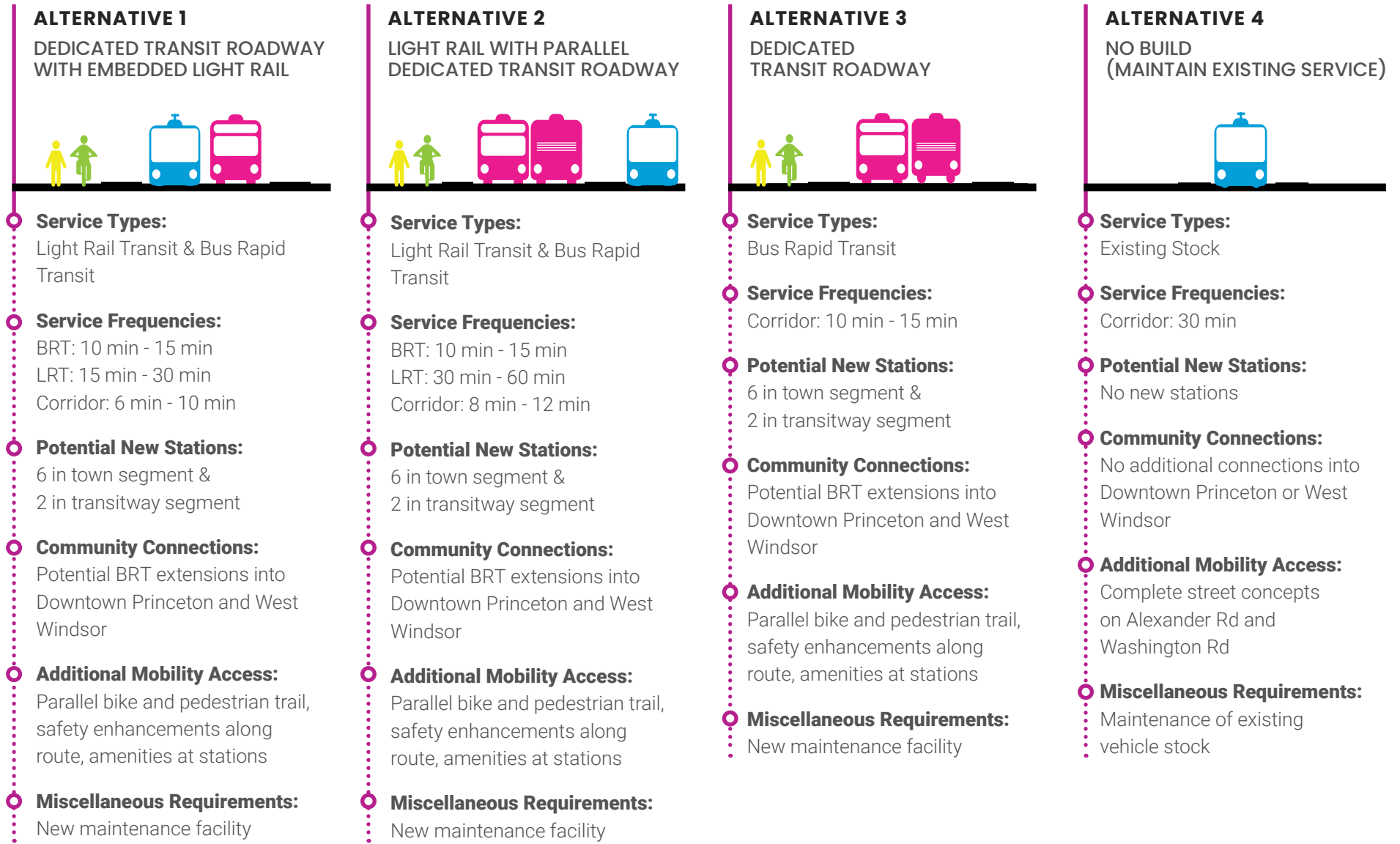










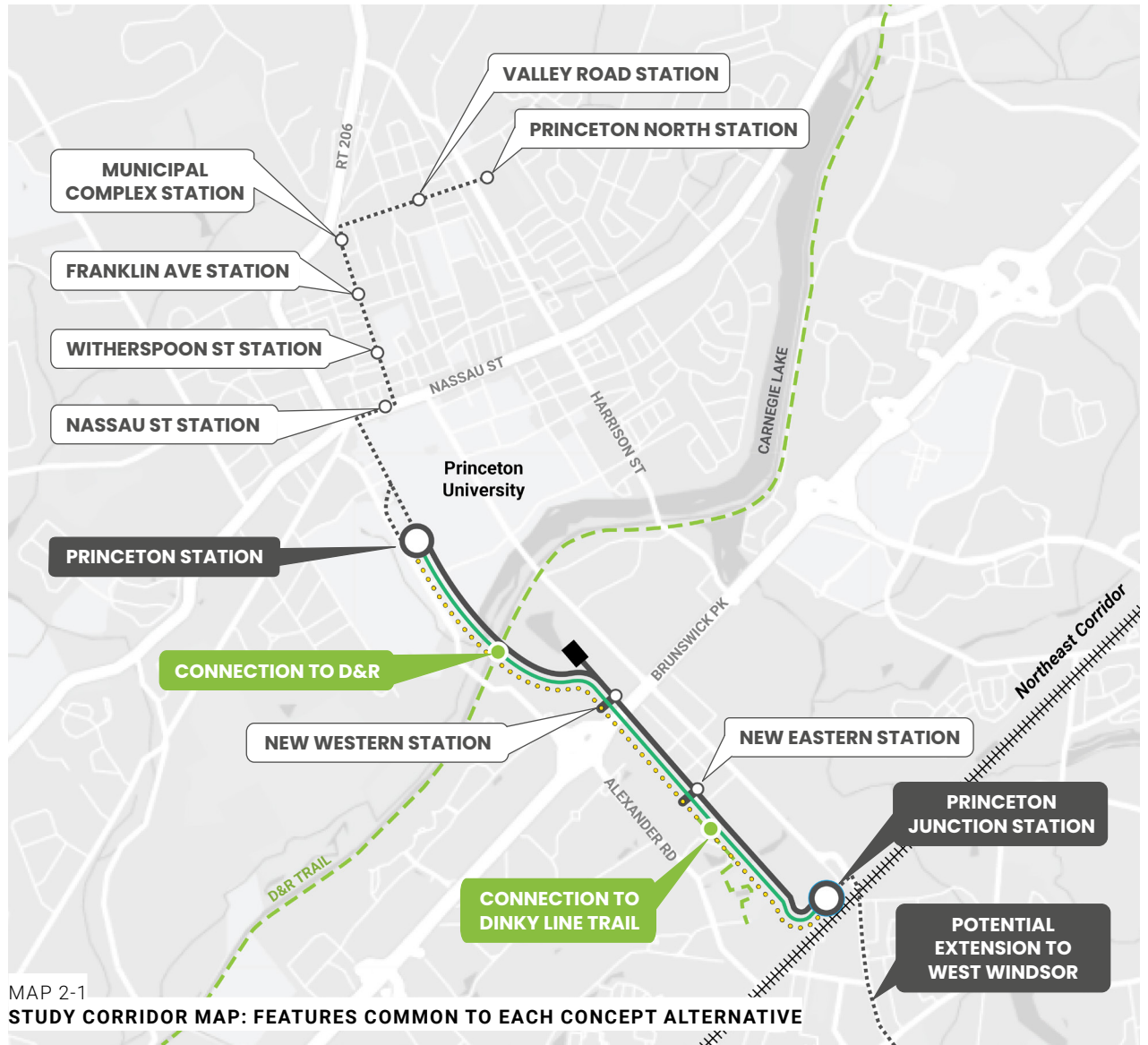
FIGURE 2-2  
TRANSITWAY CONCEPTS EVALUATION

### 1. ALL CONCEPT BUILD ALTERNATIVES

There are several features that are common to each of the concept Build alternatives, including active mode accommodations, potential new stations, as well as potential extensions into Princeton and West Windsor. **Map 2-1** depicts on the Study Corridor, the features that are common to each concept Build alternative. These features would not be present in the No Build alternative.

#### LEGEND

-  EXISTING DINKY ALIGNMENT
-  POTENTIAL NEW TRANSIT EXTENSION (RUBBER TIRE ONLY)
-  EXISTING REGIONAL TRAIL
-  POTENTIAL NEW BIKE/PED TRAIL
-  EXISTING STATION
-  POTENTIAL NEW STATION
-  POTENTIAL NEW MAINTENANCE FACILITY
-  CONNECTION TO REGIONAL TRAILS



## POTENTIAL EXTENSIONS TO PRINCETON AND WEST WINDSOR

Stakeholder and community/rider feedback received at the initial stages of this study made it clear that residents, employees, students, and visitors within the study area recognize that **the current service is not meeting their mobility needs and expectations**. As such, each of the concept Build alternatives include a potential extension of service into Princeton and West Windsor **via a rubber-tire vehicle that would be capable of traveling in mixed traffic as well as utilize the corridor to provide a one seat ride to/from the Princeton Junction station**. No extension of rail was considered.

There are a variety of potential methods and routes to extend service from the Princeton Branch, and the scope of this study could not accommodate an analysis of all potential options. The purpose of this study is to demonstrate how a potential extension of service would impact ridership and mobility along the Princeton Branch. Therefore, the project team focused on **identifying a potential route for extended service in Princeton** given the higher

densities, mix of uses, including institutions, as a demonstration of potential ridership and service impacts. The extension shown in **Map 2-1** is an example of what a **potential extension of service could look like and what impact it may have on overall transit operations and ridership**. It is meant to demonstrate a potential routing and is not intended to represent the final selected routing for the service, and further analysis in future phases of the project will be required to identify a final route.

## SERVICE FEATURES

The proposed route extension into Princeton is being analyzed as a rubber-tired service similar to bus rapid transit (BRT). No extension of rail is anticipated at this time. Furthermore, there is limited ROW along the project route; thus, it **is anticipated that the service would operate in mixed traffic**.

Features of the potential route extension include the following, and are also shown in **Figure 2-3**:

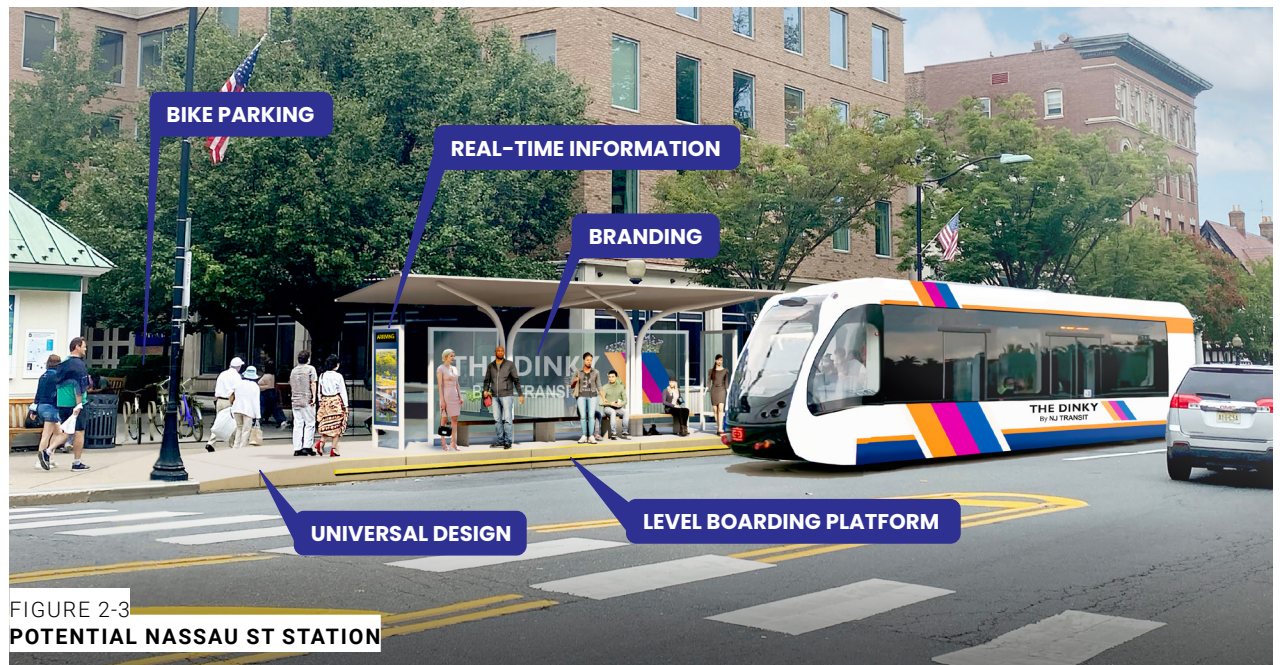


FIGURE 2-3  
POTENTIAL NASSAU ST STATION

- **Service branding:** Provides a recognizable format for stations and vehicles that makes the service more approachable for the casual rider and enhances visibility of the service.
- **Level boarding:** Provides ADA-compliant accessibility to/from the vehicles and shortens boarding and alighting times. Level boarding is typically achieved by raising the curb height at the station location.
- **On-board amenities:** Including WiFi, wide circulation areas for wheelchairs, fold-down priority seats for older or disabled passengers, automated visual and audio station announcements inside and outside the vehicle, etc.
- **Station amenities:** Including a universal design, shelter with seating area, branding, real-time transit arrival and departure information, micromobility charging, etc.

- **Direct service:** Vehicles would circulate on the route extension and then utilize the Princeton Branch corridor to provide direct service to and from the Princeton and Princeton Junction stations.
- **Electric powered vehicles with an attractive, modern design:** All vehicles analyzed in this study area were assumed to be electric powered to meet NJ TRANSIT electrification goals that are aligned with the Governor's Energy Master Plan, as well as to reduce emissions and vehicle noise. A modern vehicle design should also be considered so the service stands out and does not resemble a typical bus service.
- **Future transit technology innovations:** As vehicle technology continues to evolve, new applications for mass transit will become available for implementation. Flexibility to accommodate new technologies should be considered in future phases of this project.



FIGURE 2-4  
EXAMPLE OF LEVEL BOARDING (ADA COMPLIANT)

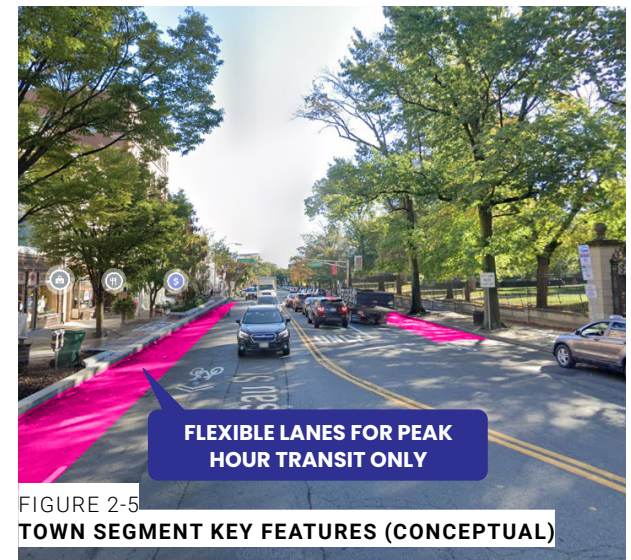


FIGURE 2-5  
TOWN SEGMENT KEY FEATURES (CONCEPTUAL)



- Transit priority treatments:** In order to facilitate safe and efficient operations through congested areas of the route, such as Nassau Street, transit priority signals could be considered at the intersections with Witherspoon Street and University Place. In addition, consideration could also be given to converting the on-street parking on Nassau Street between Witherspoon Street and University Place to peak-direction, peak-hour transit-only lanes (See **Map 2-2**). This would provide the opportunity for buses to receive priority through the congested Nassau Street corridor during typical weekday AM and PM peak hours while allowing the on-street parking to remain at all other times.
- High-frequency operations:** Providing headways of every 10 minutes or less during extended operating periods on weekdays (6:00 AM – 9:00 PM), Saturday (9:00 AM – 9:00 PM), and Sunday (10:00 AM – 6:00 PM).



**POTENTIAL NEW STATIONS ON THE PRINCETON BRANCH CORRIDOR AND OPPORTUNITIES FOR DEVELOPMENT**

The project team evaluated potential new station concepts based on existing and planned development, as well as the potential for future nearby development. As a result, two new potential station concepts were identified (See **Map 2-1** and **Map 2-3**):

- **A potential station on the west side of US 1 (New Western Station)** could provide improved transit access to the residences and office buildings **along Canal Pointe Boulevard, to the south**, as well as a potential access point to planned institutional growth **on the east side of Carnegie Lake, to the north**. Furthermore, potentially developable land exists in this area between Alexander Road and the Princeton Branch which could be utilized for a park-and-ride facility and/or development. A station in this area would also provide convenient access to US 1 to support additional connections to other transit routes.

- **A potential station to the east of US 1 (New Eastern Station)** could enhance transit access to the existing commercial uses **to the south of the Princeton Branch** as well as to the existing residential neighborhoods **on the north side of the Branch**. In addition, a station in this area could also provide additional development opportunities through infill of existing underutilized commercial uses along Alexander Road.



**MOBILITY ELEMENTS**

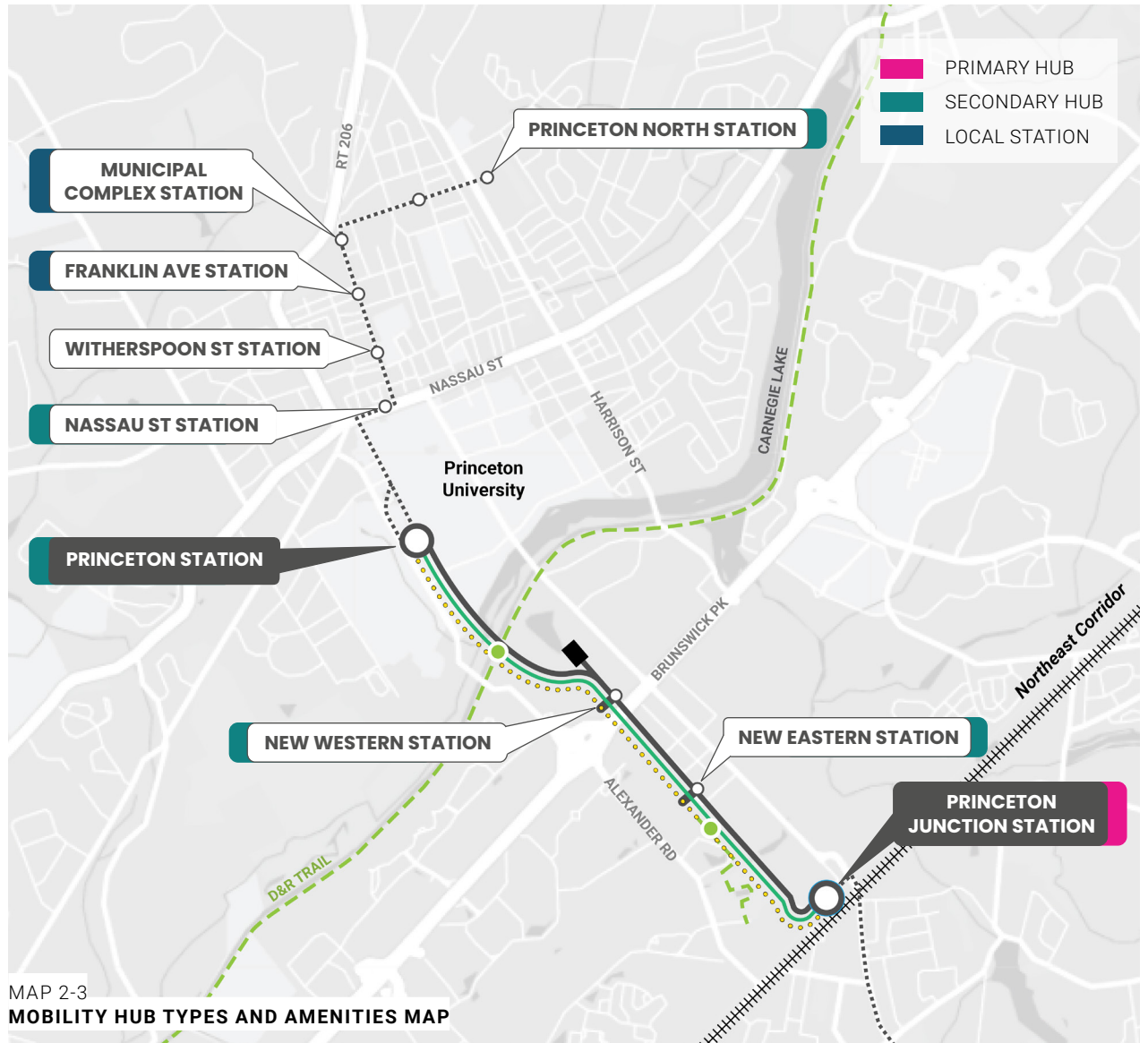
Enhancing overall mobility, particularly with active modes, was a goal that was established early in the planning process. The Princeton Branch corridor ROW is an important, but underutilized, transportation link. Incorporating consideration of mobility in and around Princeton and West Windsor could maximize the utilization of the ROW and also help to enhance transit ridership by providing more ways to access the corridor. Mobility elements incorporated into each concept alternative include:



- A proposed **parallel pedestrian and bicycle pathway along the Princeton Branch** between the Princeton and Princeton Junction stations with connections to the surrounding community via cross-streets, the D&R Canal Trail, and the Dinky Line Trail.
- Creation of **mobility hubs at stations where transit can interface with a variety of different modes**, including other transit services, transportation network companies (TNCs) like Uber and Lyft, and active modes (walking, biking, e-scooters, etc.). Components would include amenities such as bicycle and scooter parking, real-time departure and arrival information, charging stations, pump and tool stations, lockers, etc.

**LEGEND**

- EXISTING DINKY ALIGNMENT
- POTENTIAL NEW TRANSIT EXTENSION (RUBBER TIRE ONLY)
- POTENTIAL NEW BIKE/PED TRAIL
- EXISTING STATION
- POTENTIAL NEW STATION



- Providing **potential for parking intercepts for Downtown Princeton and the University** by encouraging visitors to use underutilized parking areas along the transitway corridor, such as at the Princeton Junction Station, as well as within the office parks on the north side of Alexander Road, which experience lower utilizations on evenings and weekends.
- **Utilization of LRT and BRT vehicles** that would allow for level boarding and include amenities such as on-board WiFi, wide circulation areas for wheelchairs, fold-down priority seats for older or disabled passengers, automated visual and audio station announcements inside and outside the vehicle, etc.
- **Vehicle designs that support the overall service branding** with a distinctive aesthetic, particularly for the BRT vehicles, that clearly separates the proposed transit service from a typical bus service.
- **Vehicles that use electric propulsion** and accommodate automation as the technology continues to advance and becomes available for safe use in regular, mixed-traffic operating conditions.

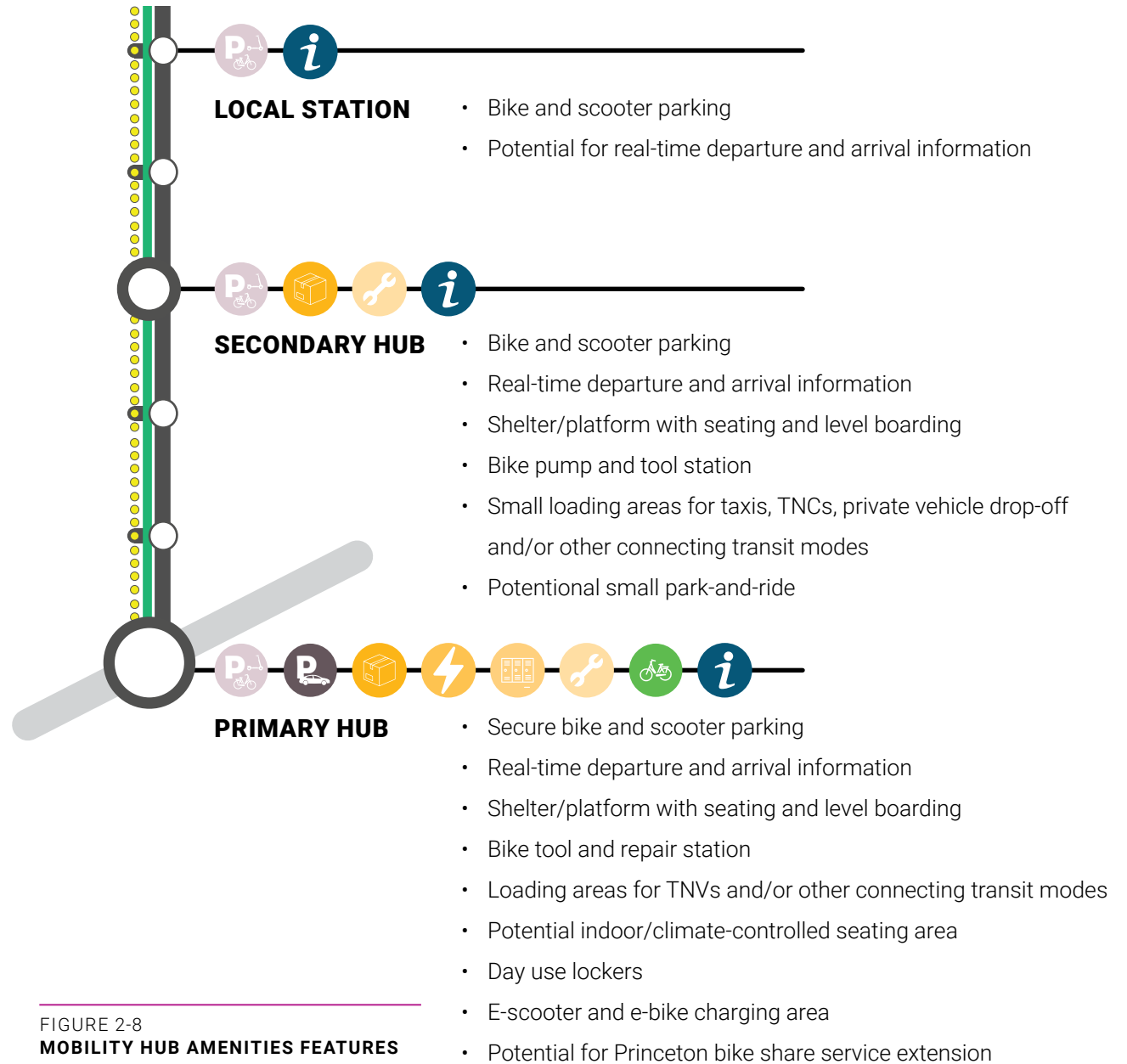


FIGURE 2-8  
MOBILITY HUB AMENITIES FEATURES

## 2. CONCEPT ALTERNATIVES

In order to evaluate the preliminary concept alternatives and select which should be advanced for further assessment, the project team developed a comparison matrix of each concept Build alternative as well as the No Build. A summary of the preliminary alternatives analysis is shown in **Table 2-1 (page 24-25)**. The analysis was then used to rank the concept alternatives for each metric based on a scale of 1 to 5 with 1 being low potential benefit/high negative impact, 3 being neutral (i.e., no change from existing), and 5 being high degree of potential improvement/low negative impact. The results of the scoring are shown in **Table 2-2 (page 26)**.

The results of the preliminary concept alternatives analysis indicate that all three concept build alternatives would enhance service on the corridor, provide opportunities for additional connections to the community, and support active modes by the inclusion of a pedestrian/bicycle path along the corridor.

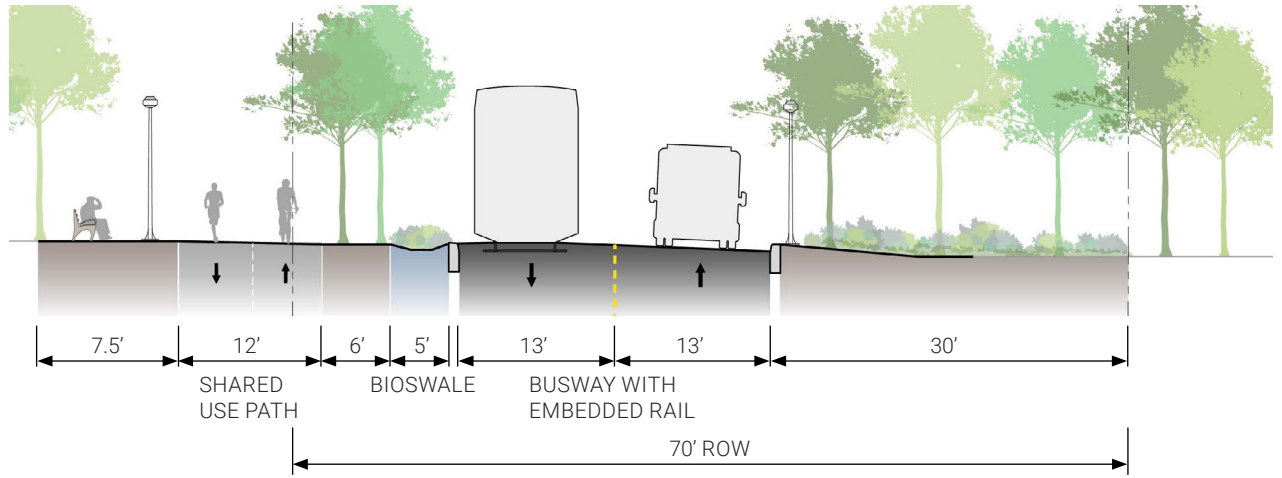


FIGURE 2-9  
EAST OF US 1 CROSS SECTION FOR ALTERNATIVE 1 (DEDICATED TRANSIT ROADWAY WITH LIGHT RAIL)

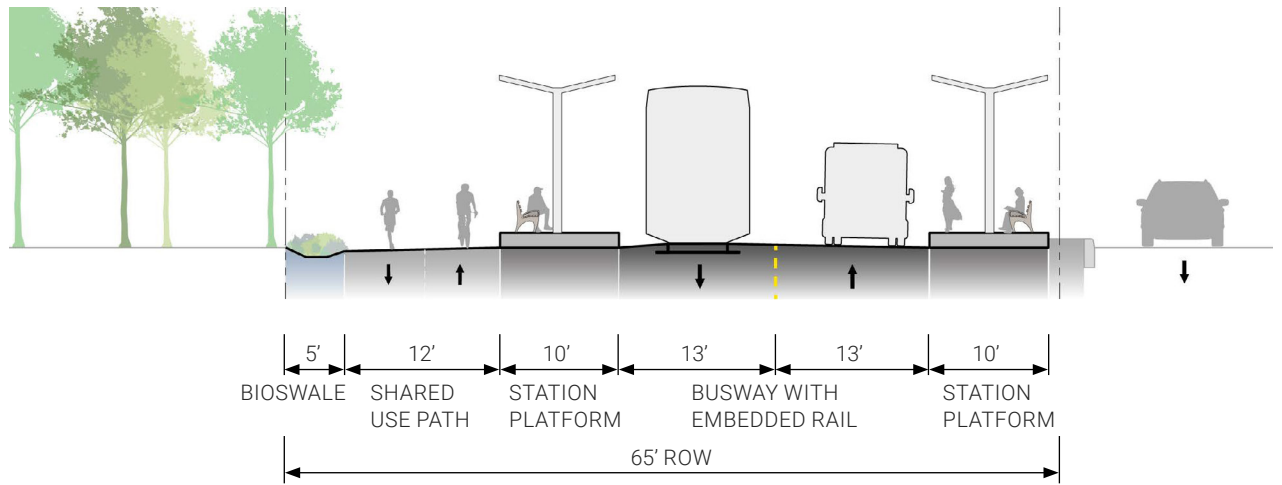


FIGURE 2-10  
CROSS SECTION FOR ALTERNATIVE 1 (DEDICATED TRANSIT ROADWAY WITH LIGHT RAIL) AT POTENTIAL NEW EASTERN STATION

<b>TABLE 2-1: SUMMARY OF PRELIMINARY CONCEPT ALTERNATIVE ANALYSIS</b>				
<b>EVALUATION FACTOR</b>	<b>ALTERNATIVE 1: DEDICATED TRANSIT ROADWAY WITH EMBEDDED RAIL</b>	<b>ALTERNATIVE 2: LIGHT RAIL WITH PARALLEL DEDICATED TRANSIT ROADWAY</b>	<b>ALTERNATIVE 3: DEDICTAED TRANSIT ROADWAY</b>	<b>ALTERNATIVE 4: NO BUILD</b>
<b>POTENTIAL PEAK PERIOD FREQUENCY</b>	6 -10 Minutes Combined LRT and BRT. Passing track allows for increased LRT frequency when compared to Alt 2.	8 to 12 Minutes Combined LRT and BRT. Single track limits LRT frequency as compared compared to Alt 1.	10 to 15 Minutes	30 Minutes
<b>ENHANCED COMMUNITY CONNECTIONS</b>	Enhanced connections to Princeton and West Windsor, two potential new stations on Princeton Branch, and overlaid transit modes.	Enhanced connections to Princeton and West Windsor, two potential new stations on Princeton Branch, and overlaid transit modes.	Enhanced connections to Princeton and West Windsor, two potential new stations on Princeton Branch, but only one transit mode.	No enhanced access or new stations and only one transit mode.
<b>EQUITY</b>	No negative impacts anticipated to vulnerable communities. Additional services would benefit areas in Princeton with low-auto ownership, and minority, senior, and low-income populations.			No negative impacts anticipated. No improvements anticipated.
<b>MOBILITY ACCESS</b>	Parallel ped/bike path, enhanced safety at intersections, and mobility hub amenities for last-mile connections.			Limited ped/bike improvements possible - complete streets on existing corridors.
<b>POTENTIAL ROW IMPACTS</b>	Minor impacts.	Significant impacts likely.	Minor impacts.	No impacts anticipated.

(Table continued on next page)

**TABLE 2-1: SUMMARY OF PRELIMINARY CONCEPT ALTERNATIVE ANALYSIS**

<b>EVALUATION FACTOR</b>	<b>ALTERNATIVE 1: DEDICATED TRANSIT ROADWAY WITH EMBEDDED RAIL</b>	<b>ALTERNATIVE 2: LIGHT RAIL WITH PARALLEL DEDICATED TRANSIT ROADWAY</b>	<b>ALTERNATIVE 3: DEDICTAED TRANSIT ROADWAY</b>	<b>ALTERNATIVE 4: NO BUILD</b>
<b>POTENTIAL ENVIRONMENTAL IMPACTS</b>	Moderate impacts anticipated primarily related to the additional impervious area/ storm water management needs.	Significant impacts likely due to substantial corridor widening around the DNR canal and Bear Brook areas.	Moderate impacts anticipated primarily related to the additional impervious area/ storm water management needs.	No impacts anticipated.
<b>POTENTIAL IMPACTS TO EXISTING TRANSIT</b>	Potential for improved interface with existing transit, ability for existing transit to use the proposed transit roadway, potential to reallocate transit resources.			No impacts anticipated.
<b>PRELIMINARY ORDER-OF-MAGNITUDE CAPITAL COST ESTIMATE</b>	\$190 M	\$230 M	\$160 M	\$37 M**
<b>STAKEHOLDER/ PUBLIC INPUT</b>	"Most preferred" by 48% of respondents.	"Most preferred" by 19% of respondents.	"Most preferred" by 13% of respondents.	"Most preferred" by 22% of respondents.

\* Cost includes fleet acquisition and capital costs for transitway and parallel ped/bike facility. \*\* Includes cost of refurbished Arrow III cars. However, it should be noted that no determination has been made at this point as to whether the Arrow III cars are capable of being refurbished. Additional analysis would be required to determine their future suitability.

<b>TABLE 2-2: CONCEPT ALTERNATIVE ANALYSIS COMPARISON</b>				
<b>EVALUATION FACTOR</b>	<b>ALTERNATIVE 1: DEDICATED TRANSIT ROADWAY WITH EMBEDDED RAIL</b>	<b>ALTERNATIVE 2: LIGHT RAIL WITH PARALLEL DEDICATED TRANSIT ROADWAY</b>	<b>ALTERNATIVE 3: DEDICTAED TRANSIT ROADWAY</b>	<b>ALTERNATIVE 4: NO BUILD</b>
<b>POTENTIAL PEAK PERIOD FREQUENCY</b>	5	4	3	1
<b>ENHANCED COMMUNITY CONNECTIONS</b>	5	5	5	1
<b>EQUITY</b>	4	4	4	3
<b>MOBILITY ACCESS</b>	5	5	5	2
<b>POTENTIAL ROW IMPACTS</b>	3	1	4	5
<b>POTENTIAL ENVIRONMENTAL IMPACTS</b>	3	1	3	5
<b>POTENTIAL IMPACTS TO EXISTING TRANSIT</b>	5	5	4	2
<b>PRELIMINARY CAPITAL COST ESTIMATE</b>	2	1	4	4
<b>STAKEHOLDER/ PUBLIC INPUT</b>	5	2	1	3
<b>TOTAL SCORE</b>	<b>37</b>	<b>28</b>	<b>33</b>	<b>26</b>

Each evaluation factor was given a score between 1 and 5, with 1 being low potential benefit/high negative impact, 3 being neutral (i.e., no change from existing), and 5 being high degree of potential improvement/low negative impact.



The substantially larger cross-section associated with **Alternative 2** introduces the potential for **significant ROW impacts**, particularly in West Windsor where residential property acquisition would likely be required, as well as environmental impacts in sensitive areas like the D&R Canal, Carnegie Lake/Stony Brook, and Bear Brook.

Furthermore, **Alternative 2** ranked 3rd in the public survey, with many survey respondents **concerned with the potential for residential property acquisitions**. Due to the potential ROW and environmental impacts as well as public feedback, **Alternative 2 is not recommended for further study**.

Additionally, **Alternative 3** was ranked as the **least preferred alternative** in the public survey.

The primary concerns of survey respondents were the **lower potential service frequencies and the discontinuation of rail service** associated with Alternative 3. Therefore, **Alternative 3 is not recommended for further study**.

Therefore, the evaluation indicates **Alternative 1** (Dedicated Transit Roadway with Embedded Light

Rail), and **Alternative 4** (No Build) **are best suited for further assessment**.

It should be noted that, despite its low ranking, a No Build alternative, Alternative 4, is required for all

EA/EIS processes. As such, the project team will refine Alternative 1 and conduct a more detailed assessment of impacts, permitting requirements, storm water management, operations, and cost.

**ALTERNATIVE 1**

DEDICATED TRANSIT ROADWAY WITH EMBEDDED LIGHT RAIL



**ALTERNATIVE 2**

LIGHT RAIL WITH PARALLEL DEDICATED TRANSIT ROADWAY



**ALTERNATIVE 3**

DEDICATED TRANSIT ROADWAY



**ALTERNATIVE 4**

NO BUILD



■ RANK 1 ■ RANK 2 ■ RANK 3 ■ RANK 4

FIGURE 2-11 MOST AND LEAST PREFERRED ALTERNATIVES RANKING COMPARISON BASED ON SURVEY RESULTS



**PREFERRED  
CONCEPT BUILD  
ALTERNATIVE**

**ALTERNATIVE 1 IN MORE DETAIL**..... 29  
ADDITIONAL ANALYSIS OF PREFERRED CONCEPT ALTERNATIVE..... 29

# ALTERNATIVE 1 IN MORE DETAIL

## ADDITIONAL ANALYSIS OF PREFERRED CONCEPT ALTERNATIVE



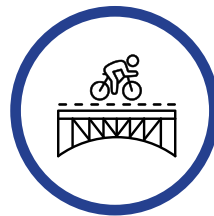
### ENVIRONMENTAL

- 459 SF Wetlands Impacts
- 0.51 Acres of Flood Hazard Area Impacts
- 0.56 Acres of Riparian Zone Impacts
- Requires Freshwater Wetlands and Flood Hazard Area individual permits



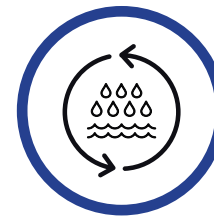
### CULTURAL/HISTORICAL

- No significant negative impacts
- New bridge structures at D&R Canal would have similar footprint
- Ped/bike path would require additional crossings but within Princeton Branch ROW
- Ped/bike path will enhance connections to D&R Canal Trail and Dinky Line Trail



### STRUCTURES

- Replace bridges over Stony Brook, D&R Canal, and Little Bear Brook
- Keep existing bridge over US 1 – one-way operation
- Separate bridges for ped/bike path (consider pre-fab when possible)
- 3,750 LF of new retaining walls



### STORMWATER MANAGEMENT

- 14.58 acres of new impervious surface (includes new P&R)
- D&R Canal Commission stringent stormwater requirements
- Bioswales and small basins along full length of corridor



### ROW/LAND USE

- Minor strip ROW adjustment may be required in undeveloped areas
- Opportunities for TOD/infill development along Alexander Road
- Would support infill and affordable housing in Princeton and West Windsor

FIGURE 3-1  
ALTERNATIVE 1 IMPACTS DIAGRAM

Based on the preliminary assessment of the early concept alternatives, it was determined that Alternative 1 (Dedicated Transit Roadway with Embedded Rail) as well as Alternative 4 (No Build) would be advanced for further study. Because Alternative 1 represents a significant potential change to the corridor, it was evaluated in more detail based on several key factors including:

- **Environment:** Alternative 1 would result in minor impacts to freshwater wetlands (459 SF), flood hazard area (0.51 acres), and riparian zone (0.56 acres), which would require freshwater wetlands and flood hazard area permits. These impacts are not anticipated to have an impact on project feasibility. Furthermore, additional high-quality transit services have been shown to reduce overall vehicle miles traveled (VMT) and related vehicle emissions, potentially enhancing air quality within the study area.
- **Structures:** Alternative 1 would require the replacement of the bridges over Stony Brook, the D&R Canal, and Little Bear Brook. In addition, approximately 3,750 LF of retaining wall

would be required along the Princeton Branch corridor for areas where there is not enough available undeveloped ROW to have a 2:1 slope to match existing adjacent topography and/or where there are environmentally sensitive areas, where slope construction would have a disproportionately negative impact.

- **Historical and Cultural Resources:** No significant negative impacts to historical and cultural resources are anticipated. The new bridge structures at Stony Brook and the D&R canal would have a similar footprint as the existing structures. However, the proposed



FIGURE 3-2  
POTENTIAL ROSZEL ROAD STATION (ALTERNATIVE 1)

pedestrian/bicycle path would require additional bridge structures within the Princeton Branch ROW. Despite this visual impact within the D&R canal area, the overall project will significantly enhance access to the D&R Canal Trail and the Dinky Line Trail.

- Stormwater Management:** The Delaware and Raritan Canal Commission (DRCC) has stringent requirements for stormwater management within the area of the D&R Canal. Therefore, every attempt should be made to utilize Green Infrastructure Best Management Practices (GI BMPs) along the corridor to provide more numerous, but smaller stormwater retention, infiltration, and treatment measures (swales and basins) rather than a few large-capacity facilities. Examples of areas that may be suitable for swales or basins, include the space between the proposed pedestrian/bicycle pathway and the transit roadway, as well as areas within the ROW on the north side of the proposed transit roadway (**Figure 3-3** and **Figure 3-4**).

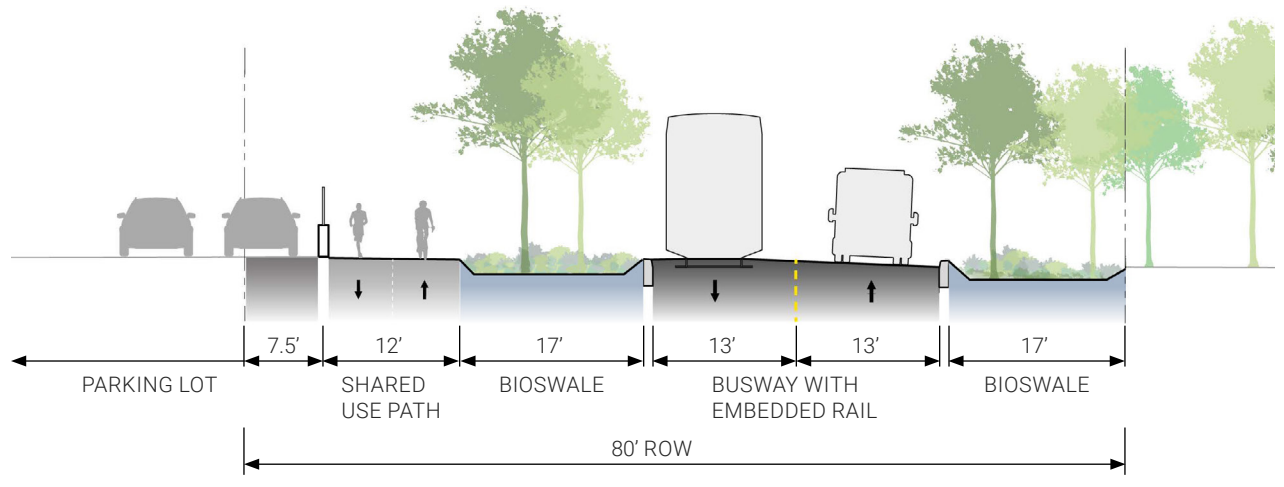


FIGURE 3-3  
**ALTERNATIVE 1 CROSS-SECTION EAST OF FACULTY ROAD WITH POTENTIAL BIOSWALES**

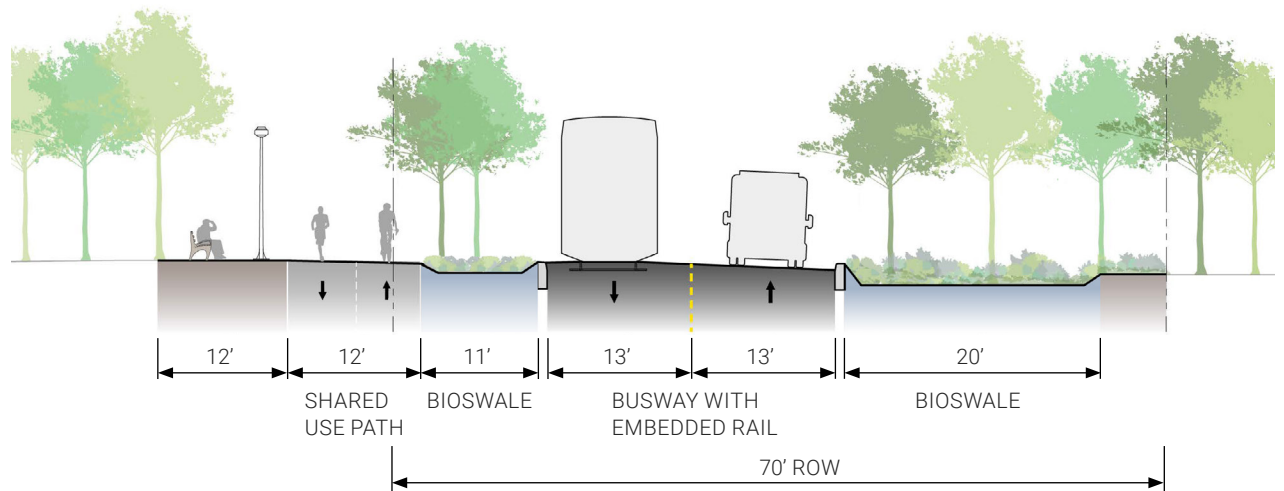


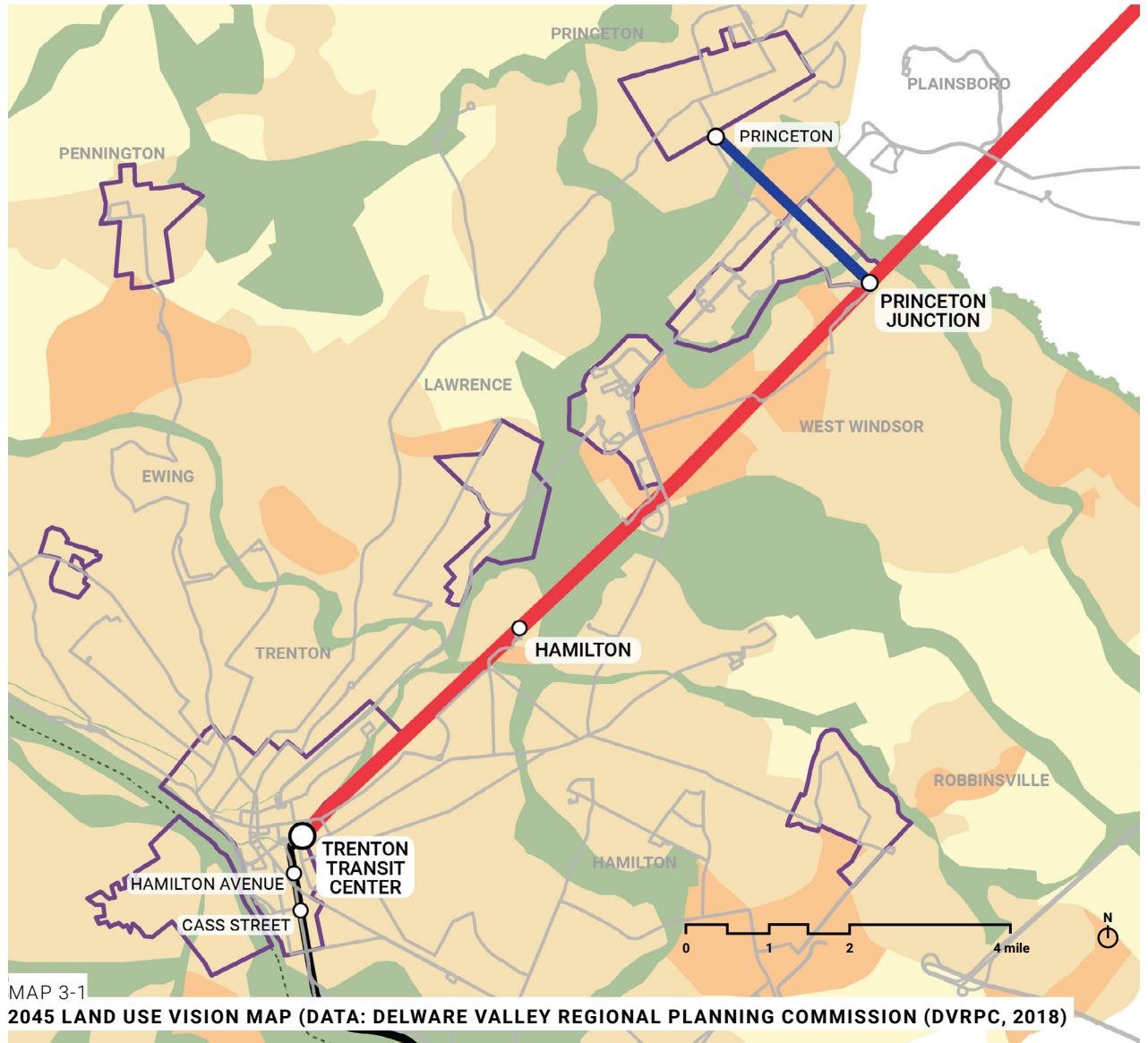
FIGURE 3-4  
**ALTERNATIVE 1 CROSS-SECTION EAST OF US1 WITH POTENTIAL BIOSWALES**

- ROW/Land Use:** Alternative 1 is anticipated to have no direct impact on existing land use because it does not require significant ROW takings that would impact adjacent properties. However, it does present the potential for future land use changes, particularly along the south side of the Princeton Branch corridor in the area of the potential new eastern and western stations, where there is vacant/underutilized land. Princeton and West Windsor may explore potential land-use changes and establish appropriate development zoning to support and encourage higher-density, transit-friendly uses near the stations. The proposed service extension into Downtown Princeton also provides the opportunity for development, as municipalities may seek to explore potential land use changes.

**CONNECTIONS 2045 PLAN**

**LAND USE VISION (DVRPC)**

- RURAL RESOURCE LANDS
- INFILL AND REDEVELOPMENT
- EMERGING GROWTH
- GREENSPACE NETWORK
- PLANNING CENTERS



- Operations:** The operation of Alternative 1 (i.e., frequency/headway and hours of service) is a critical component to understanding operational and maintenance (O&M) costs of the service as well as potential ridership. A variety of operational options were considered in this

study, and two options were evaluated in more detail. The tables below compare peak and off-peak headways, O&M cost, and ridership.

in a similar weekday ridership as Option A, but would have a lower overall O&M cost.

- Based on an assessment of both options, Option B is recommended as it would result

**TABLE 3-1: OPTION A - HEADWAYS AND RIDERSHIP**

BRT		LRT	
PEAK HEADWAYS	5 min	PEAK HEADWAYS	15 min
OFF-PEAK HEADWAYS	9 min	OFF-PEAK HEADWAYS	30 min
NUMBER OF PEAK VEHICLES REQUIRED	13	NUMBER OF PEAK VEHICLES REQUIRED	2
NUMBER OF OFF-PEAK VEHICLES REQUIRED	7	NUMBER OF OFF-PEAK VEHICLES REQUIRED	1
EST. CAPITAL COST OF FLEET*	\$17 M	EST. CAPITAL COST OF FLEET*	\$15 M
EST. ANNUAL FLEET O&M COST**	\$1.9 M	EST. ANNUAL FLEET O&M COST**	\$0.88 M
ESTIMATED WEEKDAY RIDERSHIP	1,905	ESTIMATED WEEKDAY RIDERSHIP	300
<b>ESTIMATED DAILY RIDERSHIP (TOTAL OF BOTH SERVICES)</b>		2,215	

\*Assumes one spare vehicle during peak periods. \*\*Cost of vehicle operating and maintenance costs only. Infrastructure O&M is not included because BRT and LRT will share ROW.

**TABLE 3-2: OPTION B - HEADWAYS AND RIDERSHIP**

BRT		LRT	
PEAK HEADWAYS	10 min	PEAK HEADWAYS	15 min
OFF-PEAK HEADWAYS	15 min	OFF-PEAK HEADWAYS	30 min
NUMBER OF PEAK VEHICLES REQUIRED	7	NUMBER OF PEAK VEHICLES REQUIRED	2
NUMBER OF OFF-PEAK VEHICLES REQUIRED	5	NUMBER OF OFF-PEAK VEHICLES REQUIRED	1
EST. CAPITAL COST OF FLEET*	\$10 M	EST. CAPITAL COST OF FLEET*	\$15 M
EST. ANNUAL FLEET O&M COST**	\$1.1 M	EST. ANNUAL FLEET O&M COST**	\$0.88 M
ESTIMATED WEEKDAY RIDERSHIP	1,570	ESTIMATED WEEKDAY RIDERSHIP	420
<b>ESTIMATED DAILY RIDERSHIP (TOTAL OF BOTH SERVICES)</b>		1,990	

\*Assumes one spare vehicle during peak periods. \*\*Cost of vehicle operating and maintenance costs only. Infrastructure O&M is not included because BRT and LRT will share ROW.



- **Cost:** An order-of-magnitude cost estimate was developed for Alternative 1 that considers the various components of the capital project costs (see Table 3-3). NJ TRANSIT is supportive of bicycle & pedestrian access to the Transitway as well as a parallel pathway, and has taken steps to advance early conceptual design for the pathway, with the expectation that local partners will be able to advance the pathway through design and construction.

**TABLE 3-3: ALTERNATIVE 1 ORDER OF MAGNITUDE COST ESTIMATE BREAKDOWN**

FACILITY	ITEM	ESTIMATED ORDER OF MAGNITUDE COST
<b>TRANSITWAY</b>	Construction	\$65 M
	Environmental	\$3 M
	Right-of-Way	\$13 M
	Design and Administration	\$19 M
	<b>Total</b>	<b>\$100 M</b>
<b>FLEET</b>	BRT Vehicles	\$25 M
	LRT Vehicles	\$20 M
	<b>Total</b>	<b>\$45 M</b>
<b>PARALLEL PEDESTRIAN/BICYCLE PATHWAY</b>	Construction	\$26 M
	Environmental	\$2 M
	Right-of-Way	\$9 M
	Design and Administration	\$8 M
	<b>Total</b>	<b>\$45 M</b>

# IV NEXT STEPS

RECOMMENDATIONS AND NEXT STEPS ..... 37

# RECOMMENDATIONS AND NEXT STEPS

Based on analysis of Alternatives 1 and 4 presented in the sections above, it is recommended that Alternative 1 be advanced as the initially preferred concept alternative. Alternative 1 would substantially enhance mobility and access to transit in Princeton and West Windsor, increase ridership, enhance active modes, and would minimize negative impacts to ROW, the environment, and historical and cultural resources.

The Princeton Transitway Study is a preliminary concept alternative study that is the first step in the project delivery process. The timing of subsequent study phases is not known at this time. However, the next step would be to advance Alternative 1 to preliminary design and complete the required environmental documentation, either an Environmental Assessment or Environmental Impact Statement.

Furthermore, as the project advances, NJ TRANSIT will need to further collaborate with Mercer County, the municipalities and local stakeholders to begin planning pedestrian/bicycle enhancement projects to connect to the proposed pedestrian and bicycle pathway as well as establishing TOD-supportive zoning along the Princeton Branch corridor.

