



MEMORANDUM

To: James J. Purcell, PE, PMP *Assistant Municipal Engineer*
From: Pete Kremer, AICP, PP *Senior Associate, Michael Baker International*
Subject: Harrison Street Corridor Study – Summary of Proposed Treatments
Date: May 29th, 2024

Introduction

The Harrison Street Corridor Study was initiated by the Municipality of Princeton to identify safety and mobility issues for all road users and develop strategies to improve multimodal mobility and safety along Harrison Street. As one of just three primary north-south corridors in Princeton, Harrison Street is an essential multimodal mobility corridor that serves both local and regional through-travel needs. Harrison Street changes context, land use, and cross-section width several times along the 2.5-mile study area and serves a variety of trip purposes, and a diversity of travel modes and vehicle types, including cyclists, pedestrians, and various vulnerable roadway users.

This document is intended to provide an overview of the treatments recommended throughout the corridor. Recommendations are organized by location, starting with the D&R Canal Towpath crossing in the south and ending with the U.S. 206 intersection in the north. Each key intersection and segment are explored. Recommended treatments or changes to the roadway are based on an evaluation of crash data, traffic data and modeling, and geometric considerations such as available road width and right-of-way. The changes recommended will be approved only after receiving input from the public.

When discussing recommended safety countermeasures, a Crash Modification Factor (CMF) or Crash Reduction Factor (CRF) will be provided. CMFs and CRFs are values used to indicate the expected reduction in the number of crashes after implementing a proposed treatment. CMFs are calculated based on historical safety studies and are documented by the FHWA via the CMF Clearinghouse website. A CMF of 0.85, for example, means the location would be expected to experience 85% of the previous total number of crashes. Conversely, a CRF is equal to the expected reduction in crashes expressed as a ratio. In the example, the CRF would be 0.15 due to the expected reduction of crashes by 15%.

South Harrison Street is under Mercer County jurisdiction between US Route 1 and a point 100 feet south of Western Way – any improvements along this portion of the corridor will require approval of the County. Recommended improvements at and beyond the municipal boundary at the D&R Canal will be subject to the approval of West Windsor Township and NJDOT, which has jurisdiction of the canal bridge. Other agencies, such as New Jersey State Parks and the State Historic Preservation Office, will also need to be consulted where the improvements are related to the D&R Canal Towpath. These jurisdictions are noted in the following recommendations.

The proposed treatments are presented in three sections:

- Intersection and Segment Locations – Proposed Treatments
- Bicycle Network – Proposed Treatments and Alignments
- Bike Facility Investigation – Between Franklin Avenue and Terhune Road



Summary of Proposed Treatments

Municipality of Princeton – Harrison Street Corridor Study

I. Intersection and Segment Locations – Proposed Treatments

1. Segment and Intersection: D&R Canal Towpath Crossing (MP 0.65) (Mercer County ROW)

a. Gateway treatment

- i. Together the various treatments proposed at the D&R Canal Towpath Crossing comprise a Gateway into the municipality, including signs, traffic calming, RRFB, lighting, etc. The purpose of the “Gateway” is to gain driver attention and announce that they are entering a new context with new traffic regulation by changing the look and function of the roadway context, and make clear that driver behavior will need to adjust to this new context – drive slower, be more attentive, and stop or yield accordingly to other roadway users. The gateway treatment, including official Princeton / “Welcome to Princeton” signs, will usher drivers into Princeton and clearly establish that the nature of the roadway has changed – which is critical as drivers coming from U.S. 1 who may still be in a “highway” mindset.

b. Install Transverse (Thermoplastic) Rumble Strips on the northbound approach in advance of the towpath crossing, after the Nursery Road intersection. (West Windsor Township, NJDOT) and also in the southbound direction.

- i. MUTCD approved design to alert drivers to the need to slow or stop:

Section 3K.02 Transverse Rumble Strip Markings

Transverse rumble strips consist of intermittent narrow, transverse areas of rough-textured or slightly raised or depressed road surface that extend across the travel lanes to alert drivers to unusual vehicular traffic conditions. Through noise and vibration, they attract the attention of road users to features such as unexpected changes in alignment and conditions requiring a reduction in speed or a stop.

c. Install centerline and edge line rumble strips to keep drivers in the travel lane and encourage appropriate travel speeds. (West Windsor Township, NJDOT)

- i. MUTCD approved design to alert drivers to slow or stop:

Section 3K.01 Longitudinal Rumble Strip Markings

Longitudinal rumble strips consist of a series of rough-textured or slightly raised or depressed road surfaces intended to alert inattentive drivers through vibration and sound that their vehicle has left the travel lane. Shoulder rumble strips are typically installed along the shoulder near the travel lane. On divided highways, rumble strips are sometimes installed on the median side (left-hand side) shoulder as well as on the outside (right-hand side) shoulder. On two-way roadways, rumble strips are sometimes installed along the center line (Figure 1).



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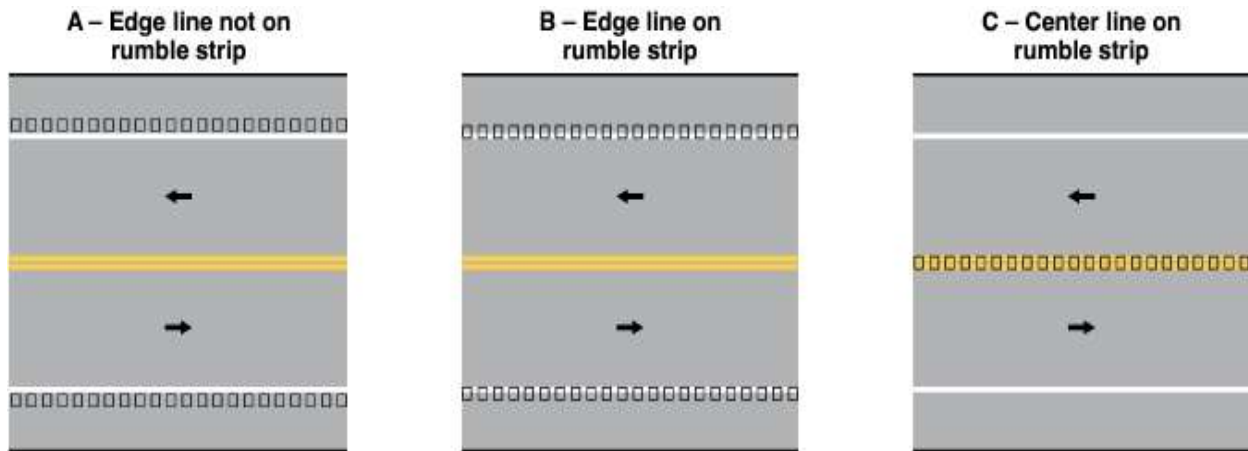


Figure 1: Rumble Strip Treatments
(Source: safety.fhwa.dot.gov)

- d. **The resulting lane width should be 11 feet.**
 - i. The current lane width is approximately 12-13 feet, which encourages higher operating speeds.
 - ii. The total cross-section width is 35 feet at the D&R Canal Towpath, meaning that crossing pedestrians and cyclists are exposed to traffic for longer than necessary.
- e. **Upgrade current flasher to RRFB.**
 - i. While the existing flasher is appropriate for a trail crossing, upgrading to a full RRFB would improve driver yielding and may reduce instances of rear end crashes at the trail crossing.
 - ii. Limited sight-distance, measured traffic speeds, and crash history are significant factors that merit an upgrade from the current design.
- f. **Install high visibility crosswalk and signs.**
 - i. The existing crosswalk is faded, and visibility does not stand out against the current paving. Installing highly reflective crosswalk markings would improve visibility for pedestrians and motorists. Crosswalks can be installed as a standalone feature or in combination with other crossing enhancements including lighting and signing, as shown in **Figure 2**.
 - ii. Along the horizontal curve leading up to the trail crossing, consider installing advanced warning signage, such as flashing LED border-enhanced pedestrian/bicycle sign (W11-15) with AHEAD sign (W16-9P). Flashing LED warning signs are visible from 1,000 feet away. LED signs are activated via pedestrian push buttons and flash only when a bike or pedestrian is present.
 - iii. MUTCD approved design to alert drivers to yield to bikes and pedestrian.



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Figure 2: Advanced Warning Sign (W11-15A & W11-15P)
(Source: Wikimedia)

- g. **Install curb extensions on both sides to shorten the crossing distance and reduce vehicle operating speeds.**
- h. **Improve street lighting at crossing subject to NJ State Parks & State Historic Preservation Office (SHPO) review and approval.**
 - i. Existing crossing has no lighting. Installing an overhead streetlight or pedestrian scale lighting at the crosswalk would improve visibility for pedestrians and motorists during the dawn and dusk hours where lighting is poor and the trail is likely to be in use.
 - ii. $CMF = 0.679$ | $CRF = 0.321$
 - 1. [Improve Street Lighting Illuminance and Uniformity](#)
- 2. **Segment: D&R Canal Towpath to Hartley Avenue (both directions) (MP 0.65 – 0.33) (Mercer County ROW; includes bridge over Lake Carnegie).**
 - a. **Install High Friction Surface Treatment (HFST).**
 - i. The steep grade in the southbound direction from Hartley Avenue to the D&R Canal Towpath Crossing has resulted in a number of rear end crashes within this stretch. HFST may mitigate crash occurrence by reducing vehicle stopping distances.
 - ii. HFST should be installed on southbound Harrison Street on approach to the D&R Canal Towpath crosswalk.
 - iii. $CMF = .80$
 - 1. [FHWA Proven Safety Countermeasures - Pavement Friction Management](#)



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- b. **Install Transverse (Thermoplastic) Rumble Strips on the bridge (concrete surface) decking over Lake Carnegie (for design details see above).**
 - i. Transverse rumble strips are recommended as a traffic calming measure to reduce operating speeds.
- c. **Install ADA-compliant curb ramps.**
 - i. Existing curb ramps at side street intersections between the D&R Canal Towpath and Hartley Avenue are not ADA-compliant.
- d. **Investigate Reduced Lane Width on bridge, in coordination with Mercer County.**
 - i. Reducing the lane width using striping could slow drivers and provide additional space for a bicycle facility; this alternative must be undertaken in coordination with Mercer County for this County-owned bridge.
- e. **Bicycle-Pedestrian accommodations on bridge over Lake Carnegie in coordination with Mercer County (two alternatives).**
 - i. **Alternative 1 (Recommended): Install Sharrows on bridge (retains existing roadway shoulder).**
 - 1. Continue sharrows from Harrison Street on the structure, extending to the D&R Canal Towpath.
 - 2. Requires striping of crosswalk just north of the bridge to provide connection to dedicated bicycle facility (see Section II for corridor-wide bicycle facility details).
 - 3. Minimal cost and engineering design effort required; can be installed with paint alone.
 - ii. **Alternative 2 (Future Vision for Bridge): Reconfigure bridge cross-section (approximately 36-ft) through widening of sidewalk to provide dedicated 8.5-ft wide two-way bicycle-pedestrian sidepath on bridge. Alternative 2 is displayed in Figure 3.**
 - 1. Reduce shoulders to 1-foot width to create opportunity for ~8.5-ft wide two-way bicycle-pedestrian shared-use sidepath, fully protected from travel lanes.
 - 2. Add 3+ ft wide raised sidewalk plus barrier/railing.
 - 3. Examination of bridge condition indicates sufficient load capacity for poured concrete extension of existing raised sidewalk on bridge, in addition to good bridge surface condition.
 - 4. Bridge currently includes at least 8 existing drainage scuppers; these would need to be incorporated into a new raised concrete sidepath to maintain existing bridge drainage capacity.
 - 5. This proposed poured concrete sidewalk extension is anticipated to require environmental review and permitting and structural engineering design of bridge deck reconstruction.



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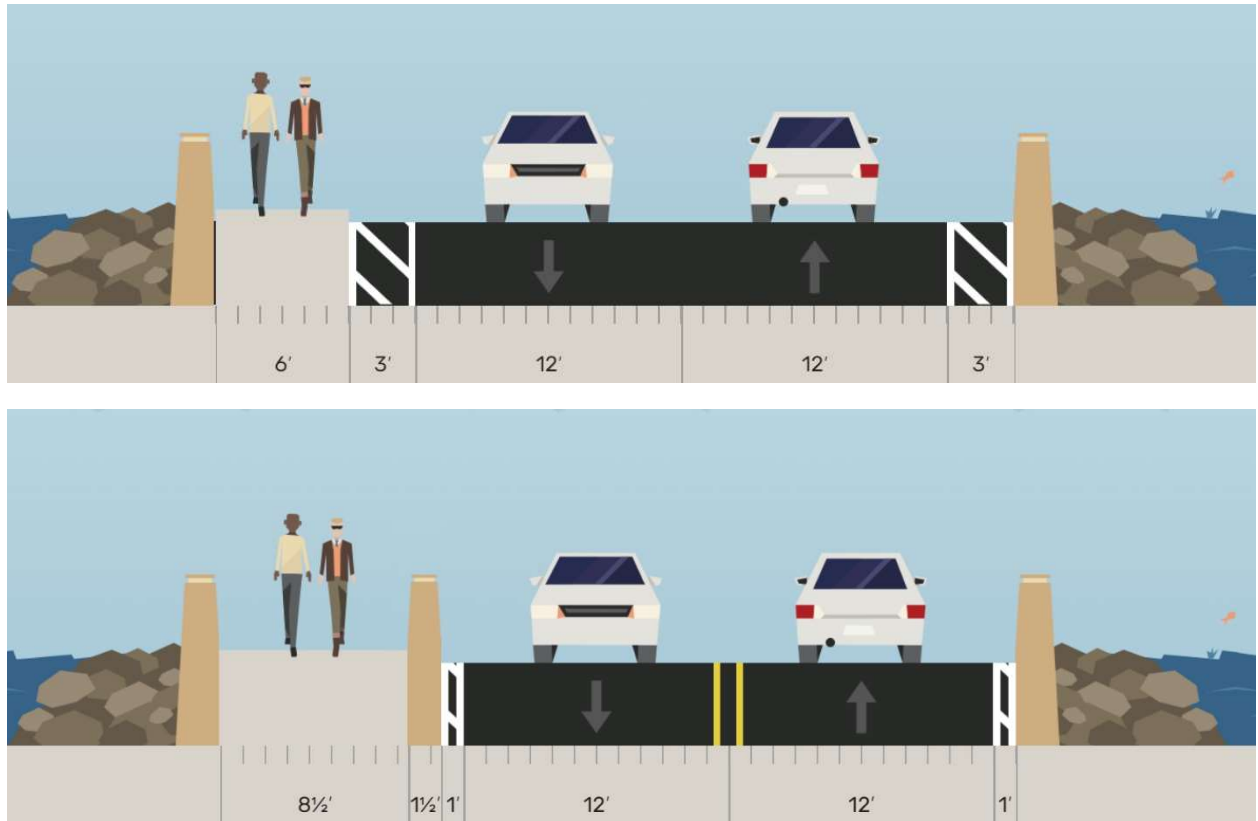


Figure 3: Existing bridge configuration (top) and proposed Alternative 2 (bottom) for the Bridge over Lake Carnegie.

3. Intersection: Hartley Avenue (MP 0.33)

- a. **Harrison Street at the Hartley Avenue intersection is under Mercer County jurisdiction and Hartley Avenue is a private road under Princeton University jurisdiction. Any proposed improvements will require coordination with County and Princeton University officials.**
- b. **Upgrade to 12" signal heads, if feasible.**
 - i. Existing signal heads are 8", to improve signal head visibility they should be increased to 12" on all approaches. This section of Harrison Street was found to be a high-crash location.
- c. **Improve street lighting at the Hartley Avenue intersection.**
 - i. The Hartley Avenue intersection is currently illuminated by a single utility-pole mounted light fixture. Adding additional lighting would improve visibility and safety during low-light conditions.
 - ii. CMF = 0.679
 1. [Improve Street Lighting Illuminance and Uniformity](#)



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d. Implement Leading Pedestrian Interval (LPIs).

- i. Implement LPIs during pedestrian crossing phases across Harrison Street. LPIs provide pedestrians 3-7 seconds to begin crossing prior to the start of the corresponding vehicle phase. By initiating the pedestrian crossing phase prior to the start of the vehicular movement, pedestrians are able to establish their presence in the crosswalk and reinforce their right-of-way.
- ii. CMF = 0.90 | CRF = 0.10
 1. [Modify Signal Phasing \(Implement a Leading Pedestrian Interval\)](#)

e. Install ADA-compliant curb ramps.

f. Install retroreflective backplates.

- i. Install retroreflective backplates to improve signal visibility and driver compliance.
- ii. Due to their impact on wind loads on mast arms, retroreflective backplates should be installed in the future, when existing aluminum mast arms are eventually replaced with steel. Steel mast arms are capable of handling the increased loading from the backplates. The signal is under Mercer County jurisdiction, thus the County is responsible for replacement of existing equipment.
- iii. CMF = 0.85 | CRF = 0.15
 1. [Add 3-inch Yellow Retroreflective Sheeting to Signal Backplates](#)

g. Prohibit right turn on red.

- i. Prohibit right turn on red on all approaches to the Hartley Avenue intersection.
- ii. CMF = 0.98^{Number of Approaches for which RTOR is prohibited} (all crash types except Bicycle and Pedestrian)
 1. [Prohibit Right-Turn-On-Red](#)

4. Segment: Hartley Avenue to Prospect Avenue (MP 0.33 – 0.04¹)

- a. **Harrison Street is under Mercer County jurisdiction between the municipal boundary with West Windsor and a point approximately 100' north of Western Way. Any proposed improvements will require coordination with County officials.**
- b. **Install curb extension in southbound direction at Western Way to protect on-street parking from parked vehicle crash strikes.**
 - i. On-street parking along southbound Harrison Street between Western Way & Hartley Avenue experiences Parked Vehicle crash strikes. The proposed curb extension alignment forces through-traffic away from the parking spaces, encourages slower speeds, and provide protection for the parked vehicles, reducing the Parked Vehicle crashes experienced through this section. Figure 4 depicts the existing condition.

¹ The Mile Posts on Harrison Street change about 0.04 miles south of the Prospect Avenue intersection, where the roadway jurisdiction changes from Mercer County to the Municipality of Princeton. At this location, Mile Posts start increasing going north.



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Existing Condition

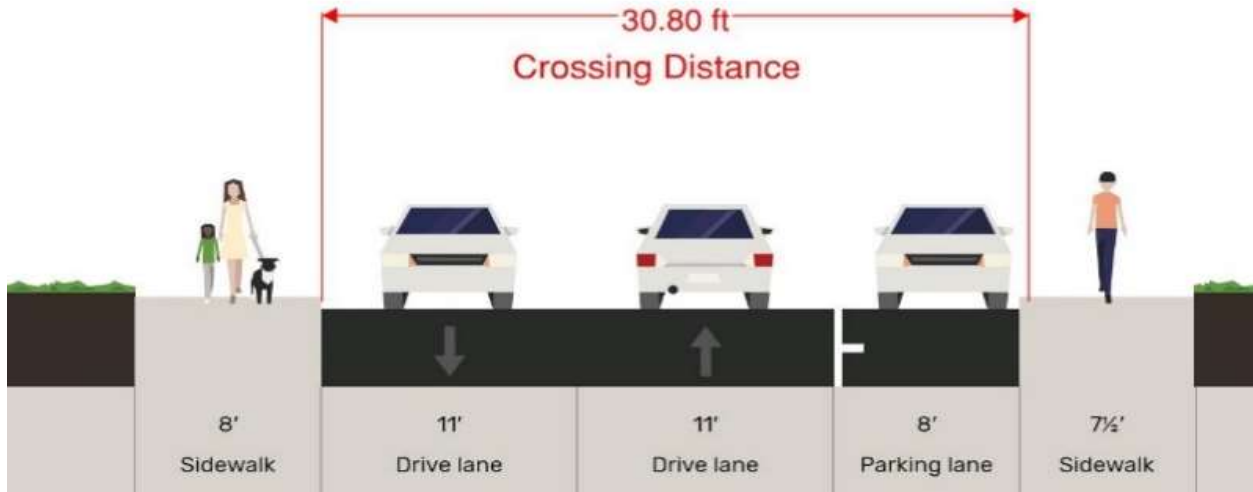


Figure 4: Typical Section - Existing Condition between Western Way and Hartley Avenue (Southbound direction)
(Source: streetmix.net)

- ii. The proposed curb extension and protected parking are shown in **Figure 5**.



Figure 5: Example of Curb Extension at Parking Lane

c. Install ADA-compliant curb ramps.

- i. Existing curb ramps at side street intersections between Hartley Avenue and Prospect Avenue are not ADA-compliant. Reconstruct curb ramps to be compliant.



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5. Intersection: Prospect Avenue (MP 0.04)

a. **Convert to roundabout.**

- i. The Prospect Avenue intersection experienced 13 crashes (including 4 Right Angle crashes) between 2016 and 2020. Modern roundabouts are FHWA Proven Safety Countermeasures and have been demonstrated to decrease right angle crashes (and injury crashes overall).
- ii. The roundabout can also slow traffic to posted speeds in this segment with high recorded travel speeds.
- iii. Installation of the proposed roundabout at this location will require sidewalks and curb ramps to be reconstructed. Newly constructed pedestrian facilities will be ADA-compliant.
- iv. CMF = 0.37 (Fatal & Injury crashes only)
 1. [Convert Signalized Intersection to Modern Roundabout](#)
- v. CMF = 0.76 (All crash severities)
 1. [Convert Signalized Intersection to Modern Roundabout](#)

b. **Improve street lighting at the Prospect Avenue intersection.**

- i. The Prospect Avenue intersection is currently illuminated by a single utility-pole mounted light fixture. Adding additional lighting would improve visibility and safety during low-light conditions.
- ii. CMF = 0.679 | CRF = 0.321
 1. [Improve Street Lighting Illuminance and Uniformity](#)

6. Segment: Prospect Avenue to Nassau Street (NJ 27) (MP 0.04 – 0.28)

a. **Install RRFB at the pedestrian crossing from the Harrison Street Park to Sergeant Street.**

- i. CMF = 0.31 | CRF = 0.69 (vehicle/pedestrian crashes only)
 1. [Install Rectangular Rapid Flashing Beacon \(RRFB\)](#)
- ii. A multi-use path in Harrison Street Park exits to South Harrison Street with a crosswalk to Sergeant Street. The Sergeant Street intersection experiences a high-volume of crossing pedestrians and cyclists accessing the park. To improve safety at this busy intersection for pedestrians and cyclists, an RRFB should be installed to enable safer crossing of Harrison Street.

b. **Improve street lighting at crossing.**

- i. Existing crossing has no overhead lighting. Installing an overhead streetlight or ped-scale lighting at the crosswalk would improve visibility for pedestrians and motorists during the dawn and dusk hours where lighting is poor and the trail is likely to be in use.
- ii. CMF = 0.679 | CRF = 0.321
 1. [Improve Street Lighting Illuminance and Uniformity](#)

c. **Install ADA-compliant curb ramps.**

- i. Existing curb ramps at side street intersections between Prospect Avenue and Nassau Street (NJ 27) are not ADA-compliant. Reconstruct curb ramps where necessary.



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7. Intersection: Nassau Street (NJ 27) (MP 0.28)

- a. **Intersection under NJDOT jurisdiction. Recommended improvements will require coordination with NJDOT prior to approval.**
- b. **Improve lighting at the Nassau Street (NJ 27) intersection.**
 - i. The intersection is currently illuminated by a single utility-pole mounted light fixture at the intersection and a standalone light pole on the southbound approach. Additional lighting would improve visibility and safety during low-light conditions.
 - ii. CMF = 0.679 | CRF = 0.321
 1. [Improve Street Lighting Illuminance and Uniformity](#)
- c. **Install HFST on all approaches to the Nassau Street (NJ 27) intersection.**
 - i. A safe systems approach to reducing roadway safety risk dictates that roadway design should attempt to account for human error. As a high-crash location, reducing stopping distances and impact speeds is critical to reducing crash frequency and severity at the Nassau Street (NJ 27) intersection. While the intersection is a non-traditional location to install HFST, it is appropriate, given its high speeds, volumes, and crash history. According to FHWA, HFST *is applicable* on intersection approaches at high-volume locations².

8. Segment: Nassau Street (NJ 27) to Hamilton Avenue (MP 0.28 – 0.52)

- a. **Install mountable median (similar to those on Mercer Street and Hodge Road) at two locations and delineate 11-foot lanes with edge line striping on both sides of Harrison Street at Mershon Drive.**
 - i. The first mountable median should be installed between Mershon Drive and Spruce Circle. The second mountable median should be installed between Spruce Circle and the approach to Hamilton Avenue. Full turns movements between Mershon and Harrison, and Spruce Circle and Harrison will still be available. Public input is required prior to any decision being made regarding the installation of mountable median along Harrison Street.
 1. These treatments keep drivers in the travel lane, encourage appropriate travel speeds, taking up the excess pavement without moving the curbs and sidewalks.
 - ii. Nassau Street (NJ 27) to Ewing Street is a crash hot spot; experiencing approximately 60 crashes between 2016 and 2020. Downhill grade and wide, un-marked travel lanes encourage high travel speeds and aggressive driving behaviors on approach to intersection at Hamilton Avenue.
- b. **Replace, repair, and widen sidewalk and sidepaths.**
 - i. Widen sidewalks at existing bus stops to the curb lines to improve boarding and alighting.
- c. **Install ADA-compliant curb ramps.**

² Applicable locations for installation of High Friction Surface Treatment is discussed in FHWA's presentation: High Friction Surface Treatment (HFST) Quick Reference, slide 5. This slide specifies that intersection approaches are an applicable location due to the high-level of "friction demand." <https://www.fhwa.dot.gov/publications/research/safety/highfriction/High-Friction-Surface-Treatment-final.pdf>



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- i. Existing curb ramps at side street intersections between Nassau Street (NJ 27) and Hamilton Avenue are not ADA-compliant. Reconstruct curb ramps to be compliant.

9. **Intersection: Hamilton Avenue (MP 0.52)**

a. **Improve street lighting at the Hamilton Avenue intersection.**

- i. The Hamilton Avenue intersection is currently illuminated by a single utility-pole mounted light fixture. Adding additional lighting would improve visibility and safety during low-light conditions.
- ii. CMF = 0.679 | CRF = 0.321
 1. [Improve Street Lighting Illuminance and Uniformity](#)

b. **Implement Leading Pedestrian Interval (LPIs).**

- i. Implement LPIs during pedestrian crossing phases across Harrison Street. LPIs provide pedestrians 3-7 seconds to begin crossing prior to the start of the corresponding vehicle phase. By initiating the pedestrian crossing phase prior to the start of the vehicular movement, pedestrians are able to establish their presence in the crosswalk and reinforce their right-of-way.
- ii. CMF = 0.90 | CRF = 0.10
 1. [Modify Signal Phasing \(Implement a Leading Pedestrian Interval\)](#)
- iii. Additionally, the feasibility of implementing pedestrian recall for the Harrison Street phases at the Hamilton Avenue intersection was evaluated. Implementing pedestrian recall at the Hamilton Avenue intersection would mean adjusting the signal timing to automatically include a pedestrian crossing phase during every cycle that runs concurrently with the Harrison Street phase. Introducing pedestrian recall may improve safety for pedestrians by reducing the delay they experience when waiting to cross, this could decrease the frequency of pedestrians crossing without the right-of-way.

Ultimately, it was determined that introducing pedestrian recall at this intersection was not appropriate. There are two issues with the introduction of pedestrian recall. The first, is that the pedestrian signal and push button have an auditory component that emits during every pedestrian crossing phase. Currently, the auditory signal only emits when a pedestrian presses the push button. If pedestrian recall were implemented, the auditory signal would emit during all hours of the day and night, potentially disturbing nearby residents. To mitigate this potential nuisance, the pedestrian signal would either need to be silenced (not preferred) or be adjusted to only emit when a pedestrian presses the push button. The feasibility of the latter is unknown since it would mean that only emitting the auditory crossing message during some pedestrian crossing phases (i.e. when pedestrians press the push button). Currently, it is unknown if the pedestrian signal controller has this capability. Determining whether this was feasible requires coordination with the manufacturer of the push button to evaluate this approach. The second issue with the introduction of pedestrian recall would not meet pedestrian expectancy. Introducing pedestrian recall could subvert pedestrian expectations and create additional complexity in the pedestrian network.

c. **Install retroreflective backplates.**

- i. Install retroreflective backplates to improve signal visibility and driver compliance.



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- ii. Due to their impact on wind loads on mast arms, retroreflective backplates should be installed in the future, if existing aluminum mast arms and poles are eventually replaced with steel. Steel mast arms are capable of handling the increased loading from the backplates.
- iii. In the short term, Princeton could replace the existing black signal head housings, with yellow housings, which are more visually conspicuous.
- iv. $CMF = 0.85$ | $CRF = 0.15$
 - 1. [Add 3-inch Yellow Retroreflective Sheeting to Signal Backplates](#)

d. **Prohibit right turn on red.**

- i. Prohibit right turn on red on all approaches to the Hamilton Avenue intersection. Currently, right turn on red is only prohibited on the southbound and eastbound approaches.
- ii. $CMF = 0.98$ ^{Number of Approaches for which RTOR is prohibited} (all crash types except Bicycle and Pedestrian)
 - 1. [Prohibit Right-Turn-On-Red](#)

10. **Segment: Hamilton Avenue to Franklin Avenue (MP 0.52 – 0.70)**

- a. **Install mountable median design (similar to those on Mercer Street and Hodge Road) and delineate 11-foot lanes with edge line striping on both sides of Harrison Street at Hawthorne Avenue where existing pavement is covered by striped gore area.**
 - i. Downhill grade and wide, un-marked travel lanes encourage high travel speeds and aggressive driving behaviors on approach to intersection at Hamilton Avenue.
 - 1. These treatments keep drivers in the travel lane, encourage appropriate travel speeds, taking up the excess pavement without moving the curbs and sidewalks or interfering with driveway access.
- b. **Install ADA-compliant curb ramps.**
 - i. Some existing curb ramps at side street intersections between Hamilton Avenue and Franklin Avenue are not ADA-compliant. Reconstruct curb ramps to be compliant.

11. **Intersection: Franklin Avenue (MP 0.70)**

- a. **Improve street lighting at the Franklin Avenue intersection.**
 - i. The Franklin Avenue intersection is currently illuminated by a single utility-pole mounted light fixture. Adding additional lighting would improve visibility and safety during low-light conditions.
 - ii. $CMF = 0.679$ | $CRF = 0.321$
 - 1. [Improve Street Lighting Illuminance and Uniformity](#)
- b. **Install retroreflective backplates.**
 - i. Install retroreflective backplates to improve signal visibility and driver compliance.
 - ii. Due to their impact on wind loads on mast arms, retroreflective backplates should be installed in the future, if existing aluminum mast arms are eventually replaced with steel. Steel mast arms are capable of handling the increased loading from the backplates.



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- iii. In the short term, Princeton could replace the existing black signal head housings, with yellow housings, which are more visually conspicuous.
- iv. CMF = 0.85 | CRF = 0.15
 - 1. [Add 3-inch Yellow Retroreflective Sheeting to Signal Backplates](#)
- c. **Implement Leading Pedestrian Interval (LPIs).**
 - i. Implement LPIs during pedestrian crossing phases across Harrison Street. LPIs provide pedestrians 3-7 seconds to begin crossing prior to the start of the corresponding vehicle phase. By initiating the pedestrian crossing phase prior to the start of the vehicular movement, pedestrians are able to establish their presence in the crosswalk and reinforce their right-of-way.
 - ii. CMF = 0.90 | CRF = 0.10
 - 1. [Modify Signal Phasing \(Implement a Leading Pedestrian Interval\)](#)
- d. **Prohibit right turn on red.**
 - i. Prohibit right turn on red on all approaches to the Hamilton Avenue intersection.
 - ii. CMF = 0.98^{Number of Approaches for which RTOR is prohibited} (all crash types except Bicycle and Pedestrian)
 - 1. [Prohibit Right-Turn-On-Red](#)
- e. **Terminate proposed bike facilities and connect to bike boulevard on Franklin Avenue.**
 - i. Franklin Avenue is the southern terminus of the road diet on Harrison Street and will require the proposed bike lanes (one bike lane on each side of the street) in this case adjacent to the shopping center) to transition to an on-street facility. Franklin Avenue is a designated bicycle boulevard and the proposed bike facilities on Harrison Street will be designed to connect to Franklin Avenue.

12. Segment: Franklin Avenue to Valley Road (MP 0.70 – 1.10)

- a. **Road Diet of Harrison Street, continue to Valley Road and Terhune Road.**
 - i. Diet to a single thru lane in each direction starting at the Franklin Avenue intersection. The existing Harrison Street 4-lane cross section at the Princeton Shopping Center is shown in Figure 6.



Figure 6: Typical Section - Existing Condition (Looking Northbound)

- b. **Widen sidewalk (5-ft min.; 6-ft des.) on northbound side. Install sidewalk along southbound Harrison Street where sidewalk is currently missing.**



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- i. Widen sidewalks at existing bus stops to the curb lines to improve boarding and alighting or provide bus turnouts.
- c. **Install bike facilities: Raised Bicycle Lanes & Wide Sidewalks (Option 1A). One bike lane on either side of Harrison Street, separated from the road by curb (Figure 7). The bike lanes will be adjacent to sidewalk on both sides of the roadway (Figure 6). At driveways, carry bicycle lane and sidewalk through at ‘sidewalk level’; turning vehicles traverse driveway curb apron and are brought up to bike-ped level.**
 - i. CMF = 0.694 | CRF = 0.306
 - 1. [Install Bicycle Lanes](#)
 - ii. For a further discussion of investigated Bicycle Facilities see Report Section: *III. Bike Facility Investigation – Between Franklin Avenue and Terhune Road*.
 - iii. For a discussion of quick build alternative options for bicycle facility implementation, avoiding long-term construction costs and impacts, see Section III.



Figure 7: Typical Section – Option 1A: On-street One-way Separated Bicycle Lanes (Looking Northbound)

- d. **Bike facility transition to sharrows at Clearview Avenue (existing condition at Clearview Avenue to the south of bicycle facility).**
 - i. The proposed bike lane on either side of the roadway allows for an easy transition to a shared lane, or sharrows that currently exist on the road network from Clearview Avenue to the D&R Canal. “Bicycles Allowed Use of Full Lane” Sign (R9-20) should be installed to alert all road users of the shared road condition, as shown in Figure 8.



Figure 8: Bicycles Allowed Use of Full Lane Sign (R9-20) (Source: MUTCD)



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- e. Install truck apron and shared bicycle turn lane at future Walgreens driveway, as shown in Figure 9 and 10.
 - i. A mountable truck apron is suitable at the future Walgreens driveway to provide traffic calming for turning vehicles. A ~2-inch raised concrete island apron is mountable by trucks, but traversal by passenger vehicles is deterred, thereby reducing the overall driveway width, and consequently the speed of turning vehicles, and improving driver yield behavior.
 - ii. Dedicated right-turn lane into Walgreens parking lot should be maintained with combined turn and bike lane markings as shown in Figure 9.

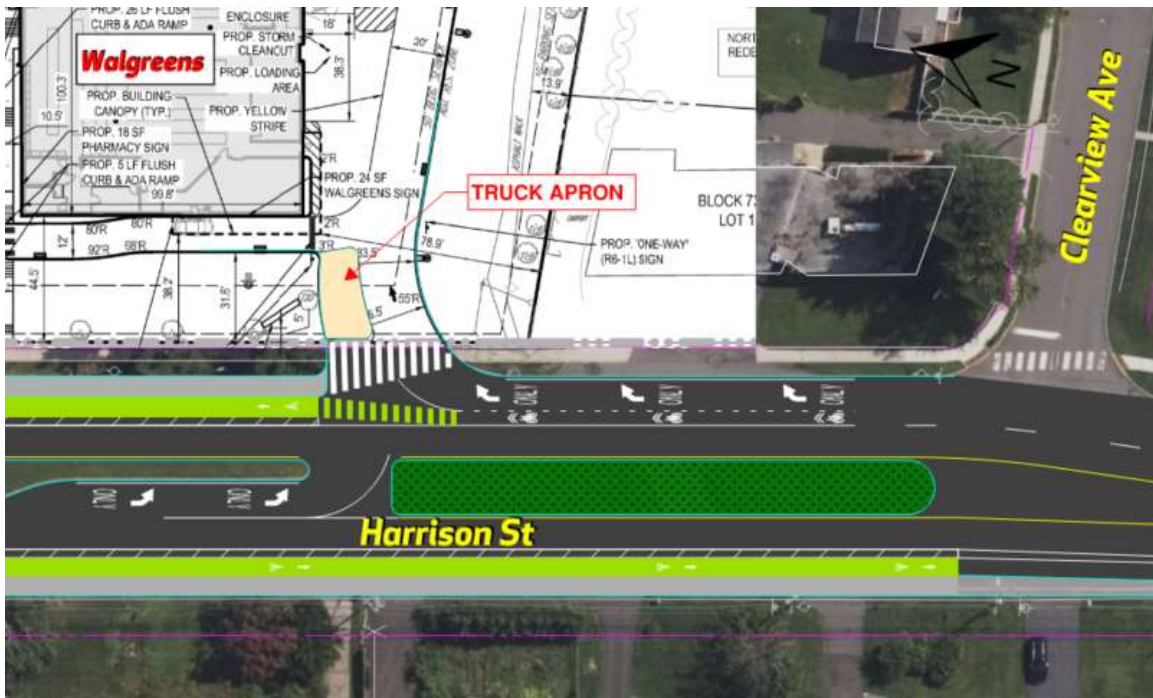


Figure 9: Truck Apron design at future Walgreens driveway. Note that the accompanying bicycle facility may be on-street (as shown) or raised, per the preferred recommendation.



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Figure 10: Combined Bike and Turn Lane Example (Source: NACTO)

13. Intersection: Valley Road (MP 1.10)

a. Accommodate road diet.

- i. The road diet alignment requires a reduction of travel lanes on Harrison Street from five lanes to three lanes. The dieted configuration would provide a single through lane and left turn only lane in each direction on Harrison Street. If dieted, the Valley Road intersection could remain in its signalized arrangement or be converted to roundabouts as shown in Figure 11.

b. Convert to roundabout.

- i. The Valley Road intersection experienced 15 Right Angle crashes between 2016 and 2020 – more than half of the crashes that occurred at the intersection over the five-year period. Modern roundabouts are FHWA Proven Safety Countermeasures and have been demonstrated to decrease right angle crashes (and injury crashes overall).
- ii. The proposed roundabout would include shared-use paths wide enough (8 feet) to accommodate cyclists and pedestrians. Allowing both user groups to navigate the intersection.
- iii. CMF = 0.37 (Fatal & Injury crashes only) | CRF = 0.63
 1. [Convert Signalized Intersection to Modern Roundabout](#)
- iv. CMF = 0.76 (All crash severities) | CRF = 0.24
 1. [Convert Signalized Intersection to Modern Roundabout](#)



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- c. **Bike facility transitions at roundabouts.**
 - i. Bike ramps upstream and downstream of roundabout allow bikes to transition from dedicated bicycle facilities to sidepaths, and allow bikes to navigate the roundabout separated from vehicles, as shown in Figure 12.



Figure 11: Roundabout Concept at Valley Road



Figure 12: Bike lane transition on roundabouts (Source: Left - FHWA 22041; Right - Google Earth)



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Municipality of Princeton – Harrison Street Corridor Study

14. Segment: Valley Road to Terhune Road (MP 1.10 – 1.23)

- a. **Continue Road diet alignment from Valley Road to Terhune Road**
 - i. Continue the proposed Harrison Street road diet to Terhune Road.
 - ii. Road diet alignment feeds directly to/from the proposed Terhune Road roundabout.
- b. **Continue the bicycle lanes from Valley Road to Terhune Road.**
 - i. Install separated bike lanes and provide bike crossing pavement markings at intersections and commercial driveways.
 - ii. CMF = 0.694 | CRF = 0.306
 1. [Install Bicycle Lanes](#)
 2. See Item 12.c. above and related Figure 12 for design details and recommended configuration.

15. Intersection: Terhune Road (MP 1.23)

- a. **Accommodate road diet.**
 - i. The road diet alignment requires a reduction of travel lanes on Harrison Street from five lanes to three lanes. The dieted configuration would provide a single through lane and left turn only lane in each direction on Harrison Street. If dieted, the Terhune Road intersection could remain in its signalized arrangement or be converted to roundabout as shown in Figure 11.
- b. **Terminate Harrison Street bike facilities at Terhune Road; provide interconnect to proposed bike lanes on Terhune Road.**
 - i. Terhune Road is the northern terminus of the road diet on Harrison Street and will require the proposed protected bike lanes alignment. Current plans for the developments along Terhune Road call for a bicycle lane to be installed along the road, east of the Harrison Street intersection. The proposed bicycle facilities on Harrison Street will be designed to provide a safe connection to the proposed bicycle lanes on Terhune Road to bolster the network of safe bike facilities in Princeton.
- c. **Convert to roundabout.**
 - i. While the existing intersection has limited crash history (five Right Angle crashes over five years), conversion to a roundabout would help reduce vehicle speeds and would pair well with the conversion to a roundabout at Valley Road and Bunn Drive.
 - ii. CMF = 0.37 (Fatal & Injury crashes only)
 1. [Convert Signalized Intersection to Modern Roundabout](#)
 - iii. CMF = 0.76 (All crash severities)
 1. [Convert Signalized Intersection to Modern Roundabout](#)

16. Segment: Terhune Road to Bunn Drive (MP 1.23 – 1.42)

- a. **Construct sidewalk along southbound (western) side of Harrison Street.**
 - i. At the Bunn Drive intersection and continuing south, southbound Harrison Street Install sidewalk along the southbound (western) side of Harrison Street.



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17. Intersection: Bunn Drive (MP 1.42)

a. **Convert to roundabout.**

- i. The Bunn Drive intersection has skewed geometry and large channelized right turn lanes that encourage high travel speeds for turning vehicles. Conversion to a modern roundabout design could reduce vehicle speeds to a level consistent with local context including residential areas and charter school location, while still maintaining an adequate LOS. Additionally, conversion of the Bunn Drive intersection to a roundabout would pair well with the proposed roundabouts at Terhune Road and Valley Road.
- ii. CMF = 0.37 (Fatal & Injury crashes only)
 1. [Convert Signalized Intersection to Modern Roundabout](#)
- iii. CMF = .76 (All crash severities)
 1. [Convert Signalized Intersection to Modern Roundabout](#)

18. Segment: Bunn Drive to Mount Lucas Road (MP 1.42 – 1.71)

a. **Construct sidewalk along the southbound side of Ewing Street, between Bunn Drive and Mt. Lucas Road. Potential right-of-way and utility impacts.**

- i. Constructing sidewalk between Bunn Drive and Mt. Lucas Road will eliminate a gap in the sidewalk network, improving multimodal connectivity. Completing the sidewalk network will help ensure that the Harrison Street corridor is a Complete Street.
- ii. Installing sidewalk along southbound Ewing Street between Bunn Drive and Mt. Lucas Road will require ROW and utility impacts that may be prohibitive. Any decision to construct sidewalk within this portion of the road should only be made after public input is received.

19. Intersection: Mount Lucas Road (MP 1.71)

a. **Consider HFST on EB Ewing Street approach to intersection.**

- i. EB Ewing Street on approach to the Mt. Lucas Road intersection possesses a downward grade that could lengthen stopping distances and encourage higher speeds. To mitigate these issues, the installation of HFST should be considered on the EB approach to the intersection.
- ii. CMF = .80 | CRF = 0.20
 1. [FHWA Proven Safety Countermeasures - Pavement Friction Management](#)

b. **Install retroreflective backplates.**

- i. Install retroreflective backplates to improve signal visibility and driver compliance.
- ii. Due to their impact on wind loads on mast arms, retroreflective backplates should be installed in the future, if existing aluminum mast arms are eventually replaced with steel. Steel mast arms are capable of handling the increased loading from the backplates.
- iii. CMF = 0.85 | CRF = 0.15
 1. [Add 3-inch Yellow Retroreflective Sheeting to Signal Backplates](#)

c. **Prohibit right turn on red.**

- i. Prohibit right turn on red on all approaches to the Mt. Lucas Road intersection.
- ii. CMF = 0.98^{Number of Approaches for which RTOR is prohibited} (all crash types except Bicycle and Pedestrian)



Summary of Proposed Treatments

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1. [Prohibit Right-Turn-On-Red](#)
- d. **Improve street lighting at the Mount Lucas Road intersection.**
 - i. The Mount Lucas Road intersection is currently illuminated by a single utility-pole mounted light fixture. Adding additional lighting would improve visibility and safety during low-light conditions.
 - ii. CMF = 0.679 | CRF = 0.321
 1. [Improve Street Lighting Illuminance and Uniformity](#)

20. Segment: Mount Lucas Road to U.S. 206 (MP 1.71 – 1.87)

- a. **Construct sidewalk along the southbound side of Ewing Street, between Mount Lucas Road and U.S. 206.**
 - i. Constructing sidewalk between Mount Lucas Road and U.S. 206 will eliminate a gap in the sidewalk network, improving multimodal connectivity. Completing the sidewalk network will help ensure that the Harrison Street corridor is a Complete Street.
 - ii. Land use along Ewing Street within this portion of the corridor is only along the southbound side of the road. If sidewalk is constructed, it should be along the southbound side, where it is likely to serve the most users.

21. Intersection: U.S. 206 (MP 1.87)

- a. **Intersection under NJDOT jurisdiction. Recommended improvements will require coordination with NJDOT prior to approval.**
- b. **Signalize intersection, currently stop-controlled at Ewing Street terminus (Figure 13). The new signal should have 12" LED signal heads and retroreflective backplates.**
 - i. The U.S. 206 & Ewing Street intersection meets Traffic Signal Warrant 1 (Condition B) and 2, the Eight-Hour and Four-Hour Vehicular Volume.
 - ii. The US 206 and Ewing Street intersection experienced 20 crashes between 2016 and 2020. Of these crashes, one resulted in serious injuries, and two resulted in possible injuries. Six (6) Right Angle crashes occurred during the five-year period. The proposed traffic signal could reduce these crashes.
 - iii. CMF = 0.639 | CRF = 0.361
 1. [Install a Traffic Signal](#)



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- iv. Due to the horizontal curvature of US 206, north of the Ewing Street & U.S. 206 intersection, sight distance requirements may not be met through the installation of a signal alone. To avoid introducing sight distance issues with the installation of the proposed signal, it is recommended that a flashing “Red Signal Ahead” sign be installed on the southbound approach of U.S. 206, approximately 250’ north of the intersection.



*Figure 13: Traffic Signal Concept at U.S. 206 and Ewing Road
(Source: Michael Baker International, Inc.)*



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II. Bicycle Network – Proposed Treatments and Alignments

Many segments of Harrison Street are narrow, have on-street parking, high recorded traffic volumes and/or speeds, etc, making it problematic for a continuous low-stress bicycle lane along its alignment.

Figure 14 depicts the existing bicycle facilities in the Harrison Street study area. These are currently limited to the D&R Canal Towpath and bicycle boulevard segments, including:

- D&R Canal Towpath
- Spruce Street from Linden Lane to Moore Street
- Grove Avenue from Terhune Road to Franklin Avenue
- Franklin Avenue from Grove Avenue to Walnut Lane
- Walnut Lane from Franklin Avenue to Guyot Lane
- Guyot Lane from Walnut Lane to Ewing Street
- Ewing Street from Guyot Lane to Franklin Avenue

The proposed continuous bicycle facility alignment starting at the D&R Canal crossing includes the following (Figure 15):

- Provide enhanced visibility, traffic calming, safety at the D&R Canal crossing
- Crossing of county bridge over Lake Carnegie via Sharrows in lane
- Off-street trail/multiuse path (permeable surface) adjacent to Lake Carnegie (University-owned property) between South Harrison Street and Lake Lane
- Bicycle boulevard on Lake Lane to Broadmead (University-owned roads)
- Continue bicycle boulevard along Broadmead up to Nassau Street. At the Western Way intersection, road jurisdiction changes from Princeton University to Municipal. At Prospect Avenue, Broadmead becomes Princeton Avenue.
- A short segment along Nassau Street from Princeton Avenue to Linden Lane; this would be an appropriate use of Sharrow design (approx. 335 feet long)
- Continue bicycle boulevard along Linden Lane, crossing Spruce Street (existing bicycle boulevard) and Hamilton Avenue (proposed bicycle lane) up to Franklin Street (existing bicycle boulevard)
- Existing bicycle boulevard along Franklin Avenue from Linden Lane to Harrison Street
- Connect to proposed protected bike lanes on Harrison Street from Franklin Avenue to Terhune Road (proposed bicycle lane)



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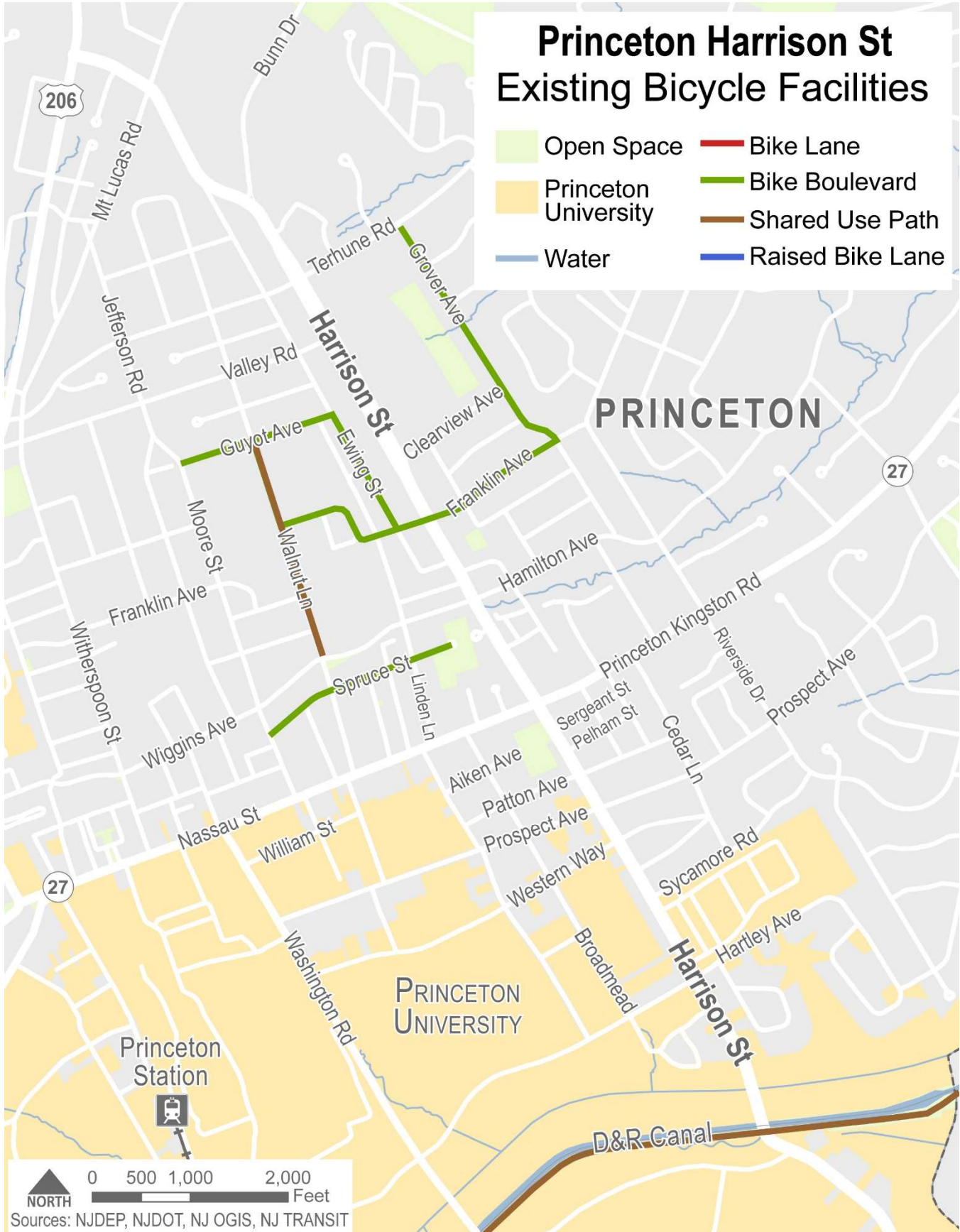


Figure 14: Existing Bicycle Facilities



Summary of Proposed Treatments

Municipality of Princeton – Harrison Street Corridor Study

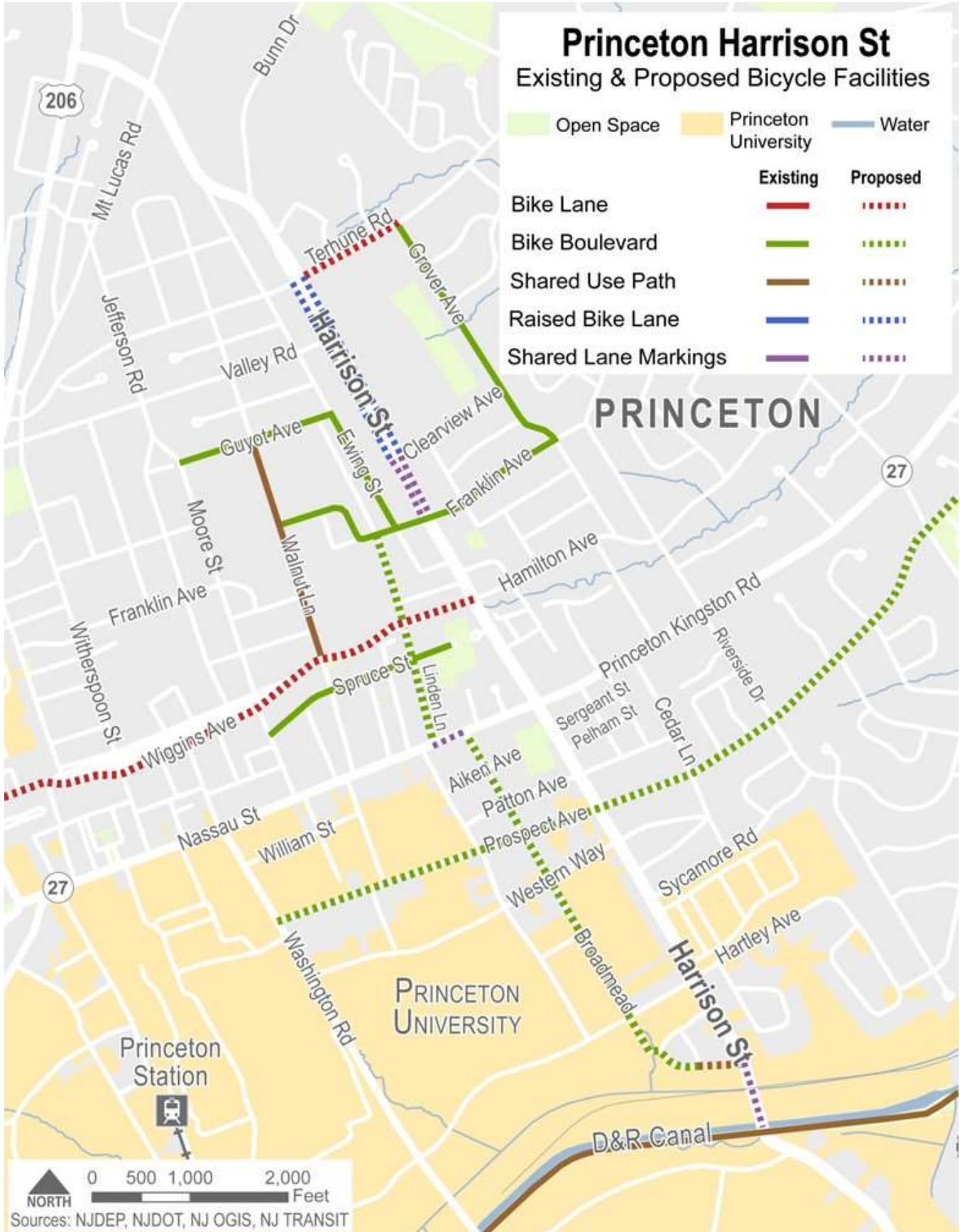


Figure 15: Existing + Proposed Bicycle Facilities



III. Bike Facility Investigation – Between Franklin Avenue and Terhune Road

Design Priorities

1. Establish a bicycling facility suitable for all ages and abilities.
2. Support a road diet through lane reduction and lane narrowing, by providing adjacent vertical elements in the reclaimed lane for speed reduction.
3. Consider provision of a sidewalk/sidepath on the southbound side of the roadway, to eliminate a gap in the sidewalk network.
4. Consider impacts to DPW operations – street sweeping and snow plowing.
 - a. Also consider impacts residential garbage collection, mail delivery, etc.
5. Consider a raised thoroughfare for bicyclist and pedestrians, raised to sidewalk level.
 - a. Turning vehicles should traverse sloping curb or apron to cross bike-ped thoroughfare, thereby improving driver yield behavior and safety for peds and bicyclists. The motorist should enter the ‘pedestrian/bicyclist’s space’, not vice-versa.

Investigated Bicycle Facilities

1. Option 1A: Raised Bicycle Lanes & Wide Sidewalks
2. Option 1B: Raised Sidepaths (for walking and bicycling)
3. Option 1C: The Dual (Redundant Facility) for commercial access
4. Option 2: On-Street Separated Bicycle Lanes (with adjacent Raised Sidewalk)
5. Option 3: Raised Two-way Cycle Track (on Northbound side)

All options investigated share the following considerations:

1. Widen the sidewalk on the northbound side of the roadway from ~4-ft existing to 6-ft proposed.
2. Similar construction costs and impacts.
 - a. Require curb line reconstruction on both sides of the roadway through the Princeton Shopping Center commercial corridor, from the PSC driveway at Walgreens to Terhune Road.
 - i. Construction Activities: Narrowed roadway (reconstruct curbline); drainage inlets (~4 southbound, 5 northbound), and sidewalk/asphalt construction (road diet conversion from asphalt travel lane to bike-ped area).
3. Require temporary construction easements and some residential and commercial driveway reconstruction.
4. Maintain existing median curb island (mature trees, curbing, and drainage inlets).
5. Maintain existing roadway appurtenances (existing roadway buffer area), e.g. utility poles, as a cost-saving measure.
 - a. Appurtenances: Utility poles (with roadway lights), fire hydrants, roadway signage, mailboxes, mature trees, garbage can storage area (residential).



Summary of Proposed Treatments

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Long-Term Bicycle Facility Design Options:

Option 1A: Raised Bicycle Lanes & Wide Sidewalks

Features

1. One raised bike lane in each direction at sidewalk-level.
2. Sidewalks adjacent to bike lanes on both sides of the roadway.
 - a. Bike lane is contrasted from adjacent sidewalk using green paint/material, signage.
3. Separated by curb from the roadway.
4. At driveways, carry bicycle lane and sidewalk through at 'sidewalk level'; vehicles traverse driveway curb apron and are brought up to bike-ped level.

Option 1A: Raised Bicycle Lanes & Wide Sidewalks



Design Considerations:

1. Option 1A provides colored differentiation between bicycling space and walking space. Signage should also be used to differentiate the two spaces.



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Option 1B: Raised Sidepaths (for walking and biking)

Features

1. One large sidepath on both sides of the roadway (for walking and biking).
2. Separated by curb from the roadway.
3. At driveways, carry sidepath through at 'sidewalk-level'; vehicles traverse driveway curb apron and are brought up to sidepath level.

Option 1B: Raised Sidepaths (for walking and biking)



Design Considerations:

1. Option 1B does not designate space specific for bicycles or pedestrians, the two groups are expected to share the space.
2. Options 1A, 1B, 1C, and 3 offer a raised thoroughfare for bicyclists and pedestrians, where Option 2 provides an on-street facility.



Summary of Proposed Treatments

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Option 1C: The Dual (Redundant Facility) for Commercial Access

Southbound Side: Install Raised Bicycle Lane & Sidewalk;

Northbound Side: Install Raised Two-Way Bicycle Facility (and Existing Sidewalk)

Features

1. Provide raised bicycle lane and sidewalk on the southbound side of Harrison Street, similar to Option 1A.
 - a. Bike lane should be designated through colored pavement and signage.
2. Provide raised two-way bike facility on northbound side of Harrison Street.
 - a. Two-way bicycle facility is separated from northbound traffic by buffer (approximately 3 feet) and sloping curb.
 - b. The southbound bike lane terminates at the Walgreens Driveway. The northbound bike lane transitions to a shared-lane arrangement.
3. At driveways, carry bicycle lane and sidewalk through at 'sidewalk level' (4 inches); vehicles traverse driveway curb apron and are brought up to bike-ped level.

Option 2: The Dual (Redundant Facility) for Commercial Access



Design Considerations:

1. The southbound lane of the bicycle track (on the northbound, commercial side, of Harrison Street) must end at the Walgreens Driveway. Without signalization or a formal crossing treatment at Clearview Avenue, the southbound bike lane has no viable connection south of the Walgreens Driveway or way to access the southbound shared lane. This bicycle track southbound 'stub' would be used for accessing the commercial lot only.
2. To accommodate this cycle track, this Option sacrifices the new supplemental sidewalk on the northbound roadway side (however the existing adjacent sidewalk is available in all Options, and may be widened from existing (~4-ft) to 6-ft proposed).



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Option 2: On-Street Separated Bicycle Lanes (with adjacent Raised Sidewalk) (Avid Bicyclist Separation)

Features

1. One on-street bike lane in each direction on either side of Harrison Street.
2. Bike lane separated from traffic by flexible delineator or similar vertical separation device.
3. New adjacent sidewalks raised on curb, on both sides of Harrison Street.
4. Provide bike crossing pavement markings at driveways.

Option 2: Install On-Street Separated Bicycle Lanes (with adjacent Raised Sidewalk)



Design Considerations:

1. Option 2 offers on-street bicycle lanes, for confident bicyclists, separated from the adjacent sidepath/sidewalk. The adjacent sidepath/sidewalk serves as a facility for, slower, less confident riders and children so that all ages and abilities are accommodated through this design option. The sidewalks are greater than 6 feet in width, to provide enough space for pedestrians and the small cohort of bicycles expected to ride on the sidepath/sidewalk.
2. Costs for Option 2 are similar to other options. Option 2 offers less separation between the on-street bicycle lane and the vehicular travel lane (bicyclists aren't raised for some 2000-ft through the commercial shopping center area).
 - a. The proposed roundabout design requires bicyclists to ramp up to sidepath/sidewalk level. Ultimately, the other options which raise bicyclists onto a thoroughfare for the extent of commercial area, are more ideal, even for avid bicyclists, when combined with the proposed roundabouts. This Option, in contrast, does not offer distinct benefits aside from a wholly separate space for in-roadway bicycling.



Summary of Proposed Treatments

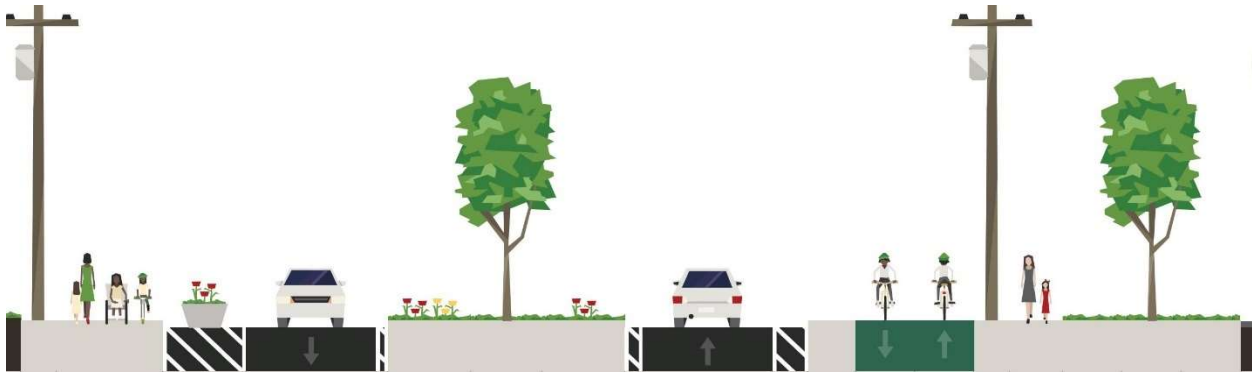
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Option 3: Raised Two-way Cycle Track (on Northbound Side)

Features

1. Two-way bicycle facility on northbound side of Harrison Street.
2. Separated by raised curb from the roadway.
3. Include new sidewalk on southbound side of roadway.
 - a. Plastic delineators or a planter box may (or street parking) be used as a traffic calming feature, to densify the roadway, and manage vehicular speeds.

Option 3: Install Raised Two-way Cycle Track on Northbound Side



Design Considerations:

1. Option 3 offers a raised two-way bicycle facility on the northbound, commercial, side of the Harrison Street. This proposed option suffers from the same operational drawbacks present in Option 1C (i.e., lack of a direct connection for southbound bike lane and transition to the on-street shared lanes condition present throughout the rest of the corridor). Given ROW and roadway width constraints, it is not feasible to extend the two-way bicycle facility to the next southerly existing signalized intersection, Franklin Avenue. For this bicycle alternative to be viable, a formal crossing treatment must be introduced at Clearview Avenue to allow southbound bikers to cross Harrison Street to continue south in the shared lane arrangement.
 - a. The crossing treatment at Clearview Avenue could be accomplished with a signalized intersection (HAWK or traditional signal) or a RRFB.
2. Plastic delineators or a planter box may (or street parking) be used as a traffic calming feature, to densify the roadway, and manage vehicular speeds.
 - a. A parking lane has certain drawbacks which include the fact that when parking lane is vacant, a wide roadway is provided to motorists which could encourage higher operating speeds. Therefore, street parking (without flexible delineators or planter boxes to densify the roadway) would fail to provide the positive traffic calming benefits seen by other options. The parking lane is not a necessity as residential driveways are present, despite its usefulness to visitors to adjacent residences, including landscapers and contractors.



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Municipality of Princeton – Harrison Street Corridor Study

Short-Term (Quick-Build) Bicycle Facility Design Options:

With the understanding that implementing the proposed bicycle facilities described earlier in this section may not be feasible for several years, Michael Baker investigated potential options that could be installed more quickly and economically in comparison to the long-term options. Quick build options were investigated for each side of Harrison Street separately, to provide flexibility with respect to potential treatments. Investigated quick build design options include:

1. Southbound Quick Build Option 1: Protected Bicycle-Pedestrian Area
2. Southbound Quick Build Option 2: Parking Protected Bicycle Lane
3. Northbound Quick Build Option 1: Protected Two-Way Bicycle Facility with Flexible Area

The preferred options based on the initial investigation are Southbound Quick Build Option 1: Protected Bicycle-Pedestrian Area and Northbound Quick Build Option 1: Protected Two-Way Bicycle Facility with Flexible Area.

All 'Quick-Build' Options share the following considerations:

1. Similar construction costs and impacts.
 - a. *Does NOT* require outside curb line reconstruction or associated construction activities.
2. *Does NOT* require temporary construction easements and some residential and commercial driveway reconstruction.
3. Maintain existing median curb island (mature trees, curbing, and drainage inlets).
4. Maintain existing roadway appurtenances (existing roadway buffer area), e.g. utility poles, as a cost-saving measure.
 - a. Appurtenances: Utility poles (with roadway lights), fire hydrants, roadway signage, mailboxes, mature trees, garbage can storage area (residential).



Summary of Proposed Treatments

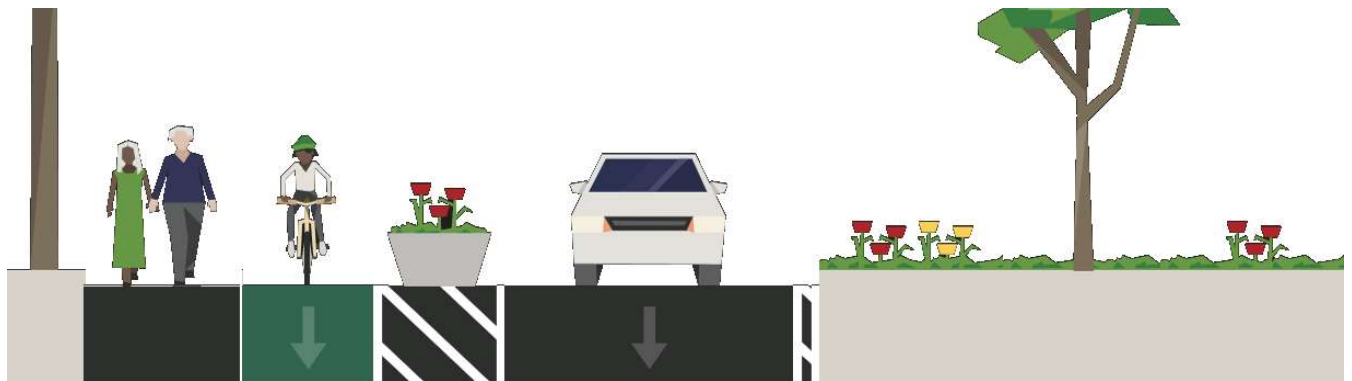
Municipality of Princeton – Harrison Street Corridor Study

Preferred: Southbound Quick Build Option 1: Protected Bicycle-Pedestrian Area

Features

1. On-street bicycle lane and adjacent walkable shoulder.
2. Separated from the roadway by planter box or similar vertical separation device (concrete barrier, plastic delineator, etc.).
3. Provide bike crossing pavement markings at driveways.

Southbound Quick Build Option 1: Protected Bicycle-Pedestrian Area



Design Considerations:

1. Southbound Quick Build Option 1 provides a protected area for walking and bicycling, which are contrasted from one another with either painted bicycle and pedestrian symbols on pavement, and/or a green painted bicycle lane.
2. Separation is achieved using a planter box or similar separation device, which may also serve as a snow-storage area.
3. Openings to allow longitudinal access for DPW street sweeping and snow plowing, or municipal garbage collection can be provided.



Summary of Proposed Treatments

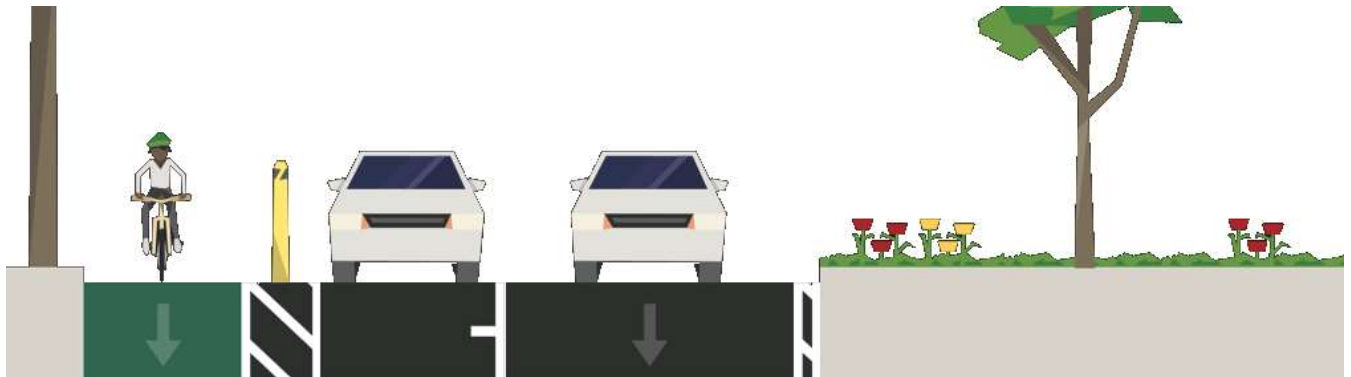
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Southbound Quick Build Option 2: Parking Protected Bicycle Lane

Features

1. On-street bicycle lane.
 - a. Walkable shoulder area is not provided.
2. Separated from the roadway by flexible delineator or similar vertical separation device.
3. Provide bike crossing pavement markings at driveways.

Southbound Quick Build Option 2: Parking Protected Bicycle Lane



Design Considerations:

1. Southbound Quick Build Option 2 provides a protected area for bicycling, but not walking.
2. Separation is achieved using a narrower flexible delineator and parking lane.
3. Parking lane drawbacks include the fact that when parking lane is vacant, a wide roadway is provided to motorists which could encourage higher operating speeds. Southbound Quick Build Option 2 fails to provide the positive traffic calming benefits seen by other options. The parking lane is not a necessity as residential driveways are present, despite its usefulness to visitors to adjacent residences, including landscapers and contractors.
4. Provisions for openings for vehicle maintenance-vehicle access are more challenging, in contrast to Southbound Quick Build Option 1.
 - a. Narrow maintenance equipment for sweeping and snow-plowing of the bicycle lane are likely required.



Summary of Proposed Treatments

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Preferred: Northbound Quick Build Option 1: Protected Two-Way Bicycle Facility with Flexible Area

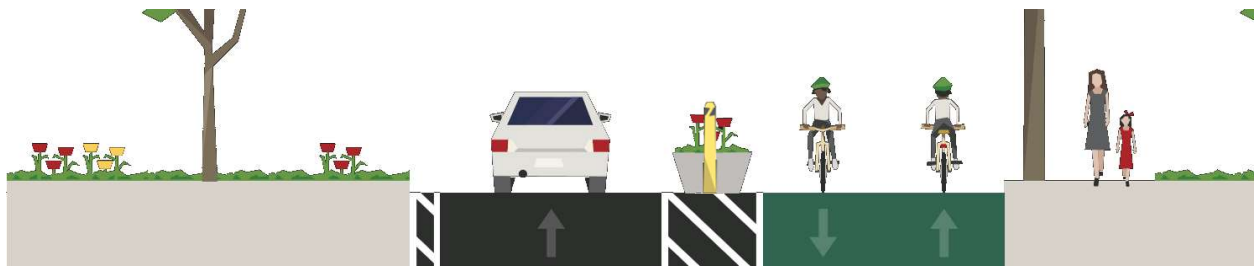
Features

1. On-street bicycle lane (~6-ft wide).
 - a. Existing sidewalk remains for pedestrians.
2. Separated from the roadway by planter box or similar vertical separation device.
 - a. Select flexible delineator for added space and opportunity to introduce bicycle parking as needed (although preferential to locate bicycle parking within the shopping center).
3. Provide bike crossing pavement markings at driveways.

Northbound Quick Build Option 1: Protected Two-Way Bicycle Facility



Northbound Quick Build Option 1: Protected Two-Way Bicycle Facility
(with Planter Box or Delineator)



Design Considerations:

1. Northbound Quick Build Option 1 provides a protected area for bi-directional bicycling.
2. Separation is achieved using a planter box or similar separation device, which may also serve as a snow-storage area.
3. Traditional maintenance equipment can easily navigate the proposed two-way bicycle facility space, given that the width of ~12-ft exceeds ~8-ft standard equipment width.
4. The two-way bicycle facility is also compatible with a bicycle lane on the southbound side of the roadway, which may serve as an effective southbound 'bypass' bicycle lane of the commercial area. Provision of a such a southbound bicycle lane allows the bicycle track (northbound side of Harrison Street), shown above, to function as a convenient bicycle facility to reach the shopping center destinations before bicycle track termination at the Walgreens Driveway (where the SB lane transitions to bicycle sharrows).