Grade-separated pedestrian and bicycle crossings

May 2017
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1 Introduction and summary

This working paper outlines a process for identifying and prioritizing potential new grade-separated crossings for pedestrians and bicyclists. A grade-separation is any structure that conveys pedestrians and bicyclists over or under interstates, railroad tracks, and busy streets.

This working paper is intended to function as a companion document to Working Paper 9.1: At-Grade Pedestrian and Bicycle Crossings

Benefits of grade-separated crossings

Grade-separated crossings can be essential and beneficial components of the walking and biking environment and can help to encourage walking and biking.

Along Flagstaff’s two interstate highways – I-17 and I-40 – grade-separations are the only way for pedestrians and bicyclists to get across.

For the BNSF railroad tracks, it is extremely unlikely that any additional at-grade crossings will be allowed. As a result, any new track crossings for pedestrians and bicyclists must be grade-separated.

Both the interstates and the railroad tracks typically have very long distances between crossings, so these features can become significant barriers and impediments to a robust pedestrian and bicycle network.

Major streets can be crossed at-grade; however, in some cases the width of the street, combined with the speed and volume of traffic, make it difficult or uncomfortable for pedestrians to cross. In these cases a grade-separated crossing can provide a safe and comfortable way across a busy street by removing pedestrians and bicyclists entirely from potential conflicts with vehicles.

Grade-separated crossings can also enhance convenience and functionality for pedestrians and bicyclists. They can shorten out-of-direction travel by allowing users to follow a more direct routes and not requiring pedestrians and bicyclists to go out of their way to reach a legitimate crossing. Such crossings can also eliminate delay, since pedestrians and bicyclists do not have to wait for signals, or slow down or stop to cross a street or intersection.

Methodology

The methodology for identifying and prioritizing potential grade-separated crossings entails five steps:

1 An inventory is created of existing grade-separated pedestrian and bicycle
Grade-separated pedestrian and bicycle crossings.

2 Suitable locations for new grade-separated crossings are identified based on a number of factors.

3 A preliminary prioritization of potential new grade-separated crossings is determined using four evaluation criteria.

4 Potential new grade-separated crossings are reviewed individually to generate specific recommendations for what facilities are needed and for the timing and urgency of the crossing.

5 Cost estimates are prepared to provide a sense of scale of the funding resources needed to implement new grade-separated crossings.

Summary

- Grade-separated crossings, which allow pedestrians and bicyclists to cross over or go under interstate highways, railroad tracks, and busy streets, can be essential and beneficially components of the walking and biking environment.

- Grade-separations need to be planned judiciously and designed with care in order to be successful. Because they are expensive, grade-separations will always be limited in number and must be reserved for places where they will work best.

- There are 21 existing grade-separated crossings for pedestrians and bicyclists in Flagstaff, including nine underpasses, eight tunnels, two bridges, and two overpasses.

- There is potential for an additional 44 new grade-separated crossings on the interstate highways, BNSF railroad tracks, and major streets.

- Of the 44 new crossings, 14 are existing structures that could be retrofit to accommodate pedestrians and bicyclists, and 30 would be new structures built from the ground-up.

- Potential grade-separations can be sorted in four categories to better understand how they can be built in the future: roadway projects, development projects, FUTS projects, and grade-separation projects.

- An initial prioritization of potential grade-separations, based on consideration of four factors, helps determine which are most important and most urgently needed. The four factors are pedestrian generators and attractors, social factors that encourage walking and biking, crossing difficulty, and
anticipated or existing level of use.

- Potential grade-separated crossings have been divided into one of four recommended terms – short, medium, long, or deferred – to reflect their priority and the immediacy of the need for the crossing. Seven grade-separated crossings are recommended in the short term, and another none are recommended in the medium term.

- The total cost of all 44 potential grade-separated crossings is estimated at $64 million. Short term projects are estimated to cost $15 million, and medium term projects will add another $21 million.
## Considerations for grade-separations

Notwithstanding their advantages, grade-separations need to be planned judiciously and designed with care in order to be successful. Grade-separated crossings are significantly more expensive than at-grade crossings, so they will always be limited in number and must be reserved for places where they will work best.

This section describes several important considerations in planning for grade-separated crossings. For all of the potential new grade-separations described in this working paper, these considerations were taken into account to the extent possible.

### As a crossing facility

A grade-separated crossing should never be considered as a substitute for accommodating pedestrian and bicyclist crossings at an intersection. In most cases, intersections and mid-block crossings can be designed with adequate at-grade crossings to meet pedestrians needs.

Grade-separations should be planned only where they make the crossing more convenient and appealing for pedestrians and bicyclists, and should never be less convenient than an at-grade crossing. Grade-separated crossings may not be used if pedestrians and bicyclists feel they can cross at street level in the same amount of time as using the grade-separation.

### Topography

Grade-separated crossings are most functional when existing topography allows for a structure under or over a roadway without the need for extensive ramps to gain or lose elevation. For example, when land on either side of the roadway is elevated, such as when the roadway has been cut into existing grade, a bridge structure over the roadway becomes more feasible. When the roadway is elevated above existing grades on either side, a tunnel is easier to install.

Ideally, the running grade of the approach to the grade-separation will remain as close as possible to existing grade and will not need to gain or lose significant elevation to make the crossing.

When ramps are needed, the ramp should be gradual and designed as an integral part of the structure, such that using the ramp feels like a natural and comfortable part of the trail. Ramps that are short and steep, including ramps that spiral or switchback, will be perceived as artificial and inconvenient.
Design

Good design is critical, particularly in the case of tunnels and underpasses, for the comfort and perceived safety of users. When crossings are not well-designed, they may be uncomfortable and perceived as unsafe or undesirable, and will not be used.

Appropriate design includes structures that are open and inviting, well-lighted, accessible, and visible with long sight lines. Design must also account for drainage, maintenance, lighting, and other technical considerations.

Locational considerations

In short, grade-separated crossings should be planned for places where they are most useful and will be used. This means that they should be sited to allow users to connect origins and destination, where land uses are denser and more compact, along existing line of travel for pedestrians and bicyclists, and where there is already a demand for crossings.

Location is a critical element for grade-separations; if are perceived to be too far out of the way they will not be used.
3 Existing grade-separated crossings

For the first step in this analysis, an inventory was made of all the existing grade-separated pedestrian and bicycle crossings in Flagstaff. A total of 21 existing crossings were found.

Locations of existing grade-separations are shown on Map 1, and detailed descriptions of all 21 are included in Appendix A on page 26.

Types

There are four types of grade-separated crossings:

- **Bridge**: a structure over an interstate highway, railroad tracks, or major road for the exclusive use of pedestrians and bicyclists

- **Tunnels**: a structure under an interstate highway, railroad tracks, or major road for the exclusive use of pedestrians and bicyclists

- **Overpass**: a structure that conveys a roadway over an interstate highway, railroad tracks, or major road that also accommodates pedestrians and bicyclists, either on a FUTS trail or via sidewalks and bike lanes

- **Underpass**: a structure that conveys a roadway or drainage under an interstate highway, railroad tracks, or major road that also accommodates pedestrians and bicyclists, either on a FUTS trail or via sidewalks and bike lanes

According to Table 1, most of the existing grade-separations are either underpasses (nine) or tunnels (eight). There are only two existing bridges, and two existing overpasses.

Completeness

There are additional existing overpasses and underpasses in Flagstaff; however a number of them are not counted in this inventory because they do not presently include facilities to accommodate both pedestrians and bicyclists.

Overpasses and underpasses are not counted as complete unless they have a FUTS trail, or include both sidewalks and bike lanes on both sides of the street. There are six existing overpasses and five underpasses that are not included in the inventory are a result of not being complete. All eleven are listed below.
Incomplete underpasses

- Aquaplex Trail @ Fourth St (planned FUTS)
- Butler Ave @ I-40 (missing bike lanes)
- Karen Cooper Trail @ Thorpe Rd (planned FUTS)
- Milton Rd @ BNSF (missing bike lanes)
- Santa Fe Trail @ I-40 (missing sidewalks)

Incomplete overpasses

- Country Club Trail @ I-40 (existing sidewalk to be replaced with FUTS)
- Fourth Street Trail @ I-40 (planned FUTS trail, missing sidewalk)
- JWP Trail @ I-17 (planned FUTS, missing sidewalk and bike lanes)
- Route 66 @ BNSF (missing sidewalks)
- Walnut Canyon Rd @ I-40 (missing sidewalks)
- Woody Mountain Trail @ I-40 (planned FUTS, missing sidewalk and bike lanes)

Crossability

“Crossability” is a term that indicates if a feature can be crossed at-grade by pedestrians and bicyclists, or if crossings are prohibited and grade-separations must be used.

Interstate 40, Interstate 17, and the BNSF railroad are all defined as not-crossable features. By law, pedestrians and bicyclists are not allowed to cross interstate highways; as a result, a grade-separation is required to accommodate crossings.

Although there are several existing at-grade crossings of the BNSF tracks (Beaver Street, San Francisco Street, Ponderosa Parkway, Steves Boulevard, and Fanning Drive), BNSF has indicated that it will not allow any new at-grade crossings for pedestrians and bicyclists. As a result, any new crossings of the BNSF tracks must be grade-separated.

Table 2 provides a breakdown of the crossability status for existing grade-separations. Thirteen existing grade-separations are located on not-crossable features and eight are located on crossable features.
Crossed features

Table 3 summarizes the individual features that are crossed by existing grade-separations. Interstate 40 has the most at eight, followed by the BNSF railroad at three and Interstate 17 with two. Eight other features, all surface streets, include one existing grade-separated crossing each.

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<thead>
<tr>
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<th>Number</th>
<th>Percent</th>
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<td>BNSF railroad</td>
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<td>14.3</td>
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<tr>
<td>Interstate 17</td>
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Grade-separated pedestrian and bicycle crossings

Map 1: Existing grade-separated crossings
Planned grade-separated crossings

As a second step, potential locations for a total of 44 new grade-separated crossings have been identified. All of the planned locations are depicted on Map 3 on page 14.

Selection criteria for new locations

Potential locations for new grade-separated crossings were identified based on following circumstances:

- At-grade crossings identified in Working Paper 9.1: At-Grade Pedestrian and Bicycle Crossings, where there is a very high demand for crossings and the streets are among the most difficult to cross.

- Crossings depicted on the FUTS master plan, where planned FUTS trails cross the interstates or the BNSF railroad.

- Locations where there is an existing need to cross the interstates or BNSF railroad, based on observation or evidence of pedestrians and bicyclists already crossing at that location.

- Existing overpasses and underpasses that currently do not include complete facilities to accommodate pedestrians and bicyclists, including sidewalks, bike lanes, and FUTS trails.

- Existing tunnels that could be retrofit for FUTS trails.

- Planned future roads where FUTS trails are also planned and there is an opportunity to build a grade-separated crossing into the new roadway.

- Where there are long distances between existing grade-separated crossings along the interstates and the BNSF tracks, where there would be a benefit to having an additional crossings.

Characteristics of proposed grade-separated crossings

Status

About a third of planned grade-separations (14 of 44) will improve existing underpasses, overpasses, and tunnels for use by pedestrians and bicyclists (Table 4). The 14 existing structures include six existing overpasses and five underpasses to which bicycle and pedestrian facilities can be added. There are also three existing tunnels that are

<table>
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</table>
suitable to retrofit for a FUTS trail (Table 5).

The remaining 30 planned grade-separations are new structures that must be built from scratch. Both the planned and existing but not improved grade-separations are depicted on Map 4 on page 15.

For further detail regarding the improvement level of existing structures, refer to the Completeness section in the previous chapter beginning on page 6.

**Type**

Map 5 depicts, and Table 6 lists planned grade-separations by anticipated type.

Eighteen of the 44 planned grade-separations are anticipated to be tunnel structures, and seven will be built as bridges. Overpasses will accommodate eight future grade-separations, and underpasses will be used for seven.

For four planned grade separations, existing topography does not readily suggest whether it would be more advantageous to cross over or go under. These are classified as “undetermined” for type, although they will be either a tunnel or a bridge. In these cases, further analysis and preliminary engineering may be needed to determine the appropriate structure.

**Crossability**

The 44 planned grade-separations are split evenly between those that cross features that are not crossable with at-grade facilities (22 total) and those that could be crossed using an at-grade crossing (22 total) (Table 7). Refer to the Crossability section in Chapter 3 above, beginning on page 7, for further information regarding the concept of crossability. Map 6 on page 17 shows proposed grade separations by crossability.

**Crossed features**

A total of 15 different features will be crossed by the 44 new grade-separations; these are listed in Table 8. Interstate 40 has the most planned grade-separated
crossings, with 12; followed by the BNSF tracks with seven. Milton Road and new Lone Tree Road are planned for 4 new grade-separations each, while Interstate 17 and old Lone Tree Road include 3 each.

Project categories

Planned grade-separations can be sorted into project categories to better understand how they can be built in the future. Project categories for grade-separations are described below, and summarized in Table 9 and Map 7.

- **Roadway project:** include grade-separated crossings that will be built in conjunction with a future roadway project. Typically these projects involve construction of a new road, or widening of an existing roadway, which creates a need and opportunity to add a grade-separation. A total of 16 of the planned 44 crossings are anticipated to be added in conjunction with a future roadway project.

- **Development projects:** two planned grade-separations will be constructed as part of future development projects. One is part of the Juniper Point development and consists of a tunnel to convey the planned Bow & Arrow FUTS Trail under realigned Lone Tree Road. The other is adjacent to the Canyon del Rio development, and will build a tunnel for the Foxglenn FUTS Trail under the extension of Fourth Street.

- **FUTS projects:** four planned grade-separated crossings will be built as part of future FUTS trail projects. All four projects consist of retrofitting existing structures to accommodate a FUTS trails, so it is assumed that the work will be included as part of the normal construction for a FUTS.

- **Grade-separation projects:** the last category includes grade-separations that must be built as stand-alone projects because they are not planned and there is no opportunity to build them as part of another project. Half (22 of 44) of planned grade-separations fall into this category.

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<td>BNSF railroad</td>
<td>7</td>
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<td>Milton Road</td>
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</tr>
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<td>New Lone Tree Road</td>
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</tr>
<tr>
<td>Interstate 17</td>
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<td>Route 66 West</td>
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<td>FUTS project</td>
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<td>Development project</td>
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</table>
Planned grade-separations

Map 3
Grade-separated pedestrian and bicycle crossings

Map 4
Planned grade-separations by status

Status
- Existing - not improved
- Proposed

1 Mile
Grade-separated pedestrian and bicycle crossings

Map 5
Planned grade-separations by type

Type
- Bridge
- Tunnel
- Overpass
- Underpass
- Undetermined

Legend

Map 5: Planned grade-separations by type

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Map 6
Planned grade-separations by crossability

Crossability
- Not-crossable feature
- Crossable feature

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5 Initial prioritization

For this step, an initial prioritization score is derived for all 44 potential grade-separated crossing locations, based on the four factors described below. An initial prioritization provides a preliminary assessment of the need for and priority of the potential crossing.

Prioritization factors

Pedestrian generators and attractors

This factor considers the proximity of the proposed grade-separation to facilities that attract or generate pedestrian and bicycle trips (listed below) and helps to identify places where people are more likely to walk and bicycle.

- Schools
- Parks
- Commercial areas
- Employment areas
- Transit stops
- Residential neighborhoods
- Existing grade-separated pedestrian and bicycle crossings
- Institutions
- NAU campus

Each potential crossing is given score based on a composite of these nine types of features; higher scores for this measure indicate higher concentrations of places that attract and generate walking and biking trips, and therefore a greater need for grade-separated crossings.

A complete description of this factor is found in Appendix A of Working Paper 7: Missing Sidewalk Inventory and Prioritization.

Social factors

The methodology for this measure is similar to that of pedestrian generators and attractors, but uses social factors that describe circumstances that make people more likely to walk or bike. Social factors used in this analysis include:

- Elderly populations
- Human service facilities
- Persons with disabilities
- Low income neighborhoods
- Affordable housing
- Children under the age of 18
- Young adults between 18 and 24
Households that do not have access to a vehicle

Each planned grade-separation is given score based on a composite of these factors; higher scores for this measure indicate higher concentrations of circumstances that lead to walking and biking and therefore a greater need for crossings.

A complete description of this factor is found in Appendix A of Working Paper 7: Missing Sidewalk Inventory and Prioritization.

**Crossing difficulty**

Describes characteristics of the street that make crossing easier or more difficult for pedestrians and bicyclists, including the number of lanes to cross, the volume of traffic, and the speed of traffic. Scores for each planned crossing are derived using the scoring system described in Table 10.

For streets that can be crossed at-grade, the maximum score for this measure is 9 points, which includes up to 3 points for each of the 3 factors – lanes, volume, and speed. For interstate highways and the BNSF railroad, which cannot be crossed at-grade and must use a grade-separated crossing, a crossing difficulty score of 12 is assigned.

**Level of use**

The fourth measure assesses the existing and potential future level of use for the crossing, based on current and anticipated pedestrian activity in the area, the frequency of observed pedestrian crossings in the vicinity, the density and character of development in the area, and the presence of pedestrian generators and attractors on both sides of the crossing.

Initial prioritization for all 44 crossings are presented on Map 8 on the following page.
Grade-separated pedestrian and bicycle crossings

Map 8: Planned grade-separations by initial prioritization

Priority
- High
- Medium
- Low


### 6 Recommended terms

The next-to-last step in the analysis describes the recommended timing of construction of the grade-separation, based on the urgency and immediacy of the need for the crossings. Recommendations for timing begin with the initial priority score described in Chapter 5, but also consider technical complexity, constructability, and ease of installation for the grade-separation.

#### Recommended terms

Planned grade-separations have been divided into one of four recommended terms, which are described below. Recommended terms are also summarized in Table 11, and illustrated on Map 9.

- **Short term**: there is an existing or immediate need for the crossing, and it is recommended for completion within the next five years.

- **Medium term**: crossings which have with less of an immediate need and are recommended in the 5 to 10-year time frame. These crossings may also be more difficult to construct in terms of technical complexity.

- **Long term**: includes projects that a beyond a 10-year time frame. In some of these cases the need for the crossing is contingent on future development, such as the extension of a road or FUTS trail, construction of a new commercial development, or redevelopment of an area.

- **Deferred**: crossings that will be implemented as part of another project, including intersections that are planned for a traffic signal or roundabout, as well as crossings that are planned as part of private development.

Seven of the 44 grade-separated crossings are needed immediately and recommended for implementation in the short term. Another nine projects are considered medium term projects, and 11 grade-separations can be delayed until the long term. A total of 17 of the 44 projects can be deferred to a future roadway or development project.
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Map 9
Planned grade-separations by recommended term

Term
- Short
- Medium
- Long
- Deferred

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7 Estimated costs

The final step in the analysis is an estimation of the cost to build planned grade-separations. Cost estimates, even though they are generalized and planning-level at this point, provide an overall sense of scale and enable pursuit of potential funding for the projects.

Estimates

Estimated costs for planned grade-separations are based on the City’s previous experience with grade-separated crossing projects, including the Crescent Bridge on the Karen Cooper Trail, the Matt Kelly Bridge on the Arizona Trail, and the Florence-Walnut Underpass; as well as actual bid proposals and construction costs for several projects in other communities.

Each project was reviewed individually, and estimates were adjusted up or down based on several factors, including the type of project (bridge or tunnel), its overall length, opportunities or limitations of the site, anticipated complexity of design and construction, and grading and topography.

- For structures that are built from the ground-up as stand-alone projects, anticipated costs for bridges range from $2 to $5 million, and cost estimates for tunnels vary from $3 to $5 million.

- Projects that are planned as a retrofit of an existing structure are considerably less expensive. For these projects, estimated costs are limited to the work needed to add a FUTS trail, sidewalks, or bike lanes.

- FUTS projects that retrofit existing structures tend to be not very complicated or expensive, as a result project costs have been included in the cost of the trail project and are not included in total cost estimates presented in this report.

- The cost of deferred projects is assumed to be part of the future roadway or development project, and not accounted for in this working paper.

Total costs

Overall, the total cost of all 44 planned grade-separated crossings is estimated at $64 million.

Cost by status

Of the total amount, about $1 million is needed to retrofit 14 existing grade-separation structures for pedestrian and bicycle use, and $63 million is

<table>
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<td>Status</td>
<td>Crossings</td>
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<td>Proposed</td>
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</tr>
<tr>
<td>Existing, not improved</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
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</table>
anticipated for construction of 30 new grade-separated structures (Table 12).

**Cost by recommended term**

There are a total of seven grade-separated projects recommended in the short term, which will cost an estimated $15 million (Table 13). Nine recommended medium-term projects comprise $21 million of the total cost, and $28 million is anticipated for 11 projects planned in the long-term.

**Cost by crossing type**

Construction of 18 planned tunnel structures will cost a total of $36.2 million, while seven planned bridges are estimated at $16 million. Four projects, totaling $11 million in estimated costs, are undetermined and could be either a bridge or a tunnel structure (Table 14).

In total, bridges and tunnel projects add up to $63.2 million of the $64 million total. Retrofit of 15 existing overpasses and underpasses is considerably less expensive at only $800,000.

<table>
<thead>
<tr>
<th>Term</th>
<th>Crossings</th>
<th>Est cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>7</td>
<td>$15.00 m</td>
</tr>
<tr>
<td>Medium</td>
<td>9</td>
<td>$21.00 m</td>
</tr>
<tr>
<td>Long</td>
<td>11</td>
<td>$28.00 m</td>
</tr>
<tr>
<td>Deferred</td>
<td>17</td>
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</table>

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<thead>
<tr>
<th>Type</th>
<th>Crossings</th>
<th>Est cost</th>
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</thead>
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<tr>
<td>Tunnel</td>
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<tr>
<td>Bridge</td>
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</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>$64.00 m</td>
</tr>
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### Appendix A | List of existing grade-separated crossings

**Table 15**

<table>
<thead>
<tr>
<th>ID</th>
<th>Crossing</th>
<th>Crosses</th>
<th>L/W/H</th>
<th>Facilities</th>
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<tr>
<td></td>
<td><strong>Bridges</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B029</td>
<td>Matt Kelly Bridge @ Cedar Ave</td>
<td>Cedar Ave</td>
<td>195</td>
<td>12</td>
</tr>
<tr>
<td>B032</td>
<td>NAU Trail @ McConnell Dr</td>
<td>McConnell Dr</td>
<td></td>
<td>FUTS</td>
</tr>
<tr>
<td></td>
<td><strong>Tunnels</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B002</td>
<td>Arizona Trail @ Butler Ave</td>
<td>Butler Ave</td>
<td></td>
<td>FUTS</td>
</tr>
<tr>
<td>B003</td>
<td>Arizona Trail @ I-40</td>
<td>I-40 (westbound)</td>
<td></td>
<td>FUTS</td>
</tr>
<tr>
<td>B024</td>
<td>Lone Tree Trail @ JW Powell Blvd</td>
<td>JW Powell Blvd</td>
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</tr>
<tr>
<td>B026</td>
<td>Loop Trail @ I-40</td>
<td>I-40</td>
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<td>Singletrack</td>
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<tr>
<td>B042</td>
<td>Route 66 Trail @ Route 66</td>
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<td>FUTS</td>
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<td>Southwest Crossing Trail @ I-40</td>
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<td>Tunnel Spring Trail @ BNSF</td>
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<td>Winifred Lynch Trail @ Hwy 89</td>
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<td></td>
<td><strong>Underpasses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B004</td>
<td>Arizona Trail @ I-40</td>
<td>I-40</td>
<td>--</td>
<td>FUTS</td>
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<tr>
<td>B093</td>
<td>Beulah Blvd @ I-40</td>
<td>I-40</td>
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<td>Lone Tree Trail @ I-40</td>
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<tr>
<td>B038</td>
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<td>I-17</td>
<td>--</td>
<td>FUTS SW BL</td>
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<tr>
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<td>Route 66 Trail @ Country Club Dr</td>
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<td>--</td>
<td>FUTS BL</td>
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<tr>
<td>B040</td>
<td>Route 66 Trail @ Fourth St</td>
<td>Fourth St</td>
<td>--</td>
<td>FUTS</td>
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<tr>
<td>B047</td>
<td>Sinclair Wash Trail @ I-17</td>
<td>I-17/Milton Rd</td>
<td>--</td>
<td>FUTS</td>
</tr>
<tr>
<td>B048</td>
<td>Sinclair Wash Trail @ I-40</td>
<td>I-40</td>
<td>--</td>
<td>FUTS</td>
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<tr>
<td>B050</td>
<td>Sinclair Wash Trail @ I-40</td>
<td>I-40 (westbound)</td>
<td>--</td>
<td>FUTS</td>
</tr>
<tr>
<td></td>
<td><strong>Overpasses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B008</td>
<td>Country Club Trail @ BNSF</td>
<td>BNSF tracks</td>
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<td>FUTS</td>
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<tr>
<td>B015</td>
<td>Fourth Street Trail @ BNSF</td>
<td>BNSF tracks</td>
<td>--</td>
<td>FUTS SW BL</td>
</tr>
</tbody>
</table>
Grade-separated pedestrian and bicycle crossings

Map 10
Existing grade-separations

Type
- Bridge
- Tunnel
- Overpass
- Underpass

May 2017
Appendix B | Descriptions of planned crossings

This appendix provides short descriptions for all 44 potential grade-separation projects.

Short term recommendations

B010/B011 | Downtown Underpass @ BNSF/Route 66

- Structure: two new pedestrian/bike tunnels in series along a planned extension of the Karen Cooper Trail. The first tunnel crosses under Route 66, and the second under the BNSF tracks, parallel to the Rio de Flag. Both tunnels would be built as part of the Rio de Flag flood control project.

- Connectivity: the tunnels would allow extension of the Karen Cooper Trail past the library, Wheeler Park and City Hall, under Route 66 and the BNSF tracks, to Phoenix Avenue. From there pedestrians and bicyclists would continue south through the Southside neighborhood on local streets, cross Butler at the existing flashing crossing, and connect to the north end of the main pedestrian/bike spine on the NAU campus. A westerly extension of the Route 66 Trail would tee into the Karen Cooper Trail in the gap between the two tunnels.

B014 | Florence-Walnut Underpass @ BNSF

- Structure: a planned tunnel will cross under the BNSF tracks just west of downtown. Although it is classified as a tunnel, the structure itself consists of a bridge for the BNSF tracks over the trail.

- Connectivity: the tunnel will connect Florence Street in La Plaza Vieja neighborhood with Walnut Street in the Townsite neighborhood. The crossing is also part of the planned alignment of the Santa Fe Trail, which parallels the tracks from downtown to the far west side of Flagstaff.

B046 | Sheep Crossing Trail @ I17

- Structure: there are two side-by-side concrete box culverts under I-17 and State Route 89A, one of which will be retrofitted for use as a FUTS trail. Each of the boxes is 10 feet in width and 10 feet tall, and the overall length is about 290 feet. Although drainage is conveyed through the tunnels, they were not built for that purpose. It appears that the tunnels were originally intended as a passage for sheep from one side of the interstate to the other. The tunnels are used frequently by bicyclists, less frequently by pedestrians, and there is significant use by quad and dirt bikes.

- Connectivity: the tunnel is planned as part of the Sheep Crossing Trail, which
connects the Ponderosa Trails neighborhood to Fort Tuthill County Park and provides another non-motorized route to events and facilities at the park.

**B063 | Switzer Wash Trail @ BNSF**

- **Structure:** a planned tunnel under the BNSF tracks somewhere between Arrowhead Avenue and First Street, along the alignment of the Switzer Wash. There is an existing culvert under the tracks which conveys the Switzer Wash; however it is not tall enough to accommodate pedestrians and bicyclists, and it is subject to flooding.

- **Connectivity:** the tunnel will support pedestrian and bike access between the Sunnyside neighborhood and the Huntington Drive corridor. There is already an existing well-used pathway between Arrowhead Avenue and Walmart that includes an illegal at-grade crossing over the BNSF tracks.

The tunnel is part of the planned alignment of the Switzer Wash Trail, which extends from the Route 66 Trail on the north to the Foxglenn Trail on the south. Two sets of tunnels are necessary for this trail; this one under the BNSF tracks, and another series of tunnels (B064) under I-40 to the south.

**B067 | University Ave @ Milton Rd**

- **Structure:** a bridge or tunnel to convey pedestrians and bicyclists across Milton Road, generally located between University Avenue on the west side of Milton and the northwest corner of the Target parking lot on the east. Existing topography does not readily suggest crossing over or going under, so further evaluation is needed to determine which would work better.

- **Connectivity:** the proposed tunnel/bridge would be an important component of a potential pedway/bikeway that parallels Milton Road and Beulah Boulevard from Lake Mary Road on the south to Dupont Avenue on the north. At this location, the pedway/bikeway would cross from the west to the east side of Milton. The structure would also support pedestrian and bicycle travel between the Woodlands Village area and the NAU campus.

**B084 | Butler Ave @ I40**

- **Structure:** there are existing sidewalks, but not bike lanes along Butler Avenue through the I-40 overpass/interchange. Bike lanes through this stretch have been planned and costed as part of the missing bike lanes analysis.

- **Connectivity:** bike lanes through the interchange are part of the plan for adding bike lanes to Butler Avenue between Ponderosa Parkway and Little America.
Grade-separated pedestrian and bicycle crossings

Map 11
Recommended short term grade-separations

Term
- Short
- Medium
- Long
- Deferred
- Existing FUTS
- Planned FUTS

May 2017
Medium term recommendations

B009 | Country Club Trail @ I40

- Structure: there is an existing sidewalk along the east side of the Country Club bridge over I-40, which is 6 feet in width and has concrete barriers on both sides. In the medium term, it may be possible to move the existing concrete barrier on the street side 4 to 6 feet to the west to create room for a 10-12 foot FUTS trail along east side. As an alternative, a full-width FUTS can be included in the future when the bridge is reconstructed, although there is no schedule for reconstruction at this time.

- Connectivity: the sidewalk on the bridge represents a narrow segment of the Country Club Trail, which continues north and south of the bridge as a 10-foot FUTS trail.

B012 | Fanning Wash @ I40

- Structure: two existing concrete box culverts under I-40 convey the Fanning Wash, but are also regularly used by pedestrians and bicyclists to cross the interstate. The existing structures may not be tall enough to support a formal crossing, and the culverts are subject to flooding. As a result, new structures may be required for a crossing.

- Connectivity: on the south side of the interstate the crossing connects directly to Soliere Avenue. On the north side, a trail connection would be needed along the Fanning Wash to connect to Huntington Drive. From that point, further analysis should be undertaken to identify potential sidewalks, bike lanes, and FUTS trails to create a convenient route for pedestrians and bicyclists through the industrial area to Industrial, Fanning, or Route 66.

This location should be considered as an either/or option with B058, which is about 2200 feet to the west along I-40. Both locations are probably not needed for grade-separations.

B020 | Karen Cooper Trail @ Thorpe Rd

- Structure: this crossing would use the western-most arch of the Thorpe Road bridge over the Rio de Flag, which was reconstructed several years ago as part of the Rio de Flag flood control project.

- Connectivity: the existing Karen Cooper Trail parallels the Rio de Flag through this area, and crosses Thorpe Road on an existing at-grade crossing. Overall, the Karen Cooper Trail generally follows the Rio from downtown Flagstaff to the Chesire neighborhood on the northwest side of the city.
B028 | Malpais Ln @ Milton Rd

- **Structure:** a dedicated pedestrian and bicycle bridge over Milton Road may work well at his location. On the west side of the street, easements or acquisition of property rights from the existing businesses would be necessary for a trail connection and ramp up to the bridge. On the campus side of the street, the grade rises somewhat from street level, making the landing from the bridge more manageable.

- **Connectivity:** in addition to providing direct access to the northwest corner of the NAU campus, the bridge would also link several potential pedestrian and bicycle facilities in this area, including the Santa Fe Trail extending to the west, the Florence-Walnut Underpass to the north, and the Milton bike/pedway along the east side of Milton. The slope beneath the two bridges may have to be reconfigured to create enough width for a shared-use path.

B045 | Santa Fe Trail @ Route 66

- **Structure:** grades at this location suggest a tunnel structure under the road, although a bridge is also a possibility.

- **Connectivity:** a grade-separation at this location will accommodate extension of the planned Santa Fe FUTS Trail, and will provide a way across Route 66 between the proposed Timber Sky development on the south side and the Clay Wash detention basin on the north. Long term plans call for a park and playing fields in the basin.

B051 | Sinclair Wash Trail @ Lone Tree Rd

- **Structure:** the Sinclair Wash is conveyed under Lone Tree Road at this location via two-existing side-by-side concrete box culverts. It may be possible to retrofit one of the boxes for use as a FUTS crossing for the Sinclair Wash Trail. However, a drainage analysis is necessary to determine of the box is needed for flow capacity. If existing drainage cannot be accommodated in one of the boxes, a separate structure would have to be built for the trail. There may be an opportunity when Lone Tree Road is reconstructed and widened.

- **Connectivity:** a tunnel for the trail at this location would provide a comfortable way across a street that is fairly busy now, but will be even busier and significantly wider in the future. The tunnel would also eliminate two very awkward street crossings for pedestrians.

B053 | Sinclair Wash Trail @ Woodlands Village Blvd

- **Structure:** the Sinclair Wash Trail crosses Woodlands Village Boulevard at-
grade at this location, but the existing crossing has minimal improvements and is generally not comfortable for pedestrians and bicyclists using the trail. The existing crossing is also identified in Working Paper 9.1: At-Grade Pedestrian and Bicycle Crossings as a potential location for a pedestrian beacon to enhance the existing at-grade crossing, but in the longer-term there may be a benefit to grade-separation. Because the existing FUTS parallels the Sinclair Wash in this location, it may be advantageous to go under Woodlands Village Boulevard. However, a bridge over the street is also an option.

- Connectivity: the crossing is on the alignment of the existing Sinclair Wash Trail, a long, continuous trail that extends south to Fort Tuthill and east to the Arizona Trail, passing through the NAU campus along the way. The crossing would also be part of a potential pedway/bikeway parallel to Milton Road.

**B058 | Steves Wash @ I40**

- Structure: there are two existing concrete box culverts in series that convey the Steves Wash under I-40. The boxes are about 85 and 100 feet in length, 10 feet in width, and 8 feet tall. There is evidence of pedestrian and bicycle use, although it does not appear to be as frequent as B012. The existing structures are undersized for a pedestrian/bicycle tunnel, and subject to flooding, so a new structure for pedestrians and bicyclists is needed.

- Connectivity: this location is similar in character and function to B012, and should be considered as an either/or option. While the south end connects directly to Soliere Avenue, there is existing industrial development between the end of the box and Huntington Drive. An easement from one or more of the property owners would be necessary to continue the trail. Once the trail reached Huntington, there would be a relatively short connection to reach Industrial Drive to the north.

**B060 | Sunset Trail @ Forest Ave**

- Structure: at this location, Forest Avenue is cut into existing grade, by about 10 feet on the north and 16 feet on the south. This allows a structure to bridge over the roadway and maintain required roadway clearance without a significant ramp up to the bridge height.

- Connectivity: the bridge would extend the Sunset Trail over Forest Avenue to the Switzer Canyon trail on the north side of McMillan Mesa. This crossing would provide a number of benefits, including creating an opportunity for a long recreational loop on McMillan Mesa south of Cedar/Forest to complement the loop in Buffalo Park, making it easier for residents on the Mesa to get to the bus stop, park facilities, and open space on the north side of Forest, and enhancing access to Basis School and other uses on the Mesa.
Grade-separated pedestrian and bicycle crossings

Map 12: Recommended medium term grade-separations
Long term recommendations

B001 | Aquaplex Trail @ Fourth St

- Structure: a future FUTS trail is planned along the alignment of an existing access road on the south side of the BNSF tracks, and will use the existing Fourth Street bridge structure to cross under Fourth Street. The existing structure may need improvement, including lighting, to facilitate the trail.

- Connectivity: the planned trail connects to Industrial Drive on the east and the future Switzer Wash Trail on the west, and enhances access to the Aquaplex on the east side of Fourth Street and the Arizona Department of Economic Security facility on the west.

B031 | NAU Trail @ I40

- Structure: this location would be suitable for a series of two pedestrian and bicycle bridges over I-40. Both the eastbound and westbound lanes of I-40 are cut into existing grade by 18 to 30 feet at this location, which makes it easier to bridge over the interstate and meet the required clearance between the interstate surface and the bottom of the bridge structure. There is also a wide, elevated median between the eastbound and westbound lanes, so the crossing can be broken into a series of two bridges with a length of 175 -200 feet each, instead of one very long bridge.

- Connectivity: the bridges connect the south end of the NAU campus with vacant land on the south side of I-40 that is owned by the university, and will enhance non-motorized access for any future university development to the south. The bridges are along the alignment of a potential extension of the NAU Trail, which currently ends near the DuBois Center on south campus. Finding a suitable alignment through south campus for a connection to the existing NAU trail may be a little complicated given the pattern of existing buildings, but connecting the trail will create a continuous north-south route through campus.

  The crossing is also located at a convenient spot midway between Beulah Boulevard and Lone Tree Road – the two closest streets to the east and west that cross I-40 – so it will improve pedestrian and bicycle connectivity for residents of the neighborhoods south of I-40.

B043 | Santa Fe Trail @ I40

- Structure: there are two existing overpass structures at this location which allow Flag Ranch Road to pass under I-40. A segment of the Santa Fe FUTS is planned along the east side of Flag Ranch Road through the interchange. The slope beneath the two bridges may have to be cut back and held with a
retaining wall to create enough width for a shared-use path.

- **Connectivity:** to the south the Santa Fe Trail follows the east side of the road and connects to the Dry Lake Trail at Kiltie Lane. To the north the planned trail alignment veers east through the planned Timber Sky development, crosses Route 66 and continues through the Clay Wash detention basin, then follows the south side of the BNSF tracks all the way into downtown.

**B052 | Sinclair Wash Trail @ San Francisco St**

- **Structure:** San Francisco Street is approximately 15 to 18 feet above grade where it crosses the Sinclair Wash, which allows installation of a tunnel structure for the Sinclair Wash Trail.

- **Connectivity:** the Sinclair Wash Trail currently crosses San Francisco Street at-grade just north of this location. A proposed tunnel would realign the trail to cross under San Francisco, which would remove the at-grade crossing and enhance non-motorized access to campus for those coming from the east. The tunnel would also keep the trail closer to the elevation of the wash and eliminate a very steep climb to the crossing on the east side of the street.

**B054 | Southside Rio Trail @ Butler Ave**

- **Structure:** a large corrugated metal pipe was constructed at this location several years ago as part of the Rio de Flag flood control project to convey the existing wash under Butler Avenue. When the Rio flood control project is complete, the Rio de Flag channel will be diverted to a reconstructed version of the wash and will use the existing pipe. The pipe may not be suitable to retrofit for pedestrian and bicycle use; as a result, an additional structure may be required to allow the trail to pass under Butler Avenue.

- **Connectivity:** on the north side of Butler Avenue, a future trail and maintenance access road will be built in conjunction with reconstruction of the wash. The trail is planned to follow the wash all the way from Butler to San Francisco Street, just south of the BNSF tracks, in downtown. To the south, a planned FUTS follows the canyon and connects to the existing Sinclair Wash Trail.

**B064 | Switzer Wash Trail @ I40**

- **Structure:** the planned alignment of the Switzer Wash Trail crosses under I-40 at the approximate location of two existing concrete box culverts aligned in series. The existing tunnels are very long (180 and 200 feet), are smaller than a desirable pedestrian and bicycle tunnel (10 feet wide and 8 feet high), and convey the Switzer Wash. As a result, they may not be suit-
able for use as a trail and a separate structure may be necessary. Interstate 40 is considerably higher than natural grade at this location, making a new tunnel structure feasible.

- **Connectivity:** the tunnel is part of the planned alignment of the Switzer Wash Trail, which extends from the Route 66 Trail on the north to the Fox-glen Trail on the south. Two sets of tunnels are necessary for this trail; this one under I-40, and another (B063) under the BNSF tracks to the north.

**B068 | Walnut Canyon Trail @ BNSF**

- **Structure:** there is a very small existing culvert that carries the Rio de Flag under the BNSF tracks. A new tunnel structure would be installed for pedestrians and bicyclists. At this location the tracks are about 30 feet above grade, so a tunnel structure is ideal.

- **Connectivity:** the tunnel would support the planned Walnut Canyon FUTS Trail, which is aligned to the east and south of Country Club, Walnut Meadows, and Amberwood neighborhoods. The trail would provide comfortable pedestrian and bicycle travel between the southeast part of the city and Picture Canyon or the mall commercial area.

A series of three grade-separations are needed to convey the trail through this area; B069 uses a series of existing tunnels under I-40, B068 is a new tunnel structure under the BNSF tracks, and B071 is a new tunnel under Route 66.

**B069 | Walnut Canyon Trail @ I40**

- **Structure:** a series of two concrete box culverts under I-40 do not appear to be used for drainage, and could be retrofitted for FUTS crossings. The tunnels are 12 feet wide and 10 feet in height.

- **Connectivity:** the tunnel would support the planned Walnut Canyon FUTS Trail, which is aligned to the east and south of Country Club, Walnut Meadows, and Amberwood neighborhoods. The trail would provide comfortable pedestrian and bicycle travel between the southeast part of the city and Picture Canyon or the mall commercial area.

A series of three grade-separations are needed to convey the trail through this area; B069 uses a series of existing tunnels under I-40, B068 is a new tunnel structure under the BNSF tracks, and B071 is a new tunnel under Route 66.
B071 | Walnut Canyon Trail @ Route 66

- **Structure:** existing grades would allow installation of a new tunnel under Route 66.

- **Connectivity:** the tunnel would support the planned Walnut Canyon FUTS Trail, which is aligned to the east and south of Country Club, Walnut Meadows, and Amberwood neighborhoods. The trail would provide comfortable pedestrian and bicycle travel between the southeast part of the city and Picture Canyon or the mall commercial area.

A series of three grade-separations are needed to convey the trail through this area; B069 uses a series of existing tunnels under I-40, B068 is a new tunnel structure under the BNSF tracks, and B071 is a new tunnel under Route 66.

B075 | Zuni Trail @ Lone Tree Rd

- **Structure:** Lone Tree Road is cut into existing grade by about 10 feet at this location, creating an opportunity to build a bridge structure over the street.

- **Connectivity:** the proposed bridge is along the planned alignment of the Zuni Trail, which follows the south side of I-40 from Lake Mary Road to Lone Tree Road.

B095 | Woodlands-Milton Trail @ Milton Rd

- **Structure:** this location may be suitable for a bridge structure over Milton Road. There is a cut section about 14 feet in height on the west side of the road which would support a bridge structure. On the east side of Milton, grades are flatter and a ramp up would be required to gain the necessary elevation for clearance over Milton Road. It appears there may be room for a ramp between two existing commercial buildings and along the edge of a parking lot, although acquisition of property rights from private development would be necessary.

- **Connectivity:** the bridge would be part of a potential new FUTS trail along an east-west alignment between Woodlands Village Boulevard and Knoles Drive on the NAU campus.
Grade-separated pedestrian and bicycle crossings

Map 13
Recommended long term grade-separations

Term
- Short
- Medium
- Long
- Deferred

Map 13
Recommended long term grade-separations

Term
- Short
- Medium
- Long
- Deferred
Deferred projects

B007 | Bow & Arrow Trail @ Lone Tree Rd

- Structure: when Lone Tree Road is realigned to the east side of the Coconino Community College campus, there is an opportunity to include a tunnel structure where the new road crosses the Bow and Arrow Wash. Realignment of the road is anticipated as part of the Juniper Point development.

- Connectivity: the tunnel would facilitate passage of the Bow and Arrow Trail under realigned Lone Tree Road. The Bow and Arrow Trail follows the wash from the Bow and Arrow neighborhood on the west to the Arizona Trail on the east.

B016 | Fourth Street Trail @ I40

- Structure: there is a 10-foot shoulder along the west side of the two bridges over I-40 at Fourth Street. In the short term, the planned FUTS along the west side of Fourth Street may use the 10-foot shoulder with some form of temporary delineators to separate pedestrians and bicyclists from traffic lanes. In the longer term, the FUTS will be included when the bridges are reconstructed to accommodate widening of Fourth Street. The ultimate cross-section of the bridges will include four vehicular travel lanes, a two-way center turn lane, bike lanes on both sides, a sidewalk on the east side, and a FUTS trail on the west side. The section will match that of the Fourth Street bridge over the BNSF tracks, to the north.

- Connectivity: new bridges will help complete the Fourth Street Trail along the west side of Fourth Street from Route 66 on the north to Butler Avenue on the south.

B019 | JWP Trail @ I17

- Structure: at some point in the future, when ADOT reconstructs the bridge over I-17, the new bridge will include bike lanes, a sidewalk on the south side, and a FUTS trail on the north side.

- Connectivity: the new bridge accommodates the JWP Trail, which parallels J.W. Powell Boulevard for its full existing and planned length.

B021 | Lone Tree Trail @ BNSF

- Structure: a FUTS trail will be included along the west side of Lone Tree Road, when the street is extended to Route 66 from its current northerly terminus at Butler Avenue. This section of Lone Tree Road will include a major overpass to carry the road over the BNSF tracks.
- Connectivity: The Lone Tree Trail is adjacent to Lone Tree Road over its entire existing and planned length, from J.W. Powell Boulevard on the south to Route 66 on the north.

**B025 | Lone Tree Trail @ Kinsey School**

- Structure: when Lone Tree Road is reconstructed and widened, there will be an opportunity to build a new pedestrian and bicycle bridge over the street in the vicinity of Kinsey School.
- Connectivity: the bridge will allow the planned FUTS to cross from the west to the east side of the street. Additionally, it will provide a comfortable crossing for students walking and biking to Kinsey School and the NAU campus from neighborhoods east of Lone Tree Road.

**B033 | New Lone Tree Trail @ I40**

- Structure: a new underpass structure for realigned Lone Tree Road at I-40 will accommodate a planned FUTS trail on the west side of the street, as well as bike lanes on both sides and a sidewalk on the west side.
- Connectivity: a FUTS trail is planned along the west side of new realigned Lone Tree Road.

**B041 | Route 66 Trail @ Lone Tree Rd**

- Structure: the extension of Lone Tree Road, from its current terminus at Butler Avenue to Route 66, will include a major bridge structure over the BNSF mainline and spur tracks. The overpass provides an opportunity to align the existing Route 66 trail under Lone Tree Road to avoid a new busy street crossing.
- Connectivity: the structure accommodates the existing Route 66 Trail, an important commuter route that runs for more than 5 miles from Mall Way on the east to Beaver Street on the west.

**B044 | Santa Fe Trail @ Milton Rd**

- Structure: a planned bridge over Milton Road on the north side of the BNSF tracks and bridge. There may be an opportunity to include the bridge with the widening of Milton Road through this section and reconstruction of the BNSF bridge to accommodate the widening of Milton.
- Connectivity: the bridge is located near the eastern end of the Santa Fe Trail, which is planned to follow along the south side of the tracks from downtown Flagstaff to the far southwest corner of town, a distance of almost 5 miles.
The east end of the Santa Fe Trail aligns with the west end of the Route 66 Trail, which together will form a continuous trail alignment more than 10 miles in length generally following the BNSF tracks from the east to the west end of Flagstaff.

B055 | Southside Rio Trail @ Lone Tree Rd

- **Structure**: similar to B041, the extension of Lone Tree Road from Butler to Route 66 will include a major bridge structure to carry the road over the BNSF mainline tracks and spur; the planned Southside Rio Trail crossing can be accommodated under this structure.

- **Connectivity**: The Southside Rio Trail is planned as part of the Rio de Flag flood control project, on an alignment that follows the realigned Rio de Flag channel between San Francisco Street on the west and Butler Avenue on the east.

B073 | Woody Mtn Trail @ I40

- **Structure**: a FUTS will be included along the west side of Woody Mountain Road when the existing bridges over I-40 are reconstructed to accommodate widening of the road. Bike lanes and a sidewalk on the east side will also be included.

- **Connectivity**: the Woody Mountain Trail follows the west side of Woody Mountain Road from the Santa Fe Trail on the north to the Forest Road 532 on the south, a distance of a little more than 2.5 miles.

B076 | Route 66 @ BNSF

- **Structure**: the existing Route 66 bridge over the BNSF tracks includes shoulders for bikes on both sides, but not sidewalks.

- **Connectivity**: the bridge is located a considerable distance east of the developed part of the city. This is a route for road cycling, so the shoulders are important; but sidewalks are probably not needed at this time in this remote of a location.

B077 | Walnut Canyon Rd @ I40

- **Structure**: a series of two existing bridges for Walnut Canyon Road over I-40. Neither of the bridges have bike lanes or sidewalks.

- **Connectivity**: The bridges are part of a route for road cyclists; so it would be beneficial to restripe the road to include shoulders for bicyclists whenever the road is restriped. It appears that the bridges are wide enough to include
11-foot travel lanes and 4-foot shoulders. Because the bridges are a considerable distance from developed areas of the city, sidewalks are probably not necessary.

**B094 | Milton Rd @ BNSF**

- **Structure:** The existing bridge carries the BNSF tracks over Milton Road at this location. Milton Road includes sidewalks in this segment, but bike lanes are missing.
- **Connectivity:** Opportunities for adding missing bike lanes were considered in *Working Paper 8 - Missing Bike Lanes Inventory and Prioritization*. There is not sufficient width on the existing street for bike lanes, consequently the addition of bike lanes is deferred until Milton Road is widened through this area and the railroad bridge is rebuilt.

**B096 | New Lone Tree Trail @ Lone Tree Rd**

- **Structure:** The corridor plan for Lone Tree Road shows a new alignment that veers east of the current alignment near this spot, and a future intersection between new Lone Tree Road and existing Lone Tree Road. A tunnel structure is proposed to convey the Lone Tree Trail under the realigned road at this intersection.
- **Connectivity:** The tunnel enables the existing FUTS trail to continue south along its current alignment on the east side of existing Lone Tree Road without having to cross the new intersection at-grade; and it facilitates a planned trail along the south and west side of new Lone Tree Road.

**B097 | New Road @ I17**

- **Structure:** Sidewalks, bike lanes, and potentially a FUTS trail will be included on a planned overpass structure over I-17 just south of the Ponderosa Trails neighborhood.
- **Connectivity:** The overpass is planned as part of a new road that will eventually connect from Woody Mountain Road on the west side of I-17 with High Country Trail on the east side.

**B099 | Hoffman Tank Trail @ JW Powell Blvd**

- **Structure:** When J.W. Powell Boulevard is constructed through this area, there will be an opportunity to include a tunnel structure for the planned Hoffman Tank Trail.
- **Connectivity:** The Hoffman Tank Trail is a planned FUTS in the south part of
the city that will be a primary point of access to the National Forest. There may also be an opportunity to reroute the Arizona Trail in this area to take advantage of the future tunnel.
Appendix C | Analysis of distance between crossings

This appendix examines the effect of new grade-separated crossings on the distance between crossings along Interstate 40, Interstate 17, and the BNSF railroad tracks.

All three of these features are considered to be not crossable, in that at-grade pedestrian and bicycle crossings are not allowed on interstate highways, and the BNSF railroad no longer permits new at-grade crossings. The concept of crossability is further explained in Chapter 4 of this document.

Only the three non-crossable features in Flagstaff are included in this analysis. A companion analysis of crossing distance along crossable features, which includes surface streets, is included as Appendix D of Working Paper 9.1 At-Grade Pedestrian and Bicycle Crossings. Proposed grade-separated crossings on crossable streets are included in that analysis.

The section below reviews the distance between crossings for the interstate and BNSF tracks in the current condition and after completion of proposed crossings. Map 11 on page 49 at the end of this Appendix illustrates existing distance between crossings, and Map 12 shows the future distance between crossings.

Distance analysis

Crossings and segments

For the purposes of this analysis, existing grade separations include the following:

- Tunnels and bridges over/under the interstates and BNSF tracks for the exclusive use of pedestrians and bicyclists. There are four existing tunnels, and no bridges.

- Seven existing overpasses and eight existing underpasses. For this analysis all structures are included, regardless of the presence of sidewalks, bike lanes, or FUTS trails.

- Five at-grade crossings of the BNSF tracks at Beaver Street, San Francisco Street, Ponderosa Parkway, Steves Boulevard, and Fanning Drive.

There are a total of 12 new grade-separations proposed to cross the interstate.
or BNSF tracks, including eight tunnels, two overpasses, one underpass, and one bridge.

Each of the three features in this analysis are divided into segments, which are defined as having crossings at both ends. Under present conditions, existing crossings divide the interstates and BNSF tracks into 22 segments. Establishment of 12 new grade-separations will divide existing segments into 34 new segments.

**Mean distance between crossings**

Table 17 shows the mean distance between crossings for the three features under current and future conditions. For all three features, the mean crossing distance is reduced from 6589 feet (about 1.25 miles) in the current condition to 4264 feet (0.81 miles) in the future, a reduction of almost a half-mile (2326 feet). The BNSF tracks and I-40 see a similar reduction (2142 and 2163 feet) in crossing distance, while the average distance between crossings along I-17 drops almost three-quarters of a mile (3952 feet).

**Maximum distance between crossings**

Before-and-after changes in the longest distance between crossings along the three features are presented in Table 18. The BNSF tracks and I-40 see similar reductions, from 3.4 to 2.5 miles for the BNSF tracks and from 3.2 to 2.5 miles for I-40. The maximum crossing distance for I-17 drops from 2.4 to 1.5 miles.

**Segments by length**

Table 20 summarizes existing and future segments by length for the three features. The length of segments is a measure of the distance between crossings.
In the current condition, only two segments are less than a half-mile in length (2640 feet). Following installation of new grade-separated crossings, a total of 11 segments will be less than a half-mile.

Only 10 existing segments have less than a mile between crossings; 26 segments will be less than a mile in length in the future condition.

There are 12 existing segments that are a mile (5280 feet) or more between crossings; this number will be reduced to eight.

<table>
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<th>Existing</th>
<th>Future</th>
<th>Change</th>
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<td>1320 to 2640 feet</td>
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<td>7</td>
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<td>2640 to 5280 feet</td>
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<td>15</td>
<td>7</td>
</tr>
<tr>
<td>5280 to 10560 feet</td>
<td>8</td>
<td>5</td>
<td>-3</td>
</tr>
<tr>
<td>More than 10560 feet</td>
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<td>3</td>
<td>-1</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>34</td>
<td>12</td>
</tr>
</tbody>
</table>
Grade-separated pedestrian and bicycle crossings

Map 12
Future crossing distance
I17-I40-BNSF

Distance
- Less than 1320
- 1320 to 2640
- 2640 to 5280
- 5280 to 10560
- More than 10560

Future crossings
Existing crossings

1 Mile