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TECHNICAL MEMORANDUM

DATE: June 15, 2022

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SUBJECT: Initial (Fatal Flaw) Screening Analysis

PROJECT NAME & NO.: Bend Midtown Pedestrian and Bicycle Crossings (1TMTC)

INTRODUCTION

This memorandum summarizes a range of ideas for improving the crossings of Greenwood Avenue, Hawthorne Avenue, and Franklin Avenue in the City of Bend. The focus of this effort is improving crossings for people walking, using mobility devices, or riding bikes. Given that there is a wide range of possible improvement solutions at each crossing, this memorandum reviews the "long list" of ideas considered and identifies those that are most aligned with project goals that should be further developed as alternatives. The criteria (all being weighted equally) for this fatal flaw evaluation are as follows:

- Cost.
- Constructability/technical feasibility.
- Community impacts.
- Alignment and benefits with respect to project core values and goals (see attachment A).
- Legal, environmental, permitting or property ownership barriers.

The project team explored a range of ideas for each crossing location in collaboration with the City of Bend and stakeholders. The concepts were then evaluated based on the criteria above and categorized as follows:

- Do not advance: concepts that do not provide high value, have very high costs relative to benefits, have permitting, legal or other issues, or do not align with the project core values and goals.
- Potentially advance: concepts that may have merit but require further discussion with City staff and/or stakeholders before determining whether they should advance or not.
- Advance: concepts recommended to advance for further refinement.

While all the criteria were considered for the ideas and concepts which have been categorized as "potentially advance" and "advance", some ideas may have been categorized as "do not advance" based on a single criterion due to a "fatal flaw," such as the inability to accommodate the ramp within a limited distance available.

The ideas, high level evaluations, and recommendations are described in narrative and, when necessary, are accompanied with conceptual sketches and maps.

The general study area and crossing locations are shown in Figure 1.

Figure 1. Study Area

Greenwood Avenue Context

The Greenwood Avenue curb-to-curb cross section as it passes under U.S. 97 is approximately 64 feet wide. This section of Greenwood Avenue consists of four travel lanes: two eastbound and two westbound. The travel lanes range from approximately 12 to 16 feet wide. Greenwood Avenue does not have existing bike lanes but has sidewalks on both sides of the street that are approximately 6 feet wide with a section that narrows to less than 4 feet. The City standards for urban walkways on arterial streets are 8 to 10 feet wide. The standard for bike lanes on arterial streets are 5.5 to 6 feet wide. The elevated sidewalk is grade separated from the roadway by a concrete wall and chain link fence.

Figure 2. NW Greenwood Ave at U.S. 97. Left image: looking east, right image: looking west

Opportunities

- Existing underpass provides a connection under U.S. 97 and the railroad.
- There is an existing sidewalk for pedestrian use.
- Wide cross section and travel lanes may provide opportunities for adding bike lanes.

Constraints

- Existing sidewalks are narrow (~6 feet wide), leaving minimal room for both people walking and riding bikes.
- There are no dedicated bike facilities on the roadway.
- High traffic and limited separation from the roadway creates a noisy pedestrian environment.
- Narrow walkways are uncomfortable and present personal safety concerns.

Hawthorne Avenue Context

The Hawthorne Avenue right-of-way is 60 feet on the west side and east side (between 1st St and 2nd St). Currently there is no right-of-way between 1st Street and the railroad. The curb-to-curb cross section west of U.S. 97 is approximately 33 feet. This section of Hawthorne Avenue consists of two travel lanes: one eastbound and one westbound with a narrow mountable curb between the travel lanes. The travel lanes are approximately 16 feet wide. Hawthorne Avenue does not have existing bike lanes but has sidewalks on both sides of the street that are approximately 5 feet wide. There is an approximately 7 feet wide landscape strip between the sidewalk and the street.

The curb-to-curb section east of NE 1st Street is approximately 36 feet wide. This section of Hawthorne Avenue consists of two travel lanes and parallel parking on both sides. The travel lanes range from approximately 10 to 11

feet wide, and the parking is approximately 7 to 8 feet wide. There are curb tight sidewalks on both sides of the street that are approximately 6 feet wide.

Figure 2a - Hawthorne Corridor

Figure 3b - Hawthorne Ave (Looking east from Hill St)

Figure 2c - Hawthorne Ave (Looking west from 1st St)

Opportunities

- The existing eastbound lane on the west side provides access onto the Bend Parkway. The City has been discussing with Oregon Department of Transportation (ODOT) the possibility of eliminating this access and therefore accommodating a bridge approach within the existing eastbound lane. The closure of the access to Bend Parkway has been identified as a recommendation in the Oregon Department of Transportation US 97 Parkway Plan. The southbound offramp onto Hawthorne from the Bend Parkway is intended to be maintained.
- The City-owned parcel on the west side of the parkway at the Northeast corner of Hawthorne and the Bend Parkway could be used for a ramp and/or stairs.
- The parcel between the railroad tracks and 1st Street is undeveloped (currently used for a storage yard and parking) and could be used for a ramp and/or stairs.

Constraints

- There are two driveways on the south side of Hawthorne near the intersection of Hill Street which limits the length of the bridge approach/ramp on the west side.
- A right-of-way, easement, or land purchase will be required for the parcel between NE 1st Street and the railroad.

- The elevation differential between the railroad and the Bend Parkway at the Hawthorne corridor.
- Maintaining a 4.5% slope (below ramp standard slopes) for the approaches will be challenging due to the grade differential between the proposed bridge deck and the existing street grades.
- High vehicle traffic coming off U.S. 97 at high speeds will create potential conflicts with the proposed bicycle and pedestrian traffic.

Franklin Avenue Context

The Franklin Avenue curb-to-curb cross section as it passes under U.S. 97 is approximately 25 feet wide. This section of Franklin Avenue consists of two travel lanes: one eastbound and one westbound. The travel lanes are approximately 11 feet wide. Franklin Avenue does not have existing bike lanes in this area but is marked with sharrows east of the railroad crossing overpass and west of the overpass near NW Hill Street. From NW Hill Street to the U.S. 97 overpass, a 17 to 19 feet wide paved path exists for non-motorized traffic, and there are approximately 5 to 6-foot-wide sidewalks on both sides of the street where the path runs under the U.S. 97 overpass. The elevated sidewalk is separated from the roadway by a decorative concrete fence west of the U.S. 97 overpass, a concrete wall and a chain link fence as it runs under the overpass, and a 12-foot-wide planting strip east of the railroad crossing. Where the sidewalk passes under the railroad tracks, the path is contained in an enclosed tunnel.

Figure 4. NW Franklin Ave at U.S. 97. Left image: looking east, right image: looking west

Opportunities

- The existing underpass provides a connection under U.S. 97 and the railroad.
- The path for non-motorized use between NW Hill Street and the overpass is wide enough to accommodate people walking and riding bicycles.
- There is an existing sidewalk for pedestrian use directly under the overpass.

Constraints

- Existing sidewalks are narrow (~5 to 6 feet wide), leaving minimal room for both people walking and riding bikes.
- Existing passage/tunnel is narrow and poorly lit, leading to personal safety and security concerns.
- The roadway cross section is narrow (~25 feet wide) and has only one travel lane in each direction, leaving minimal room in the existing structure for on-road bicycle facilities.

EVALUATION CRITERIA

The project team considered the following factors in the evaluation of each concept. These considerations are necessarily qualitative because of the very early stage of concept development and evaluation. Factors considered include:

- Cost: engineer's professional opinion as to the typical range of potential costs. Expressed on a scale as follows:
  - $: < 1,000,000
  - $$: 1,000,001 to 5,000,000
  - $$$: 5,000,001 to $10,000,000
  - $$$$: 10,000,000 to 20,000,000
  - $$$$$: 20,000,000+
- Constructability/technical feasibility: engineer's professional opinion as to the technical feasibility or constructability of a given concept, given corridor constraints.
- Community impacts: description of the potential positive and negative impacts to the immediate and surrounding community, including temporary construction impacts and detours or permanent impacts to property access, the visual landscape, etc. Benefits could include the degree to which the project provides safety, security, and comfort benefits to people walking, using a mobility device, or riding a bike, as well as economic benefits to the local business community and beyond.
- Alignment and benefits with respect to project core values and goals: evaluation of how the concept meets or responds to the project core values and goals provided in a separate memorandum.
- Legal, environmental, permitting, or property ownership barriers: discussion of potential issues and barriers related to:
  - Right-of-way, Burlington Northern Santa Fe (BNSF, freight rail owner) and Oregon Department of Transportation property: potential barrier if concept would require significant right-of-way acquisition.
  - Railroad facility impacts: if the concept is unlikely to be able to be built so as to meet railroad standards.
  - Permitting issues, or other related barriers: whether the concept is likely to have serious environmental effects or potentially be not permittable under local land use laws.
  - Other related barriers.

Table 1. Fatal Flaw Analysis

Concept ID	Short Description	Alignment & Benefits to Project Core Values & Goals	Constructability/Technical Feasibility	Community Impacts	Legal, Environmental, Permitting, Property Barriers	Cost	Team Recommendation (Categorization)	Justification
Greenwood Avenue								
G1	Maintain 4-lane configuration. (*do nothing)*		N/A	No cycling facilities: existing pedestrian crossing facilities are narrow, uncomfortable.	N/A	0	Do not advance.	Current crossing environment does not meet minimum design standards for pedestrian and bike access.
G2	Reconfigure lanes – 3rd St to Deschutes River to 3 lanes w/bike lanes.	Would provide new, dedicated space for people cycling, enhancing cyclist mobility. Enhances cyclist safety, modest improvements to cyclist comfort. Minimal improvement to pedestrian realm. Low-cost option.	No issues.	Minimal negative impacts. Construction duration would be very short. Impact to vehicle mobility, though traffic analysis (separate effort underway by City of Bend) indicates performance would be acceptable.	Minimal. Project would have minimal construction impact and utilize existing right-of-way.	$	Advance.	Lane reconfiguration should be considered as part of any alternative advanced. However, the lane reconfiguration by itself only modestly increases comfort and safety for cyclists and provides limited improvements to the pedestrian crossing environment.
G3	Reconfigure lanes to 3 lanes with bike lanes (same as G2), use paint and candlesticks within outside lanes to create more separation between pedestrians/cyclists and the driving lanes.	Similar to G2. Enhanced delineation between cycling/walking route and car traffic would improve user comfort as compared to G2.	No issues.	Similar community impacts to G2.	Minimal. Project would have minimal construction impact and utilize existing right-of-way.	$	Do not advance.	Low-cost option but provides modest benefits overall with regard to pedestrian and cyclist safety and mobility. At-grade walking/biking facilities adjacent to travel lanes are perceived by users to be less comfortable than curb-separated facilities. This could be considered as a short-term improvement (in case the City decides to allocate only minimal funding towards improvements on Greenwood in favor of allocating more resources to Franklin and/or Hawthorne.
G4	Sidewalks/paths at street level. (*take outside lane and repurpose as path, install mountable curb; maintain elevated sidewalk)* ***Greenwood Concept 1 in the June Online Open House***	Enhances safety and mobility for people walking/biking. Provides greater separation and delineation from vehicle traffic than G2 or G3.	Slightly more complex than G2 or G3, feasible.	More construction involved, greater duration for any construction impacts. Storm drainage upgrades potentially more extensive. Allows for emergency vehicle access.	Minimal to moderate. Would utilize existing right-of-way.	$$	Advance.	Need to resolve drainage and snow removal/storage issues.
G5	Lower and widen the existing grade-separated sidewalks. (*eliminate the sidewalk supported wall, keep back walls in place)* ***Greenwood Concept 2 in the June Online Open House***	Provides significant safety and comfort benefits by increasing separation from traffic and provide more space for people walking and biking.	Unknown at this time as to the structural function of the sidewalk walls with respect to the overall highway and rail crossing structures.	Longer duration construction schedule, including longer duration lane closures. Would require reconfigured access to businesses. Removes the existing level path for people using mobility devices; grades may not meet ADA standards. May increase drainage issues at low elevations. At walkways.	Ground disturbance would warrant archeological investigation. Would utilize existing right-of-way, though may require engagement with the railroad. May not meet maximum grade requirements needed to comply with the federal Americans with Disabilities Act (ADA). May impact business access on West side.	$$$	Potentially advance.	Several technical issues need resolution, including: • Emergency access. • Potential substandard shared-use path width. • Access to businesses. • Meeting federal Americans with Disabilities Act standards. • Technical feasibility of removing the existing sidewalk walls. • Drainage needed for walkways and bike lanes.
G6	Similar to G5, except raised bike lane at street level with a mountable curb.	Provides significant safety and comfort benefits by increasing separation from traffic and provide more space for people walking and biking.	Unknown at this time as to the structural function of the sidewalk walls with respect to the overall highway and rail crossing structures.	Longer duration construction schedule, including longer duration lane closures. Would require reconfigured access to businesses. Removes the existing level path for people using mobility devices; grades may not meet ADA standards. May increase drainage issues at low elevations at walkways and bike lanes.	Ground disturbance would warrant archeological investigation. Would utilize existing right-of-way, though may require engagement with the railroad. May not meet maximum grade requirements needed to comply with the federal Americans with Disabilities Act.	$$$	Advance.	Several technical issues need resolution, including: • Access to businesses. • Meeting federal Americans with Disabilities Act standards. • Technical feasibility of removing the existing sidewalk walls. • Drainage needed for walkways and bike lanes.
G7	Remove center piers to provide more room under the railroad and US 97	Provides only a modest benefit compared to other options.	Complex project – need for maintaining highway and railroad utility during construction.	Longer-duration construction impacts.	Ground disturbance would warrant archeological investigation. Would utilize existing right-of-way, would require	$$$$	Do not advance.	High costs relative to the expected benefit, and benefits not substantially different from other lower-cost, lower-disruption options.

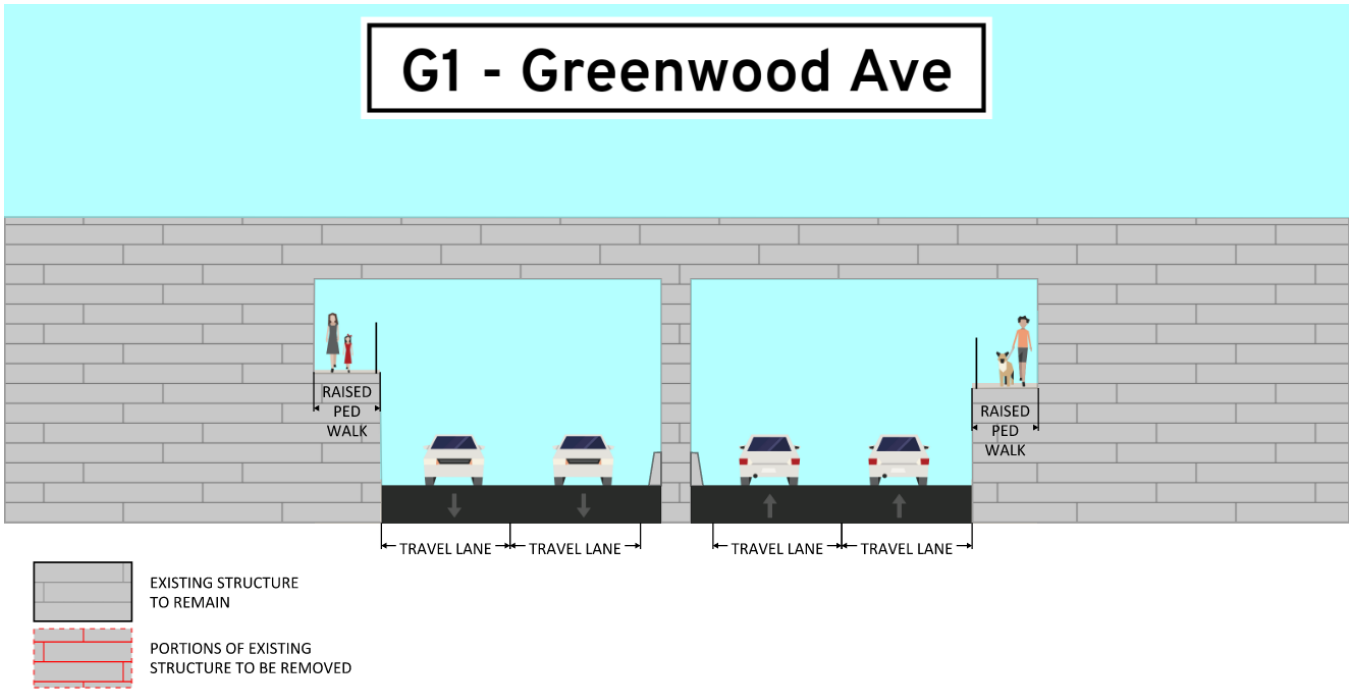
Concept ID	Short Description	Alignment & Benefits to Project Core Values & Goals	Constructability/Technical Feasibility	Community Impacts	Legal, Environmental, Permitting, Property Barriers	Cost	Team Recommendation (Categorization)	Justification
	for adding additional cycling and pedestrian facilities.				significant engagement with BSNF. Unknown whether this project would be permitted by the railroad.			
G8	Place lanes on one side of supports. (*Maintain elevated sidewalks as is, add new cycling and pedestrian space under the bridge in the space freed up by moving traffic to one side of the bridge supports)*	Potentially provides additional separation compared to G3, G4, and G5, but not as much as G6.	Would require eliminating parking, eliminating left turns on to 1st Street, presents issues in terms of transitioning people walking and biking to a two-way walking/biking facility on one side of Greenwood.	Would introduce safety concerns.	Minimal to moderate. Impacts would extend well beyond project limits.	$$$	Do not advance.	Shifting lanes to a single of the bridge supports is likely infeasible from a traffic engineering perspective. While it would ostensibly provide more space for people walking and biking, transitioning users to a single side of the roadway would require crossing traffic twice at either end of the corridor and introduce safety/comfort concerns.
G9	Widen bridge structure/opening. *(Maintain 4 lanes, remove center bridge supports, improve cycling and pedestrian facilities by widening)*	Provides only a modest benefit compared to other options, maintains through traffic lanes but no improvement to current operations.	Complex project – need for maintaining highway and railroad utility during construction.	Longer-duration construction impacts.	Ground disturbance would warrant archeological investigation. Would utilize existing right-of-way, would require significant engagement with BSNF. Unknown whether this project would be permitted by the railroad.	$$$$	Do not advance.	Very high costs relative to the expected benefit, and benefits not substantially different from other lower-cost, lower-disruption options.
G10	Construct new, separate overpass for cyclists and pedestrians. Could be located on south or north side of the existing structure.	Would enhance safety and mobility.	Extremely difficult project: must maintain clearances over highway and railroad; overpass landing sites are not obvious.	Would be highly disruptive to the businesses and homes immediately adjacent to Greenwood (both in terms of construction and permanent impacts).	Substantial permitting and railroad coordination issues.	$$$$$	Do not advance.	Overpass would be extremely disruptive to the community and adjacent businesses, has major permitting/feasibility concerns, and excessive costs.
G11	New bike/ped underpass south of existing structures.	Would greatly enhance safety and mobility but includes out of direction travel for users on north side.	Extremely difficult project.	Would be very disruptive to businesses on south side.	Would require acquisition of two properties and include demolition of existing structures. Ground disturbance would warrant archeological investigation. Would utilize existing right-of-way, would require significant engagement with BSNF. Unknown whether this project would be permitted by the railroad.	$$$$$	Do not advance.	A new underpass has major permitting concerns, feasibility concerns, and excessive costs.
Hawthorne Avenue								
H1	(Straight) bridge with long ramps. ***Hawthorne Concept 1 and 2 in the June Online Open House***	Provides a clear route for bicyclists and pedestrians.	High clearances for railroad crossing will require extensive ramping.	Ramps will block views across the street. Possible incompatible uses will occur under ramps. Ramp will eliminate a travel lane (eastside). Ramp will utilize travel lane accessing US 97, which is planned to be closed (westside).	Will require coordination and collaboration with Railroad and Oregon Department of Transportation. Possible midspan support columns will require approvals.	$$$$	Advance.	Provides an understandable and direct crossing.
H4	Hybrid undercrossing (Irving).	Provides connections for bikes and peds.	Will require extensive geotechnical evaluation. Boring will be required under railroad and highway.	Below grade crossings can be very unsafe given their lack of surveillance. Drainage will likely require pumping. Significant ventilation will be needed for air quality.		$$$$$	Do not advance.	Underground crossings without significant adjacent activity are often dangerous to users.
H5	Utilize Irving on the west side for access to bottom of west ramp on City owned property.	Enables a ramped solution without significant impacts on Hawthorne.	Appears to be sufficient area to accommodate ramp.	Establishes out of direction travel along the Parkway. Users will be required to switchback on ramp which may be difficult for large bikes with trailers.		$$$$	Potentially advance.	Provides a ramped system that does not require closure of lanes on west side. Can provide safe bike and ped connections to Hawthorne without constructing barriers in the street.
H6	Bridge with Stair and Elevator access (No Ramps). ***Hawthorne Concept 3 in the June Online Open House***	Establishes universal accessibility. Provides clear and safe connections. Utilizes the smallest footprint to accommodate the crossing.	Can be constructed without significant roadway impacts. Long term maintenance of elevator will be required.	Establishes a clear route for access that the community can easily understand. Closure of US 97 access.		$$$$	Advance.	Will provide a straightforward route that minimizes crossing times, is safe and accessible by all users.

Concept ID	Short Description	Alignment & Benefits to Project Core Values & Goals	Constructability/Technical Feasibility	Community Impacts	Legal, Environmental, Permitting, Property Barriers	Cost	Team Recommendation (Categorization)	Justification
H7	Eastside ramp integrated into proposed buildings.	Lessens the visual impact of the ramp. Could help to connect the route to new businesses.	Will require long term agreements for public access and maintenance. Will require coordinated construction of building and ramps.	Would integrate the infrastructure with the building development thereby enabling private development. Developing a public ramp within a private development may cause confusion to users regarding long term public access		$$$	Do not advance.	The benefit does not outweigh the extensive coordination with the private development in the short and long term. If businesses were to close, the ramp safety and security may be in jeopardy.
H10	Alley access (westside) – Alley located between Hawthorne and Greeley.	Provides access without impacting the west side of Hawthorne.	Similar crossing conditions as other bridge and ramp options.	Places access ramps behind existing buildings. Could likely result in safety issues related to uses under ramps.	Impacts access to private property.		Do not advance.	Given the hidden nature of alignment, it does not seem to be a good option to pursue.
Franklin Avenue								
F1	Cut holes/portals in the concrete supports for the railroad for improved pedestrian safety and comfort.	Provides minimal benefits in terms of user comfort. Does not improve conditions substantially.	Feasibility requires further structural investigation.	Minimal.	Rail structure is historic; windowing may present permitting issues.	$$	Do not advance or potentially in advance in conjunction with other improvements.	By itself, this alternative provides minimal values relative to the goals. It is potentially an intervention to consider as part of F2 or F3 which would improve the approaches and provide fuller benefits to users.
F2	Widen tunnels (up to 20') to provide more space for pedestrians and cyclists.	Would greatly enhance safety and mobility.	Feasibility requires further structural investigation.	Longer duration construction schedule, potential impacts through lane closures.	Would require significant geotechnical explorations and structural evaluation of existing highway and railroad structures.	$$$$	Potentially advance.	Widening pedestrian pathways would provide significant increase in benefits for pedestrian and cyclist safety. Would need to explore safety elements for users in confined tunnel.
F3	Widen access areas on the east side. Straighten and level the sidewalk on the east side (north). ***Franklin Concept 1 in the June Online Open House***	Partially enhances safety and comfort; would not enhance the immediate undercrossing of US 97 and railroad tracks. Would potentially improve sight lines for users, improving perceptions of safety.	May not meet maximum grade requirements needed to comply with the federal Americans with Disabilities Act.	Construction impacts to traffic (potential full road closure needed for a period of time). Minimal long-term negative impacts.	No obvious barriers.	$$$	Potentially advance.	While this alternative does not address the narrow immediate undercrossing of US 97 and the railroad, it would improve the very narrow eastside approaches to the undercrossing and potentially improve sightlines, improving perceptions of safety.
F4	Straighten wing wall between RR and US 97.	Minimal benefit to mobility or safety.	Potentially improve sight lines and space for users.	Major construction impacts to railroad, US 97.	No obvious barriers.	$$$	Do not advance.	Very expensive and disruptive project that provides narrow benefits relative to the costs.
F5	Widen bridge structures/opening and lower and widen the path. ***Franklin Concept 2 in the June Online Open House***	Would greatly enhance safety and mobility.		Longer duration construction schedule, potential impacts through lane closures.	Would require significant geotechnical explorations and structural evaluation of existing highway and railroad structures.	$$$$$	Potentially advance	Widening pedestrian pathways would see the greatest benefits for pedestrian and cyclist safety.
F6	Separate overpass for pedestrians/bikes.	Would greatly enhance safety and mobility.	Extremely difficult project: must maintain clearances over highway and railroad; overpass landing sites are not obvious.	Would be highly disruptive to the businesses and homes immediately adjacent to Franklin (both in terms of construction and permanent impacts).	Substantial permitting and railroad coordination issues.	$$$$$	Do not advance.	Overpass would be extremely disruptive to the community, has major permitting/feasibility concerns, and excessive costs.
F7	Close Franklin to vehicle traffic eastbound between Hill Street and 1st Street.	Would provide dedicated space for people walking and biking in the eastbound lane.	Traffic analysis needed to understand traffic diversion implications.	Would represent a major change to traffic circulation.	Minimally disruptive alternative.	$$	Potentially advance.	This alternative would require traffic analysis and a more detailed look at crossings to determine if it is feasible and not overly disruptive.

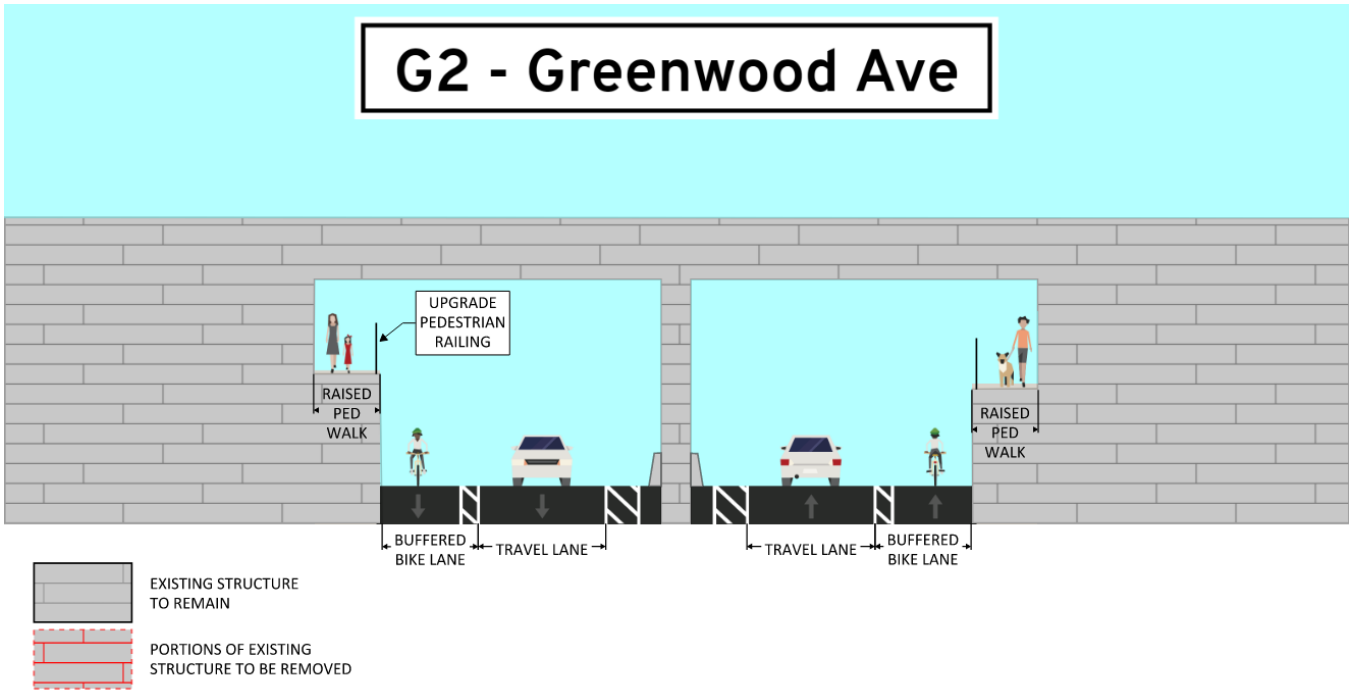
CROSSING FIGURES

The following section provides details on some of the concept ideas describe in Table 1.

Greenwood Concept 1



Greenwood Concept 2



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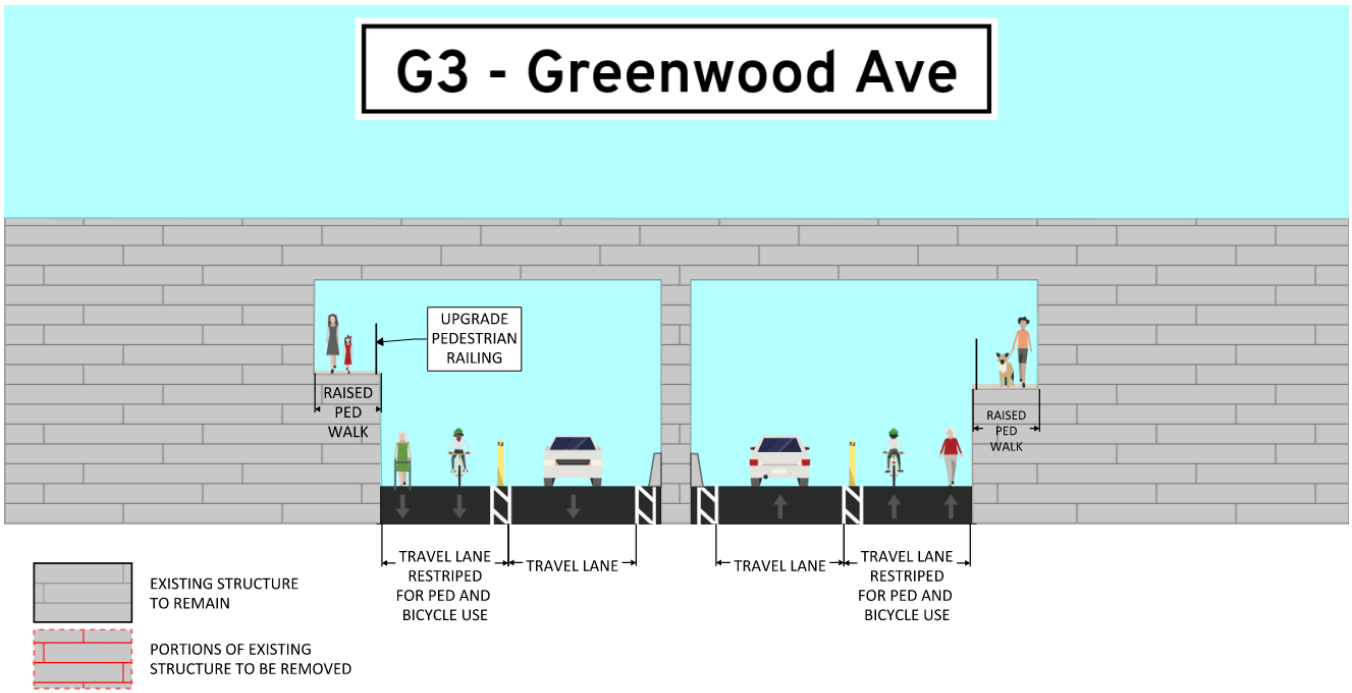
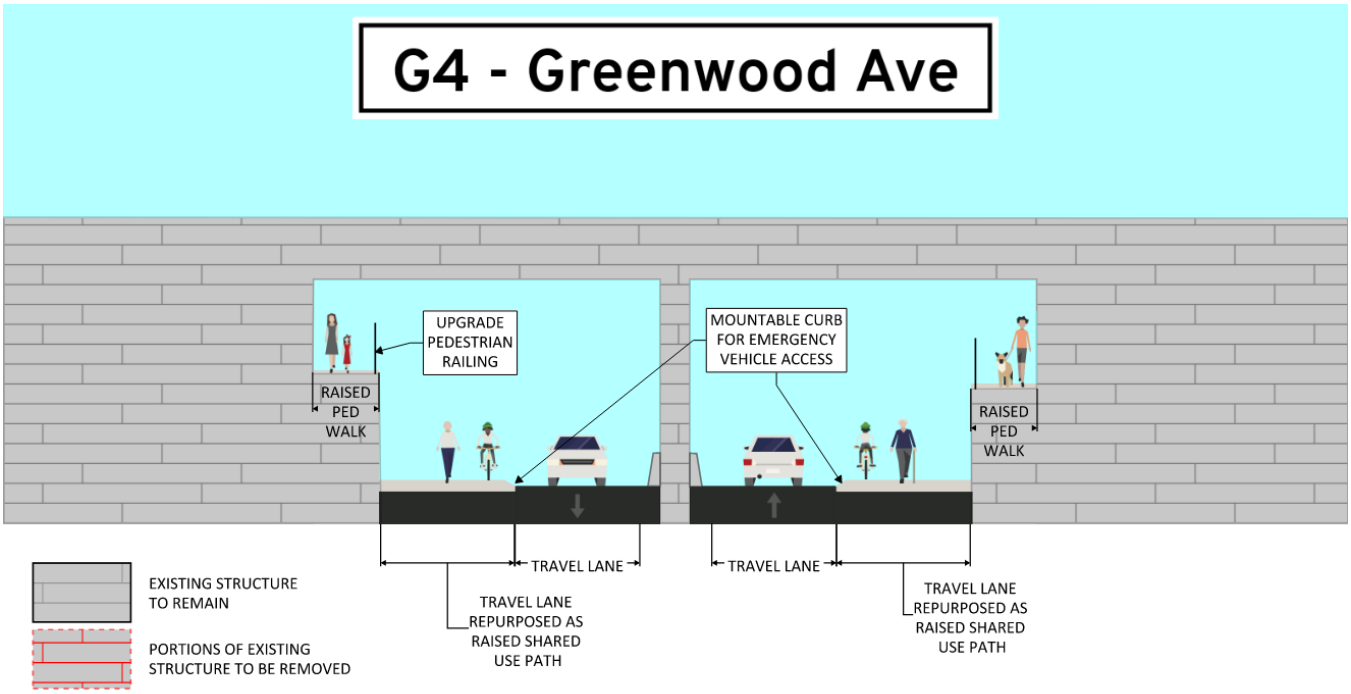


Greenwood Concept 4

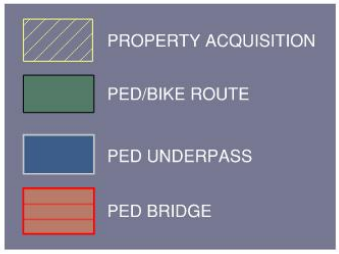


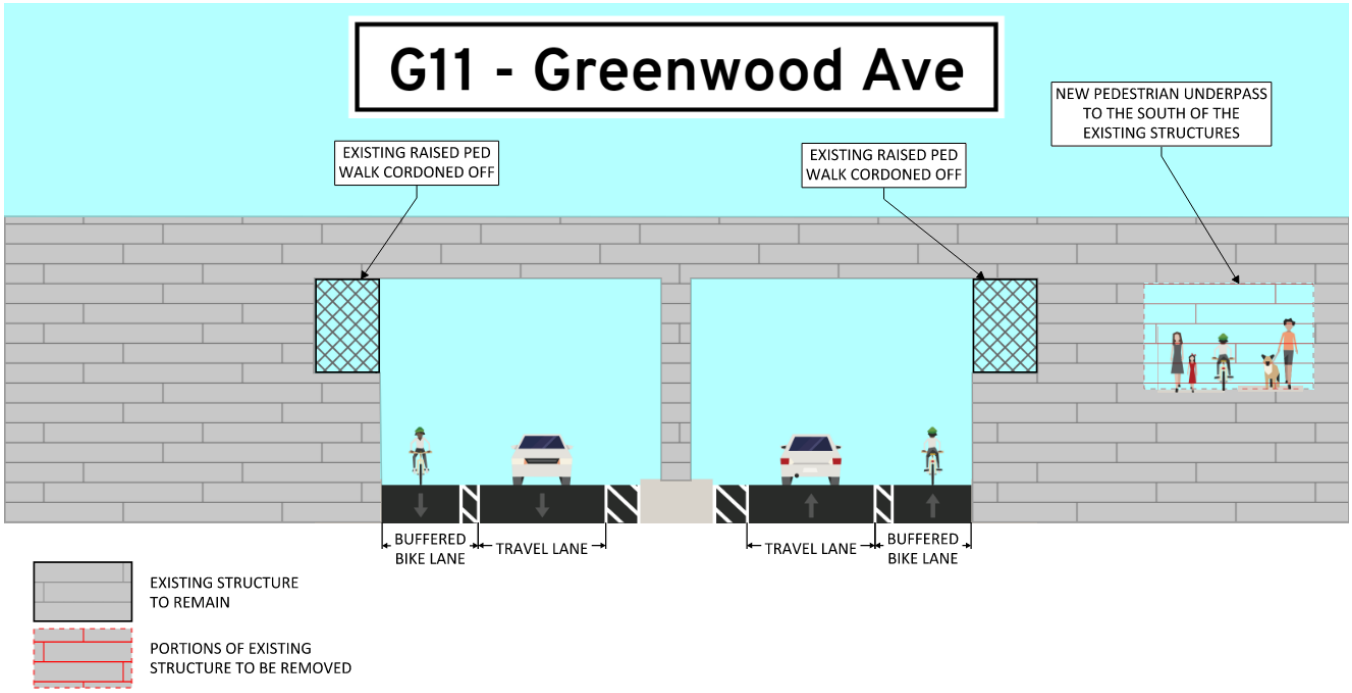
Greenwood Concept 5

Greenwood Concept 6

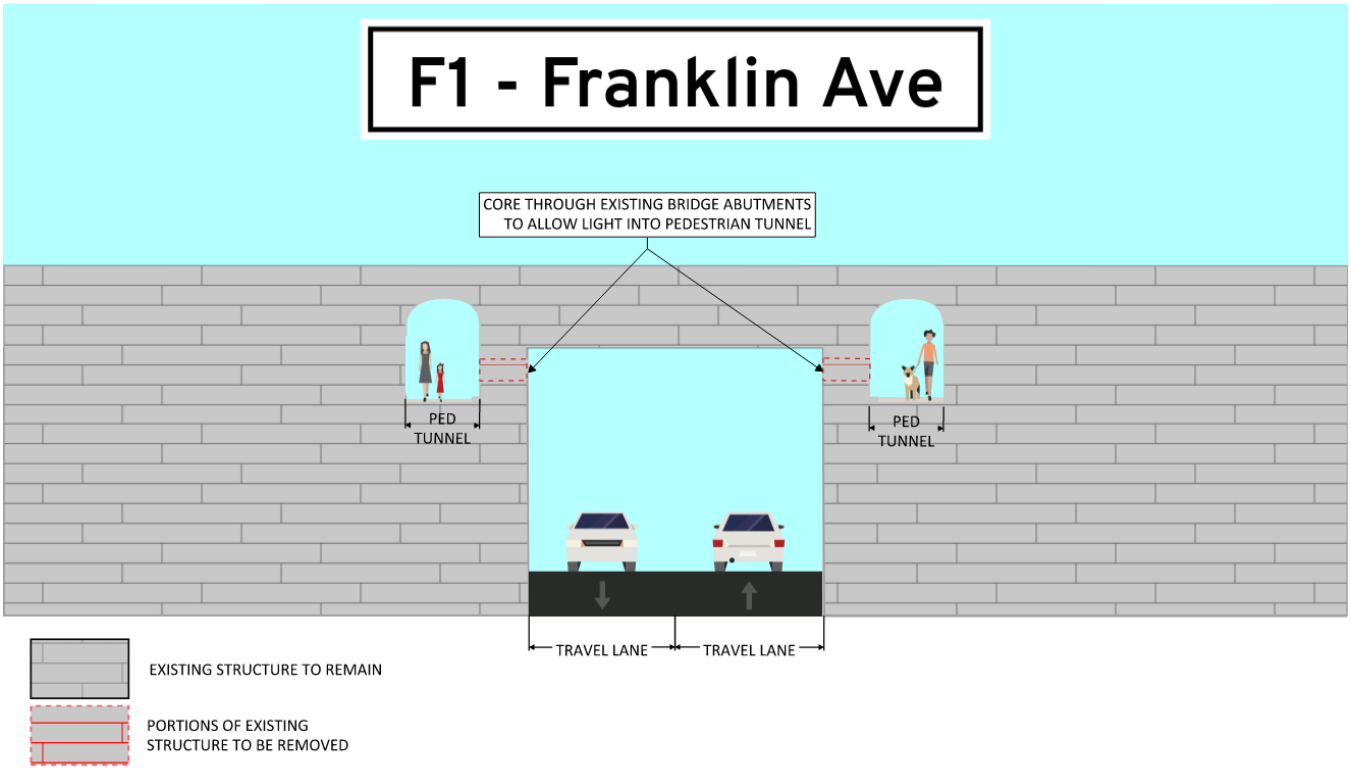
Greenwood Concept 8

Greenwood Concept 11

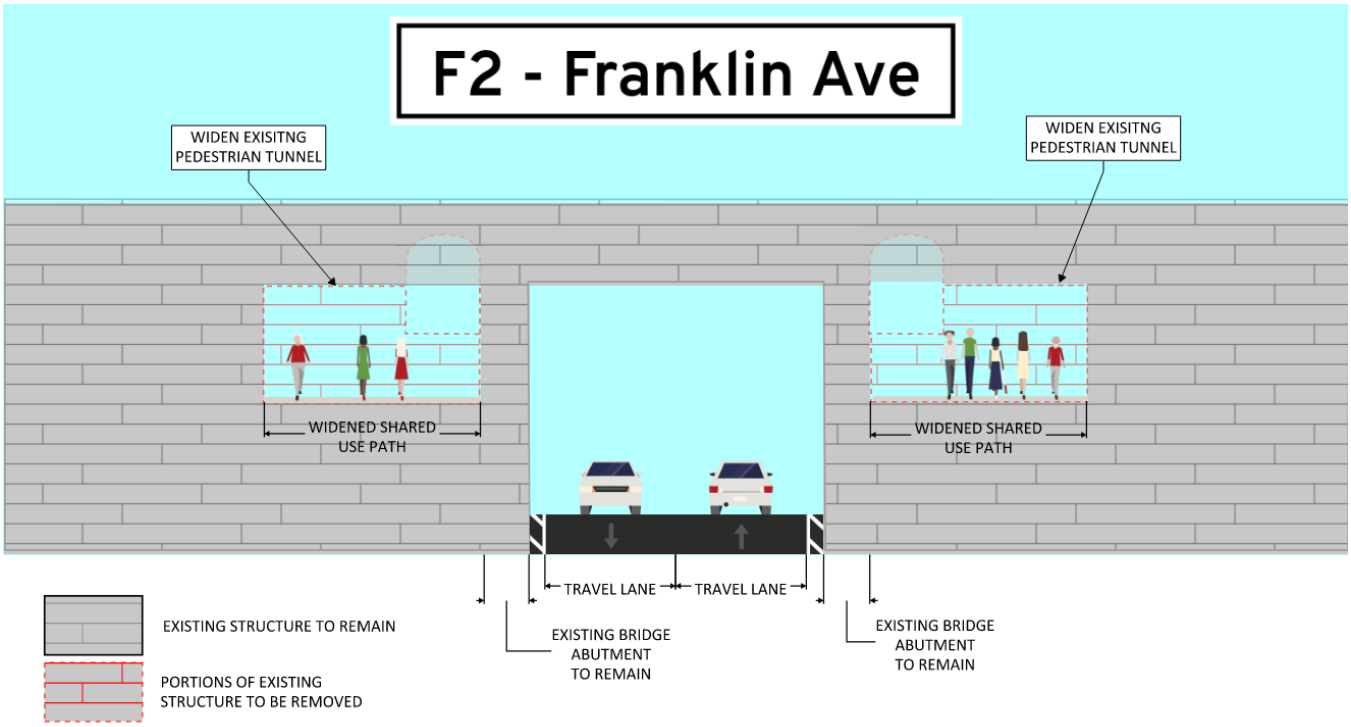




Franklin Concept 1



Franklin Concept 2



Franklin Concept 5