5 RECOMMENDED DESIGN CONCEPT

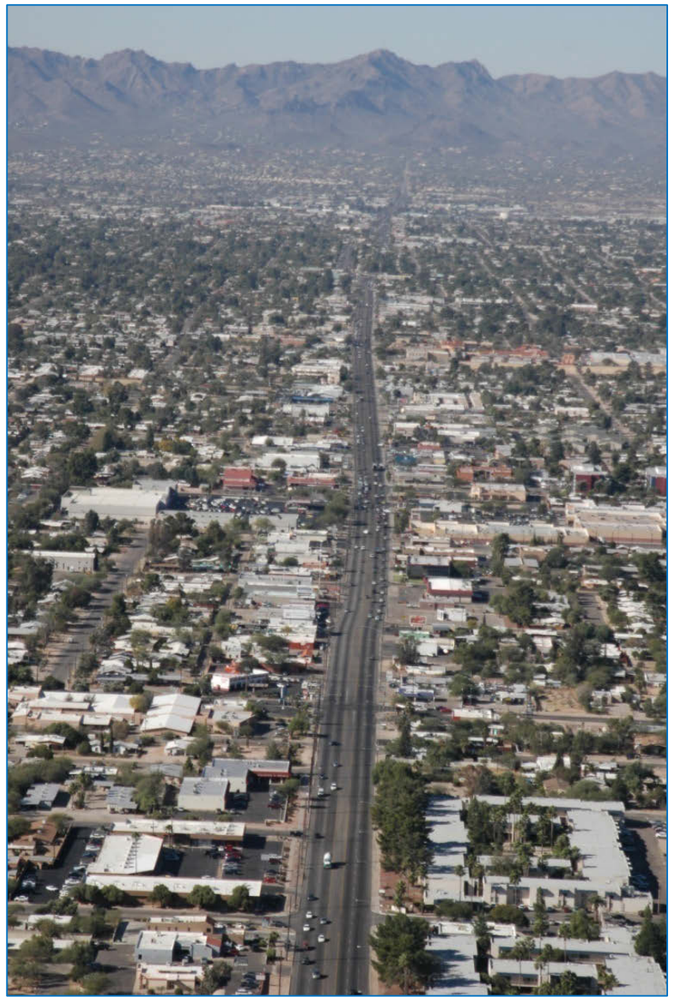
5.1 Grant Road Design Concept Development Process

5.1.1 Roadway Alignment Concept

In January 2009, the City of Tucson Mayor and Council approved a roadway alignment concept for Grant Road. The roadway alignment concept identified preliminary right-of-way limits and an initial roadway alignment that would serve as the basis for preliminary design in Phase 2. The roadway alignment concept exhibits approved in January also included design concepts for Grant Road which evolved from community involvement and public outreach events. The design concepts that were developed are described in **Chapter 5.2**. This section of the report describes the process used for developing the roadway alignment concept, the innovative and sustainable design concepts, and key roadway design criteria necessary to design the roadway itself.

The initial roadway alignment concept was prepared using community input received in 2007 and 2008, design criteria established cooperatively with City staff and the Task Force (refer to **Chapter 6** and supplemental studies conducted by the City including the *Historic Properties Assessment for the Grant Road Improvement Project, Oracle Road to Swan Road* (Phase 1 Report dated June 2008), the State of Arizona Historic Property Inventory Forms, and the *Relocation Red Flag Analysis, Grant Road: Oracle Rd. to Swan Rd., An Outline of Anticipated Relocation Issues, Actions, and Recommendations for Certain Business Types Located within the Project Limits* (dated November 2007).

The initial roadway alignment was reviewed and refined by the Task Force in four Task Force meetings conducted in July-September 2008. The resulting roadway alignment including the innovative design features were presented to property owners and the general public in a series of three open houses in October 2008 after which the Task Force reviewed public comments and refined the preliminary alignment to a recommended alignment which was presented at an informational open house in January 2009, in advance of presentation to the Tucson Mayor and Council in January 2009.



Each of the design concepts introduced in **Chapter 5.2** evolved from public input received at community conversations and workshops conducted in 2007 and 2008 (refer to **Chapter 3**). In 2007, community input resulted from over 40 community conversations with over 1,000 neighborhood, business, and special interest group representatives who provided over 5,000 written comments. In addition, over 1,200 responses resulted from website, telephone, and other survey instruments. In 2008, community input was received from over 500 community representatives who participated in six workshops covering design topics including roadway cross-sections, pedestrian and bicycle features, transit amenities, and intersection improvements.

The process for developing design concepts included an assessment of whether a particular design concept or idea was consistent with or contributed to specific Grant Road Guiding Principles. If the concept contributed positively to one or more of the Guiding Principles, an iterative design process was initiated to evaluate the feasibility of the concept for Grant Road. During concept development and design, a variety of perspectives were considered including those of the Technical Advisory Committee, the Tucson / Pima Bicycle Advisory Committee, the City Landscape Advisory Committee, the Tucson / Pima Historical Review Committee, and research on design best-practices. Design criteria were also reviewed from a variety of design references including those listed below.

- *A Policy on Geometric Design of Highways and Streets,* 2004, 5th Edition, American Association of State Highway and Transportation Officials
- *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*, Institute of Transportation Engineers
- *A Guide for Achieving Flexibility in Highway Design*, May 2004, American Association of State Highway and Transportation Officials
- *Guide for the Development of Bicycle Facilities*, 1999, American Association of State Highway and Transportation Officials
- *Guide for the Planning, Design, and Operation of Pedestrian Facilities,* July 2004, American Association of State Highway and Transportation Officials
- *Engineering Division Active Practices Guidelines*, as revised, Tucson Department of Transportation, Engineering Division

5.1.2 Preliminary Roadway Design Process

Phase 2 preliminary roadway design consisted of preparing 15 percent and 30 percent construction plans and cost estimates. Fifteen percent construction plans were prepared in the summer and fall of 2009 and submitted to the City of Tucson for City review in December 2009. A key input to the development of 30 percent construction plans was a series of neighborhood conversations conducted in early 2009 on mobility, access, and streetscape (refer to **Chapter 3**). In these neighborhood conversations, public comments received in 2008 on mobility and access were summarized and presented at neighborhood meetings to obtain clarification on public concerns on subjects such as neighborhood access to and from Grant Road, neighborhood traffic management issues, Grant Road median

openings, local access lanes, and street closures. Community input on these issues will be reflected in the 30 percent design plans provided in **Appendix A**.

5.2 Innovative and Sustainable Design Concepts

The Grant Road plans include design concepts which evolved from community involvement and public outreach events. Each of these is listed in **Table 1** and described in more detail in the next sections.

Table 1. Grant Road Innovative and Sustainable Features

Typical Street Sections • 137' Street Section • 160' Street Section
Streetscape • Landscaping, Streetscape, and Public Art • Noise Mitigation • Water Harvesting
Intersections • Indirect Left Turn Intersection • Traditional Intersection • Pelican Pedestrian Crossing • Toucan Bicycle Crossing
Bicycle Accommodations • 6' Bicycle Lane with 1' Buffer Stripe • Bike Spot • Bicycle Lane Markings in Conflict Areas
Pedestrian Accommodations • 8' Sidewalk • 12' Landscape Area
Transit Accommodations • Enhanced Transit Stops and Plazas
Access Management and Parking • Local Access Lanes • Directional Median Openings • Shared Access • Cross Access • Parking Strategies

5.3 Typical Street Sections

Three community character segment workshops were conducted in January 2008, one each for the Grant Road eastern segment (Swan Road to Tucson Boulevard), the central segment (Tucson Boulevard to 1st Avenue), and western segment (1st Avenue to Oracle Road). Feedback received from participants at the workshops confirmed the guiding principle to balance capacity, safety, and operational (mobility) needs for vehicle, bicycles and pedestrians, with access to businesses, properties, and neighborhoods along Grant Road. Participant feedback included a desire for a street section that was wider than the City of Tucson standard section for six-lane urban arterials of 120-foot to allow more space for pedestrians, but to also minimize the street width between the curbs to reduce vehicle speeds, minimize property impacts, and to preserve businesses. **Table 2** summarizes key community input received during the January 2008 workshops.

The following table summarizes the input received from each Grant Road character segment with respect to the street section.

Table 2. Community Perspectives on Street Section

Segment	Segment Limits	Key Input
Western	Oracle to 1st Ave.	• Use wider than standard cross-sections to allow for better aesthetic and multi-modal environment • Vary cross-section to fit specific situations and contexts - road doesn't have to be straight • Consider full property acquisitions rather than partial acquisitions where remaining properties would not be viable or would create an opportunity for redevelopment
Central	1st Ave. to Tucson Blvd	• In areas where cross-section takes entire property on one side, use excess right-of-way to buffer and provide access to remaining homes as well as separated and enhanced bicycle and pedestrian amenities • In other areas where cross section could fit within existing buildings, consider narrower options • Consider local access lane to serve adjacent uses • Consider full acquisitions where remaining property would not be viable
Eastern	Tucson Blvd to Swan	• Supported a cross-section that preserves buildings and businesses • Vary the cross-section alignment and width to fit situations

The Design Team and Task Force considered public input and perspectives, and developed two typical street sections for application to Grant Road. The street sections were incorporated into the recommended alignment concept that was approved by Mayor and Council in January 2009. Each section is presented below.

137-Foot Typical Section

The 137-foot street section shown in **Figure 2** is applied to segments of Grant Road where access to land uses is not a major requirement or to segments where access control strategies can be applied to minimize the adverse impacts of access on Grant Road operations and safety.

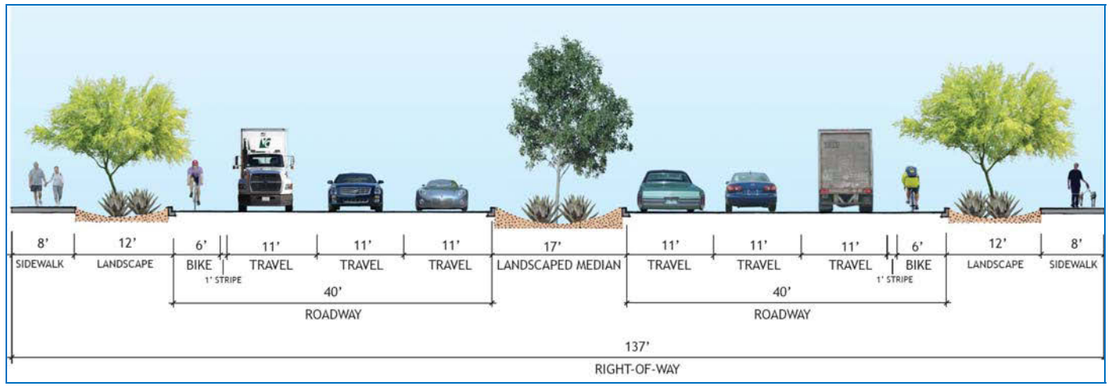


Figure 2: 137-foot Typical Street Section

- The 17-foot median was sized to support a rainwater harvesting system in combination with an enhanced storm drain system.
- The 11-foot travel lanes are proposed to minimize the street section width without compromising safety and be consistent with the "target speed" for Grant Road.
- The 6-foot bike lane with 1-foot buffer was developed in consultation with City and County staff and with a representative of the Tucson/Pima Bicycle Advisory Committee. The bike lane will be colored green in motor vehicle conflict areas.
- The 20-foot pedestrian realm includes a continuous 8-foot sidewalk and landscaped 12-foot buffer from Grant Road. The buffer is to be landscape with native plants irrigated with harvested rainwater.
- The 137-foot street section is considered as the minimum street section and reducing the median width, travel lane width, and bike lane width should not be considered. However, minor reductions in the 20-foot pedestrian realm can be considered to avoid or minimize impacts to private property.

160-Foot Typical Section

The 160-foot street section shown in **Figure 3** is applied to segments of Grant Road where access to land uses is a major requirement and segments where access control strategies cannot be implemented to minimize the adverse impacts of direct access to Grant Road. Its primary application is for areas where residential uses front onto Grant Road both to provide for access (curb cuts and on-street parking) as well as to provide additional separation and buffering from the through traffic lanes. It may also be used in locations where the nature of
businesses that front onto Grant Road support a more active retail frontage that would be well-served by on-street parking and the buffering from Grant Road through traffic.

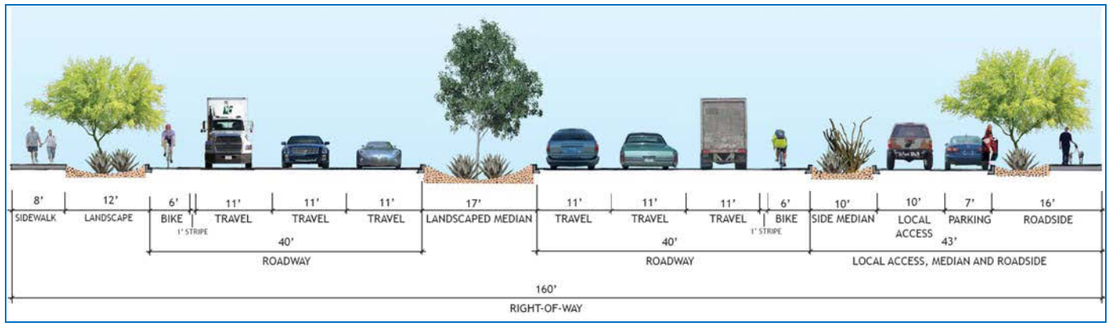


Figure 3: 160-foot Typical Street Section with Local Access Lane

- The 17-foot median in the 160-foot right of way was sized to support the rainwater harvesting system in combination with an enhanced storm drain system.
- The 11-foot travel lanes are proposed to minimize the street section width without compromising safety and be consistent with the "target speed" for Grant Road.
- The 6-foot bike lane with 1-foot buffer was developed in consultation with City and County staff and with a representative of the Tucson/Pima Bicycle Advisory Committee. The bike lane will be colored green in motor vehicle conflict areas.
- The 20-foot pedestrian realm includes an 8-foot sidewalk and landscaped 12-foot buffer from Grant Road, on the side of the street without the local access lane. The buffer is to be landscape with native plants irrigated with harvested rainwater.
- The 43-foot local access lane, side median, and pedestrian area consists of a 10-foot side median, 10-foot one-way local access lane, 7-foot parallel parking lanes, and a 16-foot pedestrian areas that includes a sidewalk and landscaped buffer. The side median and buffer is to be landscape with native plants irrigated with harvested rainwater.
- The 160-foot street section should be considered as the minimum street section and reducing the center and side median widths, travel lane width, bike lane width, and local access lane and parking lane widths should not be considered. However, minor reductions in the 20-foot and/or 16-foot pedestrian realm can be considered to avoid or minimize impacts.

5.4 Intersections

According to Pima Association of Governments (PAG) travel estimates, daily traffic volumes in 2030 on Grant Road are projected to range from approximately 48,000 vehicles (near Oracle Road) per day to more than 70,000 vehicles per day (near Alvernon Way). Analysis of these projected traffic volumes, when applied to a 6-lane arterial facility, demonstrated that several Grant Road signalized intersections will operate at unacceptable levels of delay and congestion (Level of Service E or F) in 2030 with traditional intersection improvements including dual left-turn lanes and exclusive right-turn lanes on all approaches to major intersections. It became clear to the Task Force that other alternatives should be explored for increasing intersection capacity, so that Grant Road Guiding Principles of improving mobility at major intersections could be achieved.

It was determined that the capacity provided at traditionally improved intersections can be improved through such concepts as grade-separated intersections (GSIs) or through non-traditional at-grade intersections such as indirect left-turn intersection or continuous flow intersections. It was determined early in the process that grade-separated intersections were not a viable alternative because of the significant right of way requirements, impacts to businesses and properties, and a general lack of community support for the GSI concept. As such, grade-separated intersection alternatives were not further considered. However, at the request of the City and the Citizen Task Force, the Design Team conducted research and analysis of one non-traditional at-grade intersection concept, the indirect left-turn lane intersection concept, as a possible way to increase intersection capacity, improve pedestrian travel efficiency and safety, and reduce the impacts to businesses and properties.

A review of nation-wide practices related to indirect left-turn intersections identified that the intersection concept has been operational on wide-median urban arterials in Michigan for over 30 years and has been constructed on a limited basis in North Carolina and South Carolina among a few other states. The concept however has been limited to divided multi-lane arterials with wide medians of 60-foot or wider. Operational evaluations of Michigan indirect left-turn intersections through the years have indicated significant improvements in travel time, congestion, and safety over traditional intersection concepts. The Design Team also identified that the indirect left-turn concept is being considered by local jurisdictions with narrower median widths in more developed corridors. For example, a concept design in southern California was identified on an urban arterial similar to Grant Road however the concept had not been constructed due to funding issues. The results of the national practices research was presented to City staff and the Task Force.

City staff requested the Design Team to perform traffic analyses of the concept on Grant Road for future traffic conditions. The Synchro and VISSIM traffic models were used to analyze the indirect left-turn concept at seven Grant Road intersections and compare traffic performance measures with this concept and traditional intersections. The analysis produced results similar to the benefits of indirect left-turn intersections documented in available literature. It was also determined that additional operational benefits could be achieved if traditional intersection approaches with dual left-turns and exclusive right-turn lanes were used on the north and south approaches to the indirect left-intersections. The results of the traffic modeling and analysis were presented to City staff and the Task Force.

City staff requested the Design Team to enhance the VISSIM model simulation to show traffic signing and pavement markings on Grant Road for future traffic conditions. The simulation was prepared using signing and pavement marking design criteria employed by the Michigan Department of Transportation. The simulation was presented to City staff and the Task Force and used to illustrate the intersection concept at community workshops and public open houses conducted in 2009.

The traffic analyses of the indirect left turn concept led the Design Team to recommend a combination of indirect left turn intersections and traditional intersections on Grant Road. The Task Force, at their July 12, 2008 meeting, endorsed the Design Team recommendation to construct enhanced traditional intersections and indirect left turn intersections as listed in **Table 3**.

Expressed through the Grant Road Guiding Principles, the community stated a desire to improve crossing opportunities for pedestrians to cross Grant Road. The indirect left turn intersections and other signalized intersections on Grant Road were evaluated for opportunities to increase the number of pedestrian and bicycle crossings on Grant Road. The Grant Road preliminary design concept includes 20 Pelican pedestrian crossings including 14 at indirect left-turn intersections (**Table 3**) and four Toucan bicycle signals, as listed in **Table 4**

Pelican and Toucan design concepts are explained in more detail in subsequent sections.

Table 3. Locations of Traditional Enhanced and Indirect Left Turn Intersections

Intersection Treatment	Locations
Traditional Signalized Intersection	• Park Ave. • Mountain Ave. • Tucson Blvd. • Columbus Blvd
Indirect Left Turn Signalized Intersection (with traditional intersection approaches on the north and south intersecting streets)	• Oracle Road • Stone Ave • 1st Ave • Campbell Ave • Country Club Road • Alvernon Way • Swan Road
Toucan Bicycle Crossing	• 6th/Fontana • Treat Ave. • Palo Verde Blvd. • Dodge Blvd.

Table 4. Pelican Pedestrian Crossings Locations

Pelican Location	Pelican is associated with Indirect Left Turn Intersection		Stand Alone Pedestrian Crossing
1. West of Oracle (14th Ave)	✓	Oracle Road	
2. East of Oracle (approx. 10th Ave)	✓	Oracle Road	
3. West of Stone Ave (Castro Ave)	✓	Stone Ave	
4. East of Oracle (approx. 10th Ave)	✓	Stone Ave	
5. 4th Ave			✓
6. West of 1st Ave (3rd Ave)	✓	1st Ave.	
7. Freemont / Santa Rita			
8. Vine Ave.			✓
9. Vine Ave.			✓
10. West of Campbell (Warren)	✓	Campbell Ave	
11. East of Campbell (approx. Olsen)	✓	Campbell	
12. Plumer /Wilson			✓
13. Forgeus			✓
14. West of Country Club (Loretta)	✓	Country Club	
15. East of Country Club (Camilla)	✓	Country Club	
16. Rita			✓
17. West of Alvernon (west of Elaine)	✓	Alvernon	
18. East of Alvernon (Sycamore)	✓	Alvernon	
19. Bryant Ave			✓
20. Ralph Ave			✓
21. West of Swan (Venice)	✓	Swan	
22. East of Swan (Mountain View)	✓	Swan	

5.4.1 Indirect Left-Turn Intersection

The indirect left turn intersection is an intersection design that has the potential to increase vehicle capacity through the intersection, while achieving Grant Road guiding principles of improving the pedestrian environment and minimizing impacts to business and property. An indirect left turn intersection employs a combination of a U-turn followed by a right turn to replace a prohibited left turn at the main intersection, as illustrated in **Figure 4.** The indirect left turn intersection has several advantages compared to more traditional signalized intersection improvements including dual left-turn lanes and separate right-turn lanes. The primary advantage is that it reduces the number of signal phases required, significantly increasing traffic flow through the intersection. Removal of left-turning vehicles at the intersection eliminates the need for a separate left-turn phase. The simplified signal phasing (3 phases) will allow for increased green time to be allocated to through vehicles.

Analysis of the indirect left turn demonstrates that it will benefit traffic operations, primarily as a result of the simplified traffic signal phasing at the intersection. However, it should be emphasized that the indirect left turn is not a "fix-all." As previously documented, future traffic volumes on Grant Road will approach 60,000 to 70,000 vehicles per day. Major intersections are projected to be at or over capacity with either the traditional intersection or the indirect left turn intersection. The analysis of the indirect left turn intersection indicates that it will operate at better levels of service than traditional intersections under high traffic volume conditions. The indirect left turn will result in less delay and improved travel time due to more east/west green time allocated to Grant Road.

In addition to improving vehicular mobility, indirect left turn intersections offer advantages to pedestrians over traditional intersections with the removal of the left turn lane that results in a narrower (by approximately 20-feet) roadway which pedestrians are required to cross. A traditional intersection is approximately 130-feet wide, including turn lanes. In addition, the indirect left turn provides an opportunity to combine a Pelican pedestrian signal with each turn-around, providing additional pedestrian crossing opportunities approximately 600 to 700 feet from the main intersection.

Finally, several studies have documented a reduction in left-turn crashes at indirect left turn intersections. Other benefits and trade-offs of the indirect left turn intersection, as compared to a traditional intersection are listed in **Table 5.**

Table 5. Benefits and Tradeoffs to an Indirect Left Turn Intersection

Criteria	Traditional Left-Turn Intersection	Indirect Left-Turn Intersection
Reduces vehicle crash potential		✓
Reduces pedestrian crash potential		✓
Reduces pedestrian crossing distance		✓
Increases intersection capacity		✓
Reduces travel time		✓
Requires less right-of-way		✓
Increases travel distance		✓
Driver familiarity	✓	

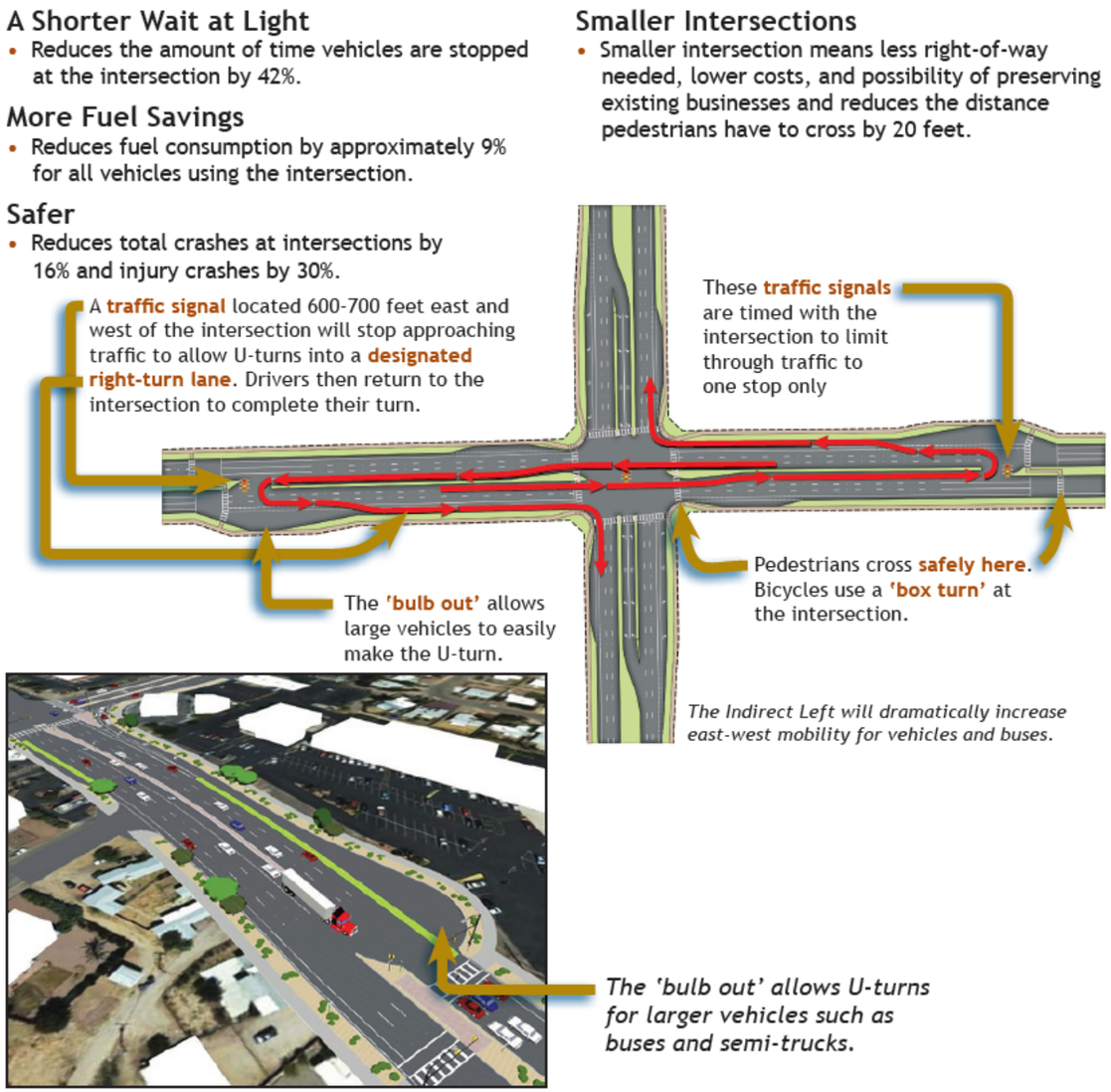


Figure 4: Indirect Left Turn Intersection

5.4.2 Enhancements to North-South Signalized Intersection Approaches

In response to community input and perspectives, traditional intersection approaches on Grant Road, including north-south street approaches to the indirect left turn, where feasible, will be enhanced to include pedestrian refuge islands that separate the through movements from the left turn lanes. The purpose of the pedestrian refuge islands is to increase the safety and comfort of pedestrians as they cross the intersection. Pedestrian refuge islands may be provided between the turn lanes and through lanes, as well as at the center median island as depicted in **Figure 5.**

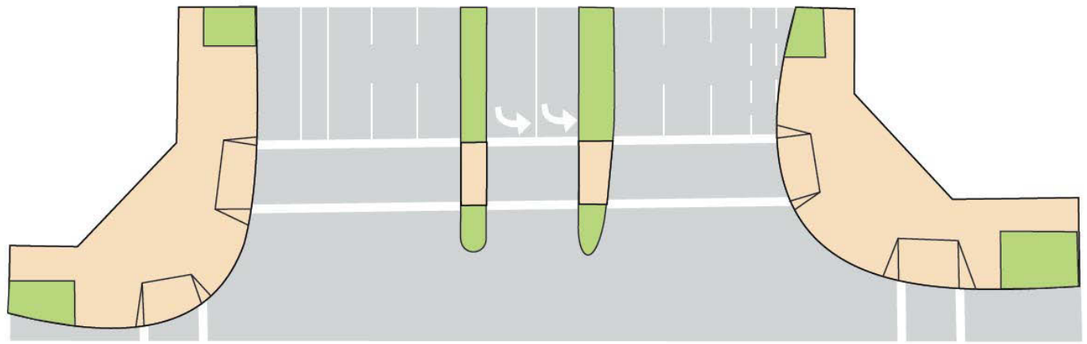


Figure 5: Intersection Pedestrian Refuge Islands

5.4.3 Pelican Pedestrian Crossings

The indirect left turn intersection provides the opportunity to construct Pelican pedestrian crossings at each indirect left turn turnaround. The PEdestrian LIght Control ActivatioN (PELICAN) provides a two-stage crossing for pedestrians. The crossing incorporates the median island refuge between the two stages. A pedestrian presses a button to activate the first signal. When the light turns red, a "WALK" signal prompts the pedestrian to proceed to the median. The pedestrian then walks a short distance along the median to activate the second signal. A second "WALK" indication appears when the traffic signal turns red. The PELICAN uses a standard Red-Yellow-Green signal for motorists and remains green unless activated by a pedestrian (CROSSINGS, Special Pedestrian/Bicycle Beacon Signals, City of Tucson, 2009).

Pelican pedestrian crossings are associated with each indirect left turnaround (with exception to the indirect left turn east of 1st Ave and west of Park Av), as depicted in **Figure 6 and Figure 7.** In addition, the Recommended Alignment includes stand-alone Pelicans (not associated with the indirect left turn) at the following locations:

- 4th Avenue
- Between Freemont Avenue Ave. and Santa Rita Ave.
- East of Plumer Avenue
- Forgeus Avenue
- Rita Avenue
- Bryant Avenue
- Ralph Avenue
- Vine Avenue

Figure 6: Pelican Pedestrian Crossing at ILT Turn-Around

Figure 7: Pelican Pedestrian Crossing at ILT Turn-Around with Shade Structure

5.4.4 Toucan Bicycle Signal

The TwO GroUps CAN cross (TOUCAN) was designed to provide a safe crossing for two groups — pedestrians and bicyclists. The Toucan has been implemented at several locations within the City of Tucson at locations of heavy bicycle and pedestrian crossing activity and along roadways that are prioritized for non-motorized uses such as "Bike Boulevards." An added benefit to the TOUCAN is that motorized traffic is not allowed to proceed through these signals, decreasing the number of cars on neighborhood streets.

A TOUCAN can be activated only by bicyclists or by pedestrians. Both use a push button to activate the signal. Bicyclists respond to an innovative bicycle signal and use a special lane when crossing. Pedestrians get a standard WALK indication and have a separate, adjacent crosswalk. The system uses a standard signal for motorists (CROSSINGS, Special Pedestrian/Bicycle Beacon Signals, City of Tucson, 2009).

Figure 8 is a photo simulation of a Grant Road Toucan crossing. A schematic diagram of how vehicles navigate through a Toucan is presented in **Figure 9.** The Grant Road preliminary design concept includes Toucan crossings at Fontana/6th Ave, Treat Ave., Palo Verde Blvd., and Dodge Blvd.

The Grant Road Toucans are a modification of Toucans that have been constructed elsewhere in the City of Tucson in that the Grant Road Toucans will be the first with a divided median and a median refigure in the center of the intersection. A schematic detail of a Grant Road Toucan is presented in **Figure 8.**

Figure 8: Toucan Bicycle Crossing

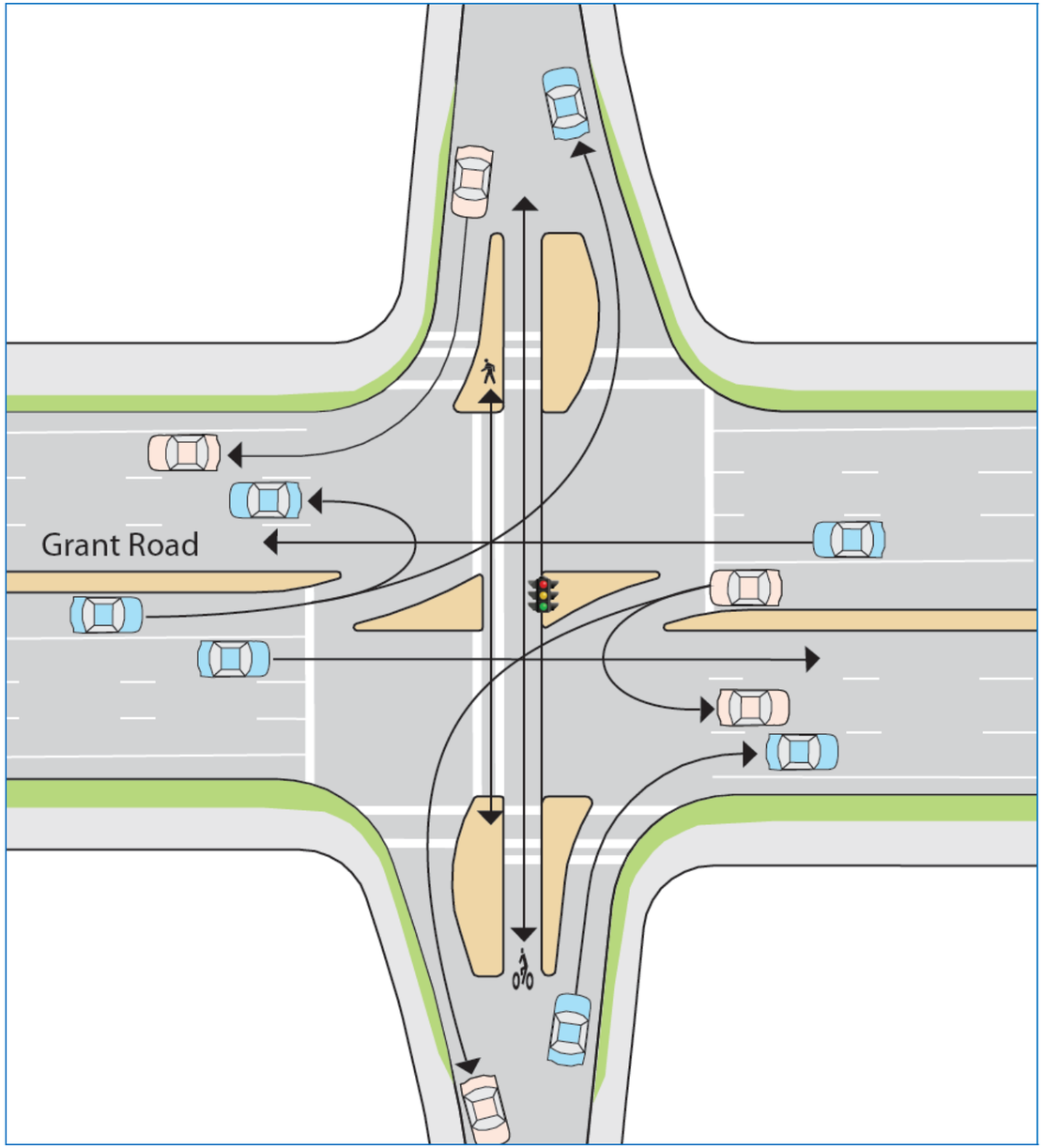


Figure 9: Grant Road Toucan Schematic

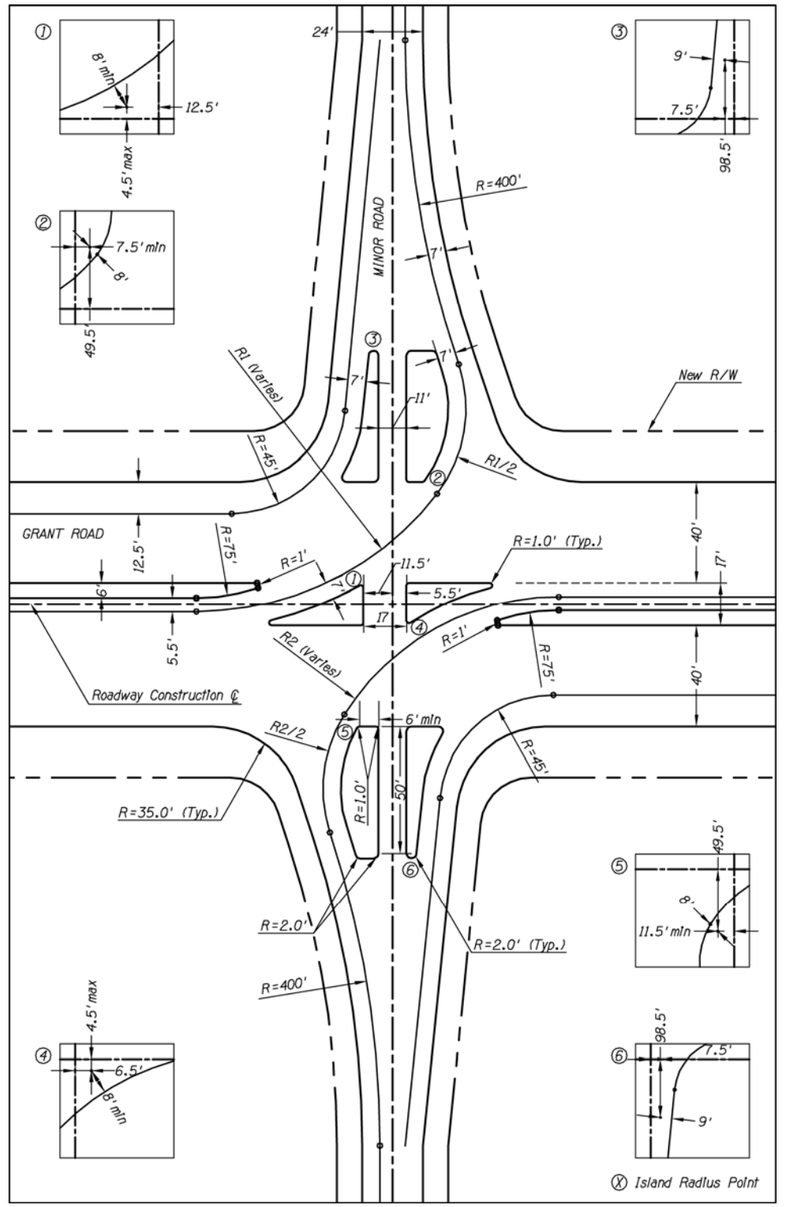


Figure 10: Grant Road Toucan Geometry

5.5 Alternate Modes

The City of Tucson is a national leader in the development and implementation of pedestrian crossings and innovative bicycle safety designs, such as the Toucan bicycle signal and the Pelican pedestrian crossing. The Grant Road Task Force has placed significant emphasis on continuing to provide excellent facilities for bicycles and pedestrians. The Grant Road Task Force Guiding Principles include several references to alternate modes as identified below (bold emphasis added).

- Improve mobility and safety for all those traveling along and across Grant Road, including pedestrians, bicyclists, transit riders, and those with disabilities, by:
  - recognizing that Grant Road is **not the exclusive domain of cars**;
  - improving transit stops and access to them as well as considering the land uses around them; and by
  - considering land use and other **needs of transit, bicycle, and walking** dependent populations.
- Provide the potential for future transit options, such as bus rapid transit, modern streetcar, light rail, or other high-capacity transit in the design of Grant Road improvements with the goal of minimizing future costs for construction and right-of-way acquisition.

The Toucan bicycle and the Pelican pedestrian signal are exemplary of the integration of bicycle and pedestrian features into Grant Road improvements. Other alternatives modes features that are integrated into Grant Road improvements, as reflected in the preliminary alignment

Alternate modes features that are recommended as part of the Grant Road Improvement Plan and reflected in the 30 percent design plans in **Appendix A**:

- Enhanced 20-foot pedestrian realm (introduced in Section 5.3)
- Flexible street sections that provide for future transit options
- Enhanced transit stops and plaza
- Enhanced bicycle lane and pavement markings
- Grant Road parallel Bicycle Boulevards

The alternate mode recommendations are discussed in more detail below.

5.5.1 Enhanced 20-foot Pedestrian Realm

The City of Tucson standard street sections generally include a 9-foot pedestrian/utility area. This will generally accommodate a 6-foot sidewalk and 3-foot landscape area.

The preliminary design concept for Grant Road enhances the pedestrian realm to 20-feet. This will accommodate an 8-foot sidewalk and a 12-foot landscape area that separates the sidewalk from the Grant Road curb. The 20-feet pedestrian realm will result in right-of-way acquisition requirements beyond what would be required with the City standard 9-feet pedestrian realm.

5.5.2 Street Section Flexibility

The standard street section that was endorsed by the Grant Road Task Force and approved by Mayor and Council provides design flexibility for future transit options such as bus rapid transit, modern street car, light rail, or other higher capacity transit technologies. The intent of the design flexibility is to minimize future costs for reconstruction and right of way should these technologies be implemented on Grant Road. **Figure 11** and **Figure 12** demonstrate that the 137-foot right of way can be modified to accommodate future transit technologies by converting an outside travel lane or the center median to a transit lane.

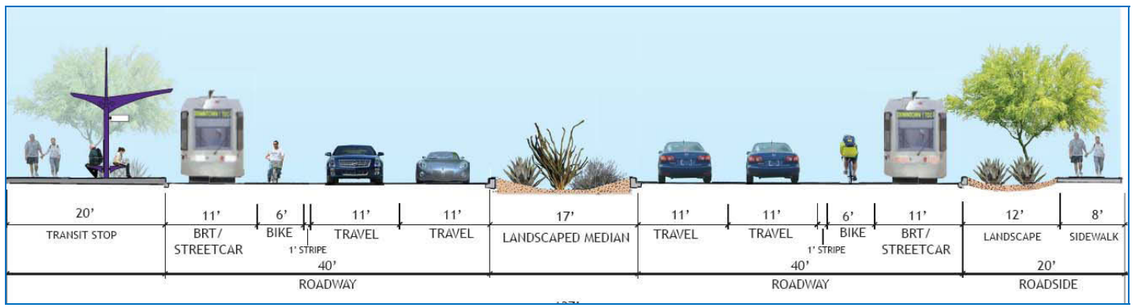


Figure 11: Standard Street Section Accommodates Future Transit (BRT)

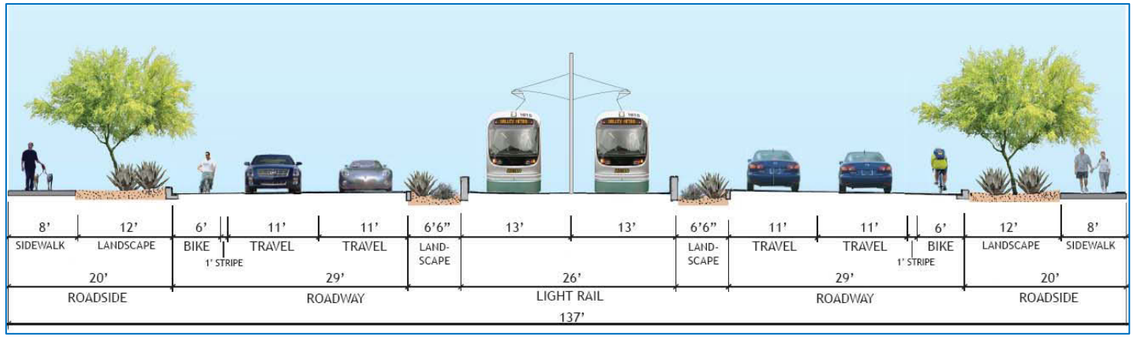


Figure 12: Standard Street Section Accommodates Future Transit (Light Rail)

5.5.3 Enhanced Transit Stops and Transit Plaza

Grant Road improvements will include enhanced transit stops. The enhanced transit stops will include shelters at every stop and amenities such as benches, bicycle parking, pedestrian level lighting, information kiosks, landscaping and shading, and connections to continuous sidewalks. Bus pullouts are provided at every transit stop. Transit stops are generally located at ¼ mile spacing.

- Transit stops and pullouts should be located as close as possible to the intersection and should be placed on the far side of an intersection, especially at intersections with marked cross walks. This will allow for the bus to wait until through traffic is stopped by a red light at the intersection, thus creating a gap in traffic flow sufficient for the bus to re-enter the through traffic lanes.
- Bus pullouts will be constructed in accordance with City of Tucson design standards where feasible. In areas where right of way is constrained, the minimum width of the bus pullout may be reduced from 12-feet to 10-feet. **Figure 14**, **Figure 15,** and **Figure 16** illustrate Grant Road bus pullouts. The width of bus pull-outs on the local access lanes is 7'.
- Bus shelters should be provided at all stops and transfer points. All bus stops must be constructed in compliance with ADA accessibility standards. TDOT requires that the wheelchair loading pads be a minimum of 9' x 5' to accommodate the bus ramp/lift plus an area for the wheelchair to easily access the ramp. A ramp and connecting sidewalk must also be provided. Single shelter pad dimensions are 4'8" x 22' long x 6" thick concrete. Double shelter pad dimensions are 6' wide x 34' long x 6" thick concrete. If a shelter is not constructed at a bus stop, the design should allow for sufficient space such that a shelter can be constructed in the future.
- An opportunity for construction of a transit plaza has been indentified on the northwest corner of the Grant-Alvernon intersection. This location has also been identified as an opportunity for an active water harvesting demonstration. Other opportunity locations for transit plazas should be investigated during the final design phases of project development. Refer to transit plaza illustration in **Figure 14**.

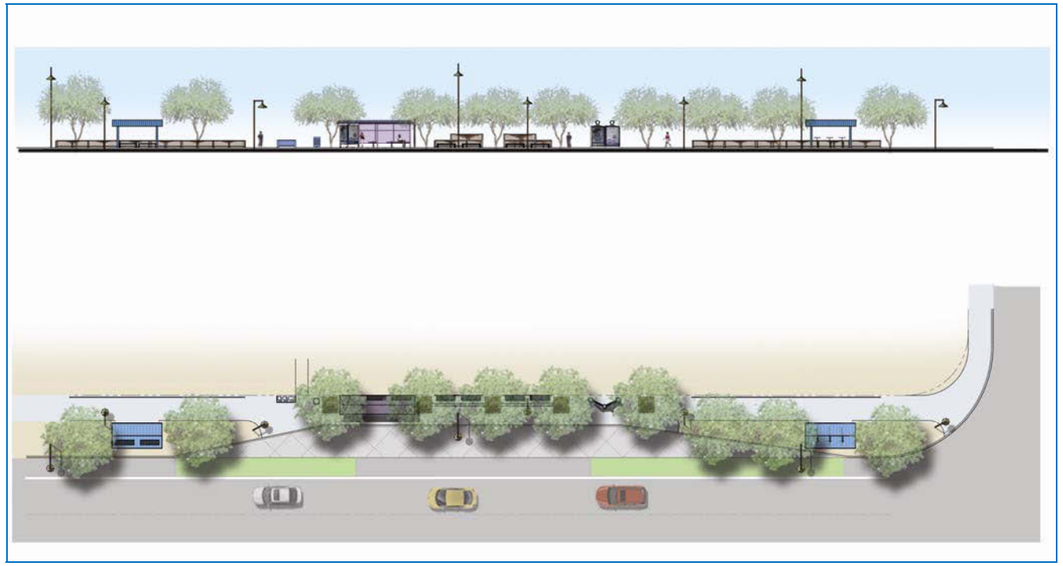


Figure 13: Enhanced Transit Stop on Grant Road

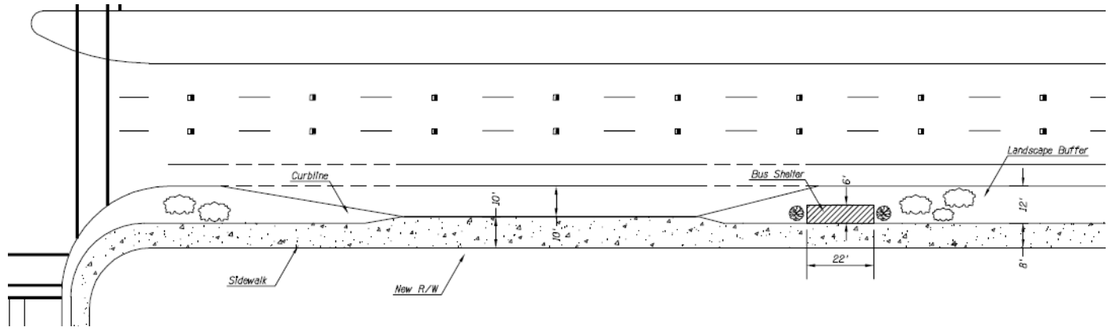


Figure 14: Typical Enhanced Transit Stop Layout with Bus Pullout

Figure 15: Typical Enhanced Transit Stop

An opportunity for construction of a transit plaza has been indentified on the northwest corner of the Grant-Alvernon intersection. This intersection is the highest transit-use intersection on Grant Road, and is one of the highest transit-use intersections in Tucson. To accommodate the high level of transit use, the transit plaza may consist of over-sized shelters and shade structures, benches, shade trees, trash receptacles, drinking fountains, bicycle racks and/or lockers. This location has also been identified as an opportunity for an active water harvesting demonstration. Refer to transit plaza illustration in **Figure 16.**

Figure 16: Enhanced Transit Plaza at Grant and Alvernon

5.5.4 Enhanced Bicycle Lane and Bicycle Pavement Markings

The public expressed a desire to improve conditions for bicyclists on Grant Road. The Grant Road Design Team, in collaboration with the City of Tucson Bicycle and Pedestrian Coordinator and the Tucson-Pima County Bicycle Advisory Committee, recommend the following design innovations.

- Enhanced 6-foot Bicycle Lanes and 1-foot Buffer
- Conflict Areas Pavement Markings
- Indirect Left Turn Intersection "Bike spot"

5.5.4.1 Enhanced 6-foot Bicycle Lanes and 1-foot Buffer

The City of Tucson standard street sections generally include a 17-foot outside travel lane to accommodate a 12' outside travel lane and a 5-foot bicycle lane. The design concept for Grant Road enhances the bicycle lane to 6-foot adjacent to a 1-foot buffer, adjacent to an 11-foot travel lane. The 1-foot buffer is anticipated to consist of a 1-foot thermoplastic application or a 1-foot white painted reflective stripe. The 1-foot buffer is responsive to bicycle community requests for increased separation from travel lanes. The 1-foot buffer and 6-foot bicycle lane is illustrated in **Figure 17.** Cross streets within Grant Road improvements will maintain a 5-foot bicycle lane, consistent with City of Tucson policy.

Figure 17: 6-foot Bicycle Lane and a 1-foot Striped Buffer

5.5.4.2 Conflict Area Pavement Markings

Intersections and locations near intersections account for a significant percent of bicycle–motor vehicle crashes. Grant Road stakeholders, and in particular representatives from the Tucson-Pima County Bicycle Advisory Committee, expressed concern about the potential for bicycles and motor vehicles to conflict in areas where vehicles turn, change lanes, or merge across bicycle lanes into right turn lanes.

The City has implemented colored pavement markings in areas where motor vehicles come into conflict with bicycles in areas where motor vehicles turn, change lanes, or merge across bicycle lanes at or near intersections. The City recently implemented a colored bicycle lane at the intersection of Grant Road and Mountain Avenue. The purpose of the green bicycle lane pavement marking is to alert motorists and cyclists to these intersection conflict areas, thereby increasing motorized vehicle yielding behaviors and potentially reducing conflicts and crashes. Green conflict area pavement markings are reflected in the Grant Road improvements in the following areas:

- Intersection approaches where the bicycle lane is placed in between the right turn lane and a through lane
- At the indirect left turn-around where u-turning vehicles may cross the bicycle lane while utilizing the turn-around area
- At bus pullouts across merging areas where the bus crosses the bicycle lane to access the bus pullout.

Figure 18: Green Conflict Area Pavement Markings

5.5.4.3 Indirect Left Turn Intersection "Bike Spot"

Grant Road stakeholders including representatives from the Tucson-Pima County Bicycle Advisory Committee, expressed concern about how bicycles make left turns at the indirect left turn intersection. To respond to these concerns, the Grant Road Design Team, in collaboration with the City of Tucson Bicycle and Pedestrian Coordinator, developed a "bike spot" pavement marking that guides cyclists in making a box-turn from Grant Road to north-south arterials, and from north-south arterials to Grant Road at the indirect left turn intersections.

The "bike spot" facilitates a "two-point left turn" or "box turn". In this type of left turn, bicyclists proceed to the far right corner of the intersection, rotate their bicycle to turn left in the cross street, and proceed when the signal changes. The following considerations apply to the "bike spot":

- It is placed after the crosswalk, as illustrated in **Figure 19**. Refer to 30 percent construction plans (**Appendix A**) for specific placement of the "bike spot."
- It is applicable only to facilitate bicyclists making left turns at the indirect left turn intersection.
- Bicyclists must follow conventional rules of the road in both parts of the two-point turn, other than that they merge to the right of through traffic as they enter the intersection.
- Bicyclists must still negotiate with right-turning traffic (same as when traveling straight ahead) to enter the intersection. Right turn lanes are provided at the intersection approaches.
- The "bike spot" (**Figure 19**) facilitates the two-point turn by placing bicyclists ahead of the stop line and crosswalk, and to the left of right-turning traffic in the cross street.

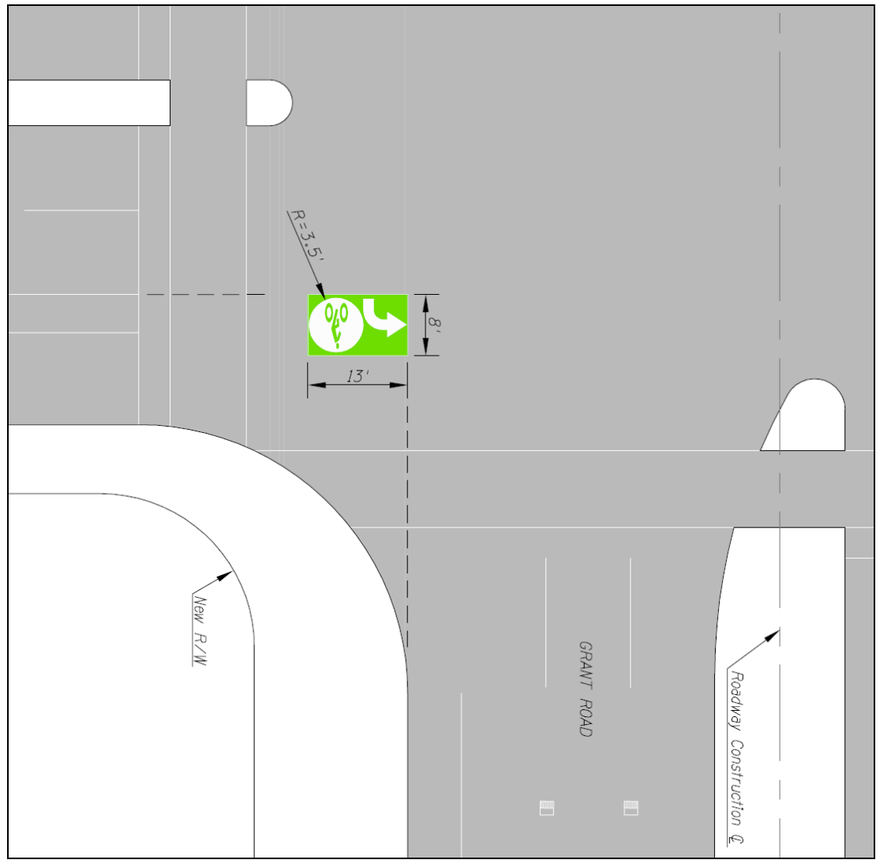


Figure 19: Indirect Left Turn Bike Spot

5.5.4.4 "Bike Box" on Mountain Ave

The City of Tucson has invested significant resources to develop Mountain Avenue as a bicycle friendly bike boulevard. Grant Road improvements will reinforce the priority of bicycles over vehicles on Mountain Avenue through construction of a "bike box" at the intersection of Mountain Avenue and Grant Road.

The "bike box" is illustrated in **Figure 20** and **Figure 21**, and consists of a green box on the road with a white bicycle symbol inside. Bicycle lanes approach and lead from the "bike box." The "bike box" is designed to prevent bicycle/vehicle collisions, particularly "right-hook" crashes that can occur between vehicles that are turning right at an intersection and bicyclists that are going straight through the intersection.

As illustrated in **Figure 20,** the "bike box" treatment includes two stop lines. The advanced stop line is for motor vehicles. The second stop line, closer to the intersection, is for bicyclists. When the traffic light is red, bicyclists position themselves in front of the vehicles in the "bike box". Right-turn-on-red by vehicles is prohibited. When the signal changes to green, bicyclists may go straight across the intersection or turn left.

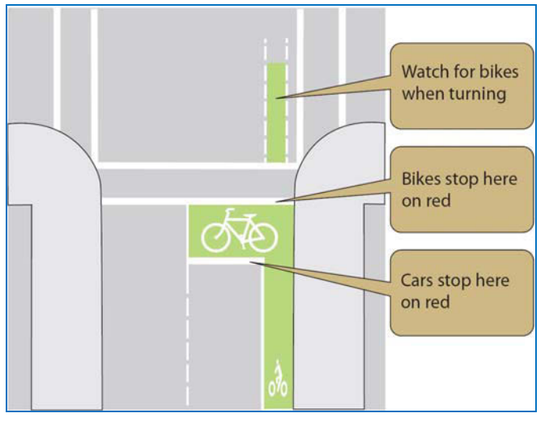


Figure 20: Schematic Diagram of Bike Box

Figure 21: Photo of Bike Box Installation

5.6 Channelized Right Turn Lanes

The indirect left turn will result in a high volume of right turning traffic at several major intersections along Grant Road. Channelized right turn lanes will be provided where right turning traffic demands exceed the capacity of a traditional right-turn lane. Grant Road channelized right turn lanes will be designed to encourage lower vehicle speeds, thus improving pedestrian safety. This will be accomplished through smaller turning radii, narrower lanes, and channelization features as illustrated in **Figure 22, Figure 23,** and **Figure 24.** Design elements that are incorporated into the channelized right turn include:

- A low-angle right-turn. Low-angle right turns slow down the speed of right-turning vehicles and improves driver visibility of pedestrians within and approaching the sidewalks
- Raised curb to provide a pedestrian refuge; pedestrian refuges are surrounded by raised vertical curb to delineate the pedestrian refuge area from the surrounding roadway
- At-grade crosswalk demarcated by pavement; the crosswalk is placed so that motorists have a clear view of the pedestrian, and both the motorist and the pedestrian have clear sight-distance and can see each other in advance of the crossing point
- Speed table in advance of the cross walk, with appropriate pavement markings
- "Pedestrian Crossing" warning signs (W11-2)
- Reduced lane-width of the approach lane for the channelized right turn, further helping to reduce vehicle speed. The pavement width in the channelized right turn lane is designed to accommodate large trucks and buses; however, edge lines and cross hatching pavement markings will be used to visually narrow the width of the channelized right turn lane to slow smaller vehicles.

Channelized right turn lanes are recommended at the following intersections:

- Grant Road/Oracle Road, eastbound to southbound
- Grant Road/Oracle Road, westbound to northbound
- Grant Road/1st Avenue, westbound to northbound
- Grant Road/Campbell Avenue, eastbound to southbound
- Grant Road/Alvernon Way, westbound to northbound
- Grant Road/Swan Road, westbound to northbound

Figure 22: Grant Road Channelized Right Turn Lane Photo Simulation

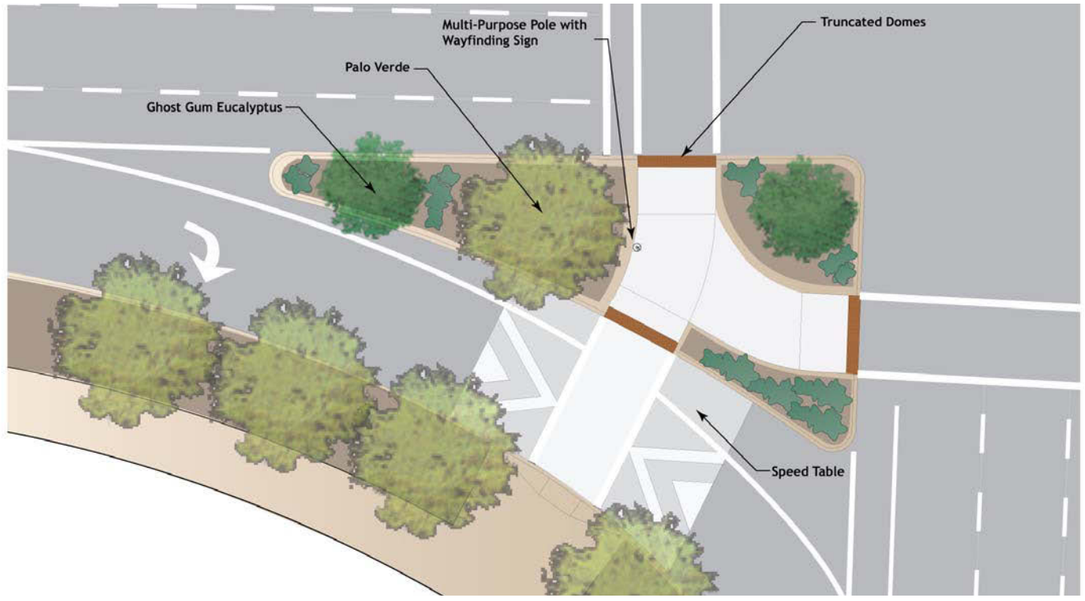


Figure 23: Grant Road Channelized Right Turn Lane

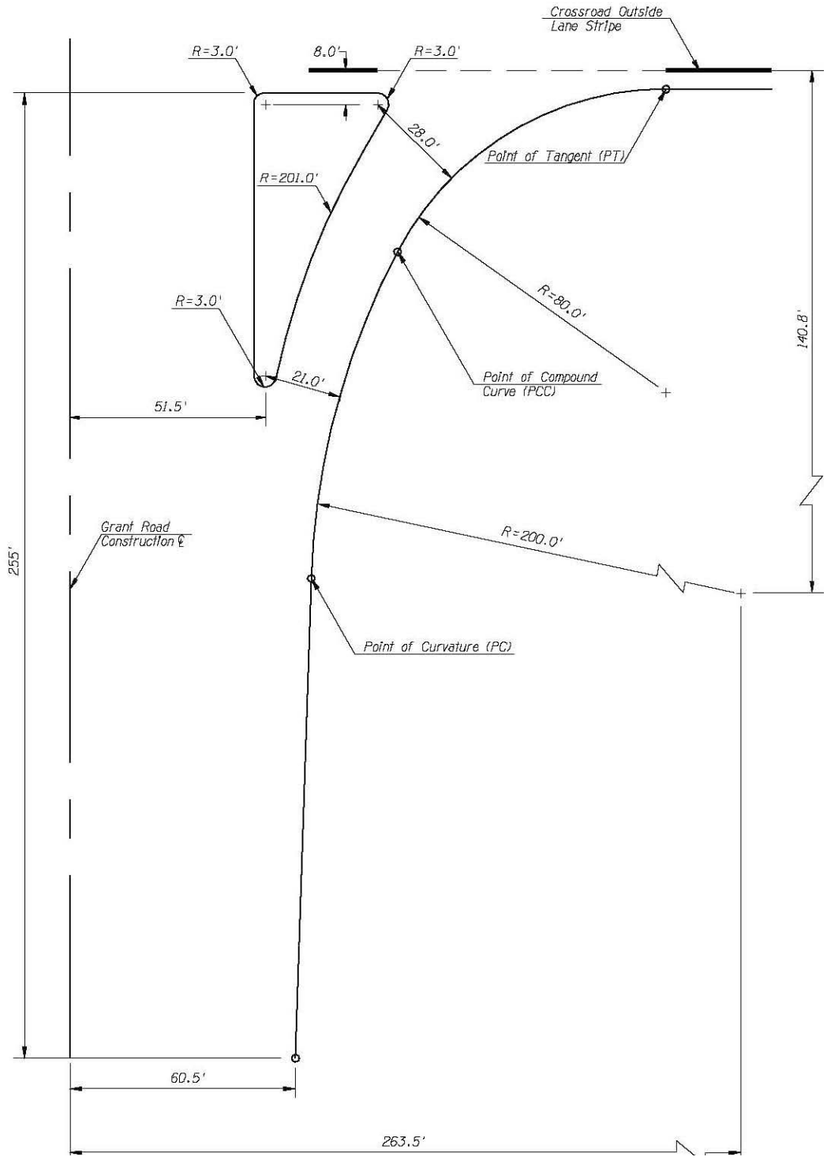


Figure 24: Grant Road Channelized Right Turn Lane Geometry

5.7 Grant Road Parallel Bicycle Boulevards

The Grant Road Task Force endorsed a recommendation to develop two bicycle boulevards that run parallel to Grant Road. The Grant Road parallel bicycle boulevards were recommended to the Task Force in response to public input received at community conversations, workshops, and open houses. The Grant Road parallel bicycle boulevards will serve as bicycle-friendly alternatives to Grant Road bicycle lanes, and will incorporate improvement features that serve to prioritize bicycles over vehicular traffic including traffic calming, bicycle signage, pavement markers, signalized traffic control at intersections with arterials, and channelization.

Two parallel bicycle boulevards are proposed: (1) Copper/Flow Bicycle Blvd, and (2) Seneca Bicycle Blvd. The recommended preliminary routing for the two Grant Road parallel bicycle boulevards are:

- Copper/Flower Bicycle Blvd: Kelso/Copper/Flower Street/San Carlos Place Bicycle Boulevard
- Seneca Bicycle Blvd.: Ventura, Seneca, Waverly, and Justin Lane.

The bicycle boulevards are proposed to extend from Oracle Road (western limit) to Swan Road (eastern limit). The conceptual route of the bicycle boulevards is depicted in **Figure** 25**.**

5.8 Access Management

Access management is the design of intersections, driveways, and median openings to access land and to provide safety and mobility. Access management attempts to balance the need to provide good mobility for through traffic with reasonable access to adjacent land uses.

Benefits of access management are reduced crashes, reduced disruptions to traffic, enhanced bicycle and pedestrian environment, improved aesthetics, and reduced travel time for business customers and deliveries.

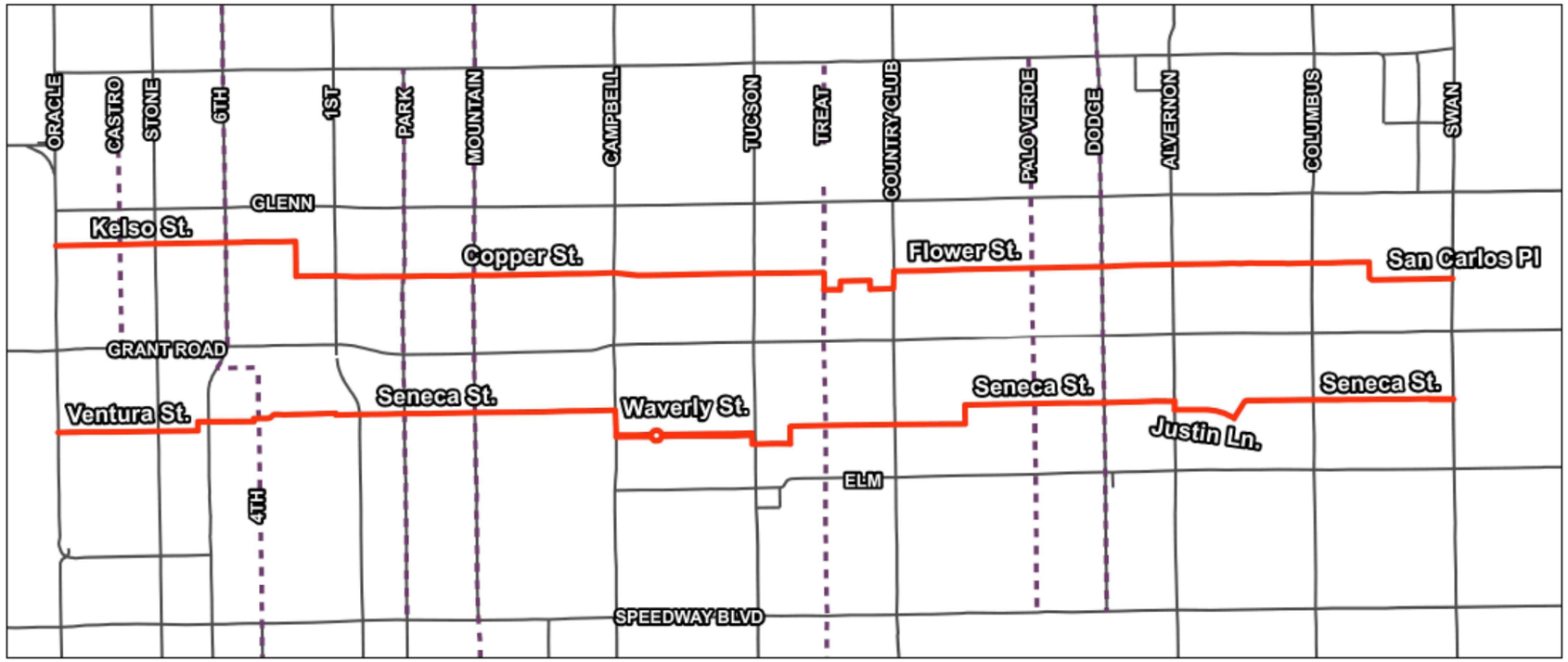


Figure 25: Grant Road Parallel Bicycle Boulevards

Currently, there are over 434 direct driveway access points from businesses and residents to Grant Road within the project limits. In many parts of Grant Road, driveway openings span for the entire frontage of the property. In many areas, vehicles are required to back on to Grant Road to leave the property. The Grant Road Design Team and Task Force recognize that access management is a critical element of an improved Grant Road. Several Grant Road Guiding Principles are directly related to improving access management:

- Balance the transportation needs of those traveling locally with those passing through Grant Road
- Improve mobility and safety for all those traveling along and across Grant Road,
- Balance mobility along and across Grant Road with access to businesses, residences, and other destinations

5.8.1 Access Management Guidelines

Grant Road improvements will be constructed consistent with *Transportation Access Management Guidelines for the City of Tucson, Revised July 2010.*

Consistent with the *Guidelines*, driveway location and spacing requirements for driveways onto Grant Road and north-south arterials and collectors, for new development or redevelopment are as follows:

- Entrance and exit drives accessing Grant Road are limited to two per 300 feet of frontage. The nearest pavement edges should be spaced at least 80 feet apart.
- There will not be any unsignalized full median openings on Grant Road. Full median openings are limited to signalized intersections.
- There should be no direct residential lot access to arterials. Direct residential lot access to collectors should be avoided in new roadway development.
- All new development should promote cross access agreements to limit the number of driveways crossing arterial and collector roadways.
- Where required to provide access to land uses, local access lanes may be considered.

Access management strategies that will be utilized on Grant Road to achieve implementation of the above guidelines and criteria include:

- Properly locate and space driveways:
- Develop shared and cross access driveway agreements
- Provide local access lanes
- Properly locate and space median openings

Each of these is discussed in more detail in the following sections.

5.8.2 Driveway Consolidation and Relocation

Studies demonstrate that crash rates increase as the spacing of unsignalized access points and driveway openings decrease, particularly for commercial entrances and exits. Vehicles entering or leaving the road at driveway operate at slower speeds than the prevailing traffic. The speed differential increases the potential for crashes, and slows roadway travel. Effective management of driveway spacing enhances corridor operations and safety.

Consolidating and relocating driveways to side streets, where feasible, will be considered in Grant Road improvements. **Figure 26** shows typical existing Grant Road conditions, where properties have multiple driveways that access Grant Road. **Figure 27** shows how driveways may be consolidated or relocated to the adjacent side street or to the rear of the property. A decision to relocate driveways to side streets should consider potential concerns from adjacent neighborhood residential areas regarding cut-through traffic.

Transportation Access Management Guidelines for the City of Tucson, Revised July 2010 states that a minimum of one hundred and fifty feet, measured at curbline, shall separate the nearest pavement edge of any entrance or exit driveway and the curbline to any signalized intersection with Grant Road, as illustrated in **Figure 28.**

In addition, consistent with the *Guidelines*, there should be no direct residential lot access to Grant Road. Direct residential lot access to cross street arterials or collectors should be avoided in new roadway development.

Figure 26: Consolidated and Relocated Driveways, Before Condition

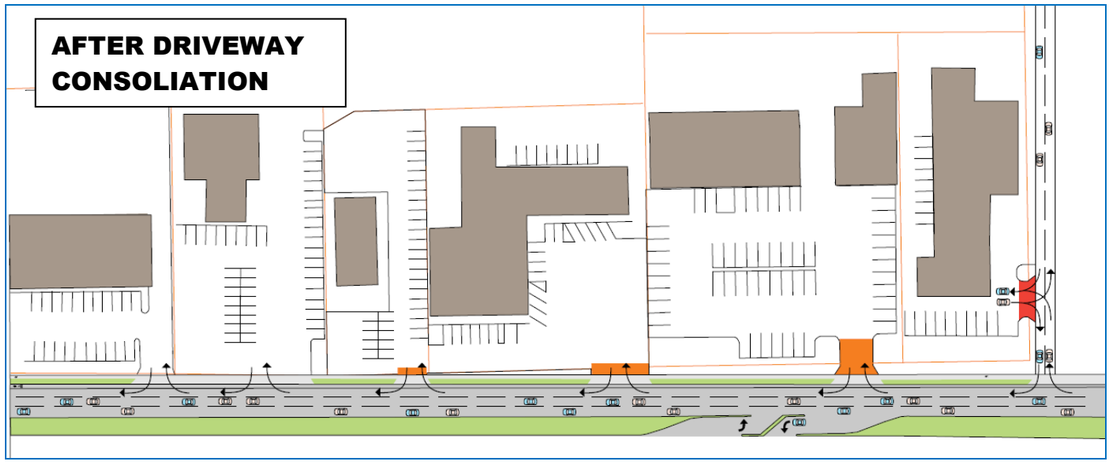


Figure 27: Consolidated and Relocated Driveways, After Condition

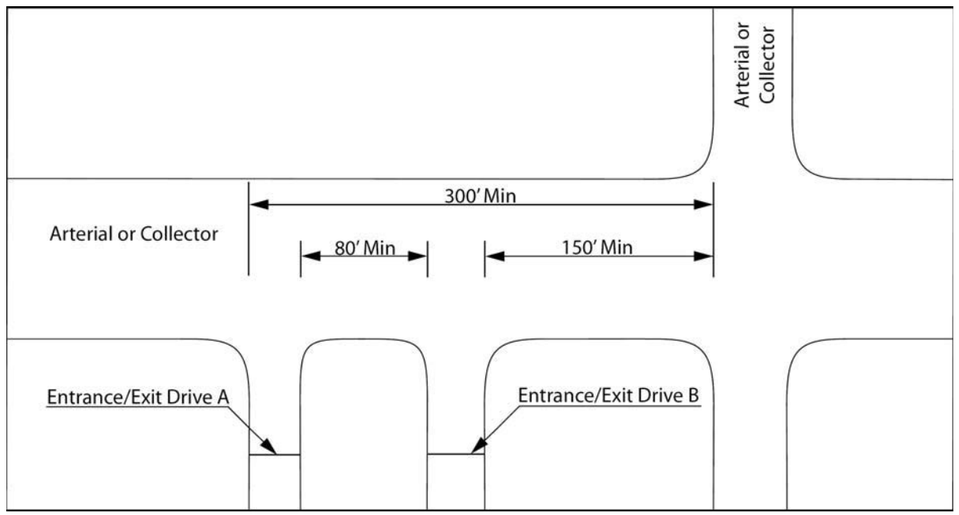


Figure 28: Driveway Spacing Requirements

Local access lanes include the following benefits:

- Reduces the number of conflict points between vehicles, pedestrians and bicyclists
- Reduces congestion by maintaining the flow of traffic
- Provides more area for landscaping
- Makes the bicycle and pedestrian friendly environment safer
- Business patrons encounter less congestion, thereby experience fewer delays accessing businesses
- Provides parking lane

5.8.3 Cross and Shared Access Management

Cross access is achieved when property owners agree to allow other parcels to cross their property to access a driveway access point. Shared access is achieved when adjacent property owners agree to share a single driveway that accesses both adjacent properties, reducing the number of driveways and conflict points along the arterial. **Figure 26** illustrates cross and shared access. These agreements enable multiple parcels to utilize a common driveway. Furthermore, inter-parcel connections can limit short trips on Grant Road. Inter-parcel connections and cross-access connections often take the form of simple driveway connections between sites, so that so that traffic moving from one to the other need not access the arterial.

In certain areas along Grant Road, particularly in commercial areas, adjacent property owners will be encouraged to coordinate access and to develop shared access or cross access agreements. Benefits of cross and shared access include:

- Reduces the number of conflict points between vehicles, pedestrians, and bicyclists.
- Reduces congestion by maintaining the flow of traffic along the arterial roadway.
- Provides more area for landscaping.
- Makes the bicycle and pedestrian environment safer.
- Business patrons encounter less congestion; thereby experience fewer delays accessing businesses.

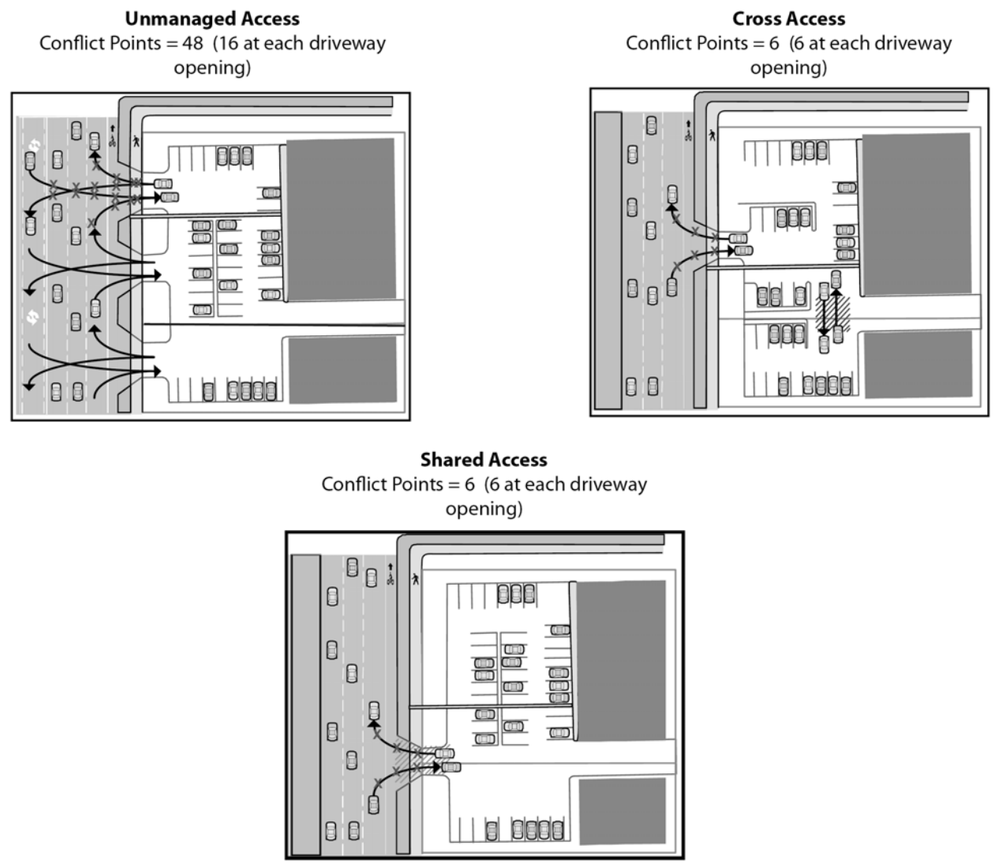


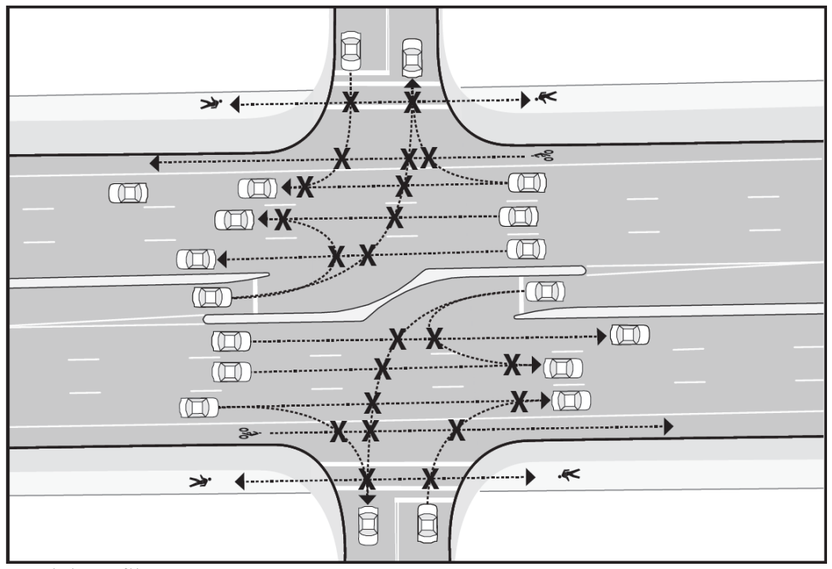
Figure 29: Unmanaged Access, Cross Access, and Shared Access

5.8.4 Median Openings

The design and spacing of median openings is critical in providing safe and efficient travel along an urban arterial. In selecting a median type, a balance is often needed between providing access to adjacent properties and ensuring adequate throughput capacity and travel speeds.

By separating oncoming traffic, and by managing turning movements, non-traversable medians offer the most significant potential to improve roadway safety and operations. The provision of a non-traversable median that separates opposing traffic effectively limits left-turns on a roadway. Safety data have shown the crash rate reduction attributable to installation of medians is up to 35 percent (*NCHRP Report 420*). Non-traversable medians prevent crossover crashes, provide room to accommodate left turn lanes for vehicles making turns to side streets, and provide refuge for pedestrians or bicyclists crossing the street.

The Grant Road Improvement Plan recommends a 17-foot wide non-traversable median. Full median openings will be limited to signalized intersections to allow traffic left-turns from north-south streets to Grant Road. There will not be any unsignalized full median openings within the project limits. Directional median openings have been recommended by the Design Team and endorsed by the Task Force to accommodate left-turns and U-turns at selected locations. Directional median openings are designed to allow left turn access from Grant Road, while limiting left turns to Grant Road. Studies have shown that directional median openings are safer than full unsignalized median openings because the number of conflict points is significantly reduced, as illustrated in **Figure 30.** The Grant Road planning and design process investigated and worked closely with the community on the location of specific median openings. In the future, it is recommended that future development comply with median openings as presented in the plan sheets included in **Appendix A**. The median opening spacing guidelines in the City of Tucson Access Management Policy should be enforced.



X = potential conflict
Number of conflicts = 22

Figure 30: Directional Median Opening Conflict Points

5.8.5 Local Access Lane

Transportation Access Management Guidelines for the City of Tucson, Revised July 2010 states that there should be no direct residential lot access to arterials. As such, direct residential access to Grant Road is not recommended. Currently, several residential lots on Grant Road have direct access to Grant Road.
An effective strategy to eliminate or reduce direct residential access to a major urban arterial is through the construction of local access lanes. Local access lanes have been constructed throughout City of Tucson, as exemplified by the local access lanes that currently exist on Grant Road east of Campbell Avenue, on the south side of Grant Road. Local access lanes on Grant Road will consist of a local street (one-way) that serves multiple properties, as illustrated in **Figure 31.**

Local access lanes include the following benefits:

- Reduces the number of conflict points between vehicles, pedestrians and bicyclists
- Reduces congestion by maintaining the flow of traffic
- Provides more area for landscaping
- Makes the bicycle and pedestrian friendly environment safer
- Business patrons encounter less congestion, thereby experience fewer delays accessing businesses
- Provides parking lane

The Grant Road Improvement Plan recommends local access lanes in the residential and commercial areas listed below.

1. Between 1st Avenue and Park Ave, south side of Grant Road
2. Between Park Avenue and Mountain Avenue, north side of Grant Road
3. Between Highland Avenue and Warren Avenue, south side of Grant Road
4. Between Norris Avenue and Tucson Boulevard, south side of Grant Road
5. Between Palo Verde Boulevard and Richey Boulevard, north side of Grant Road
6. Between Bryant Avenue and Columbus Boulevard, north side of Grant road

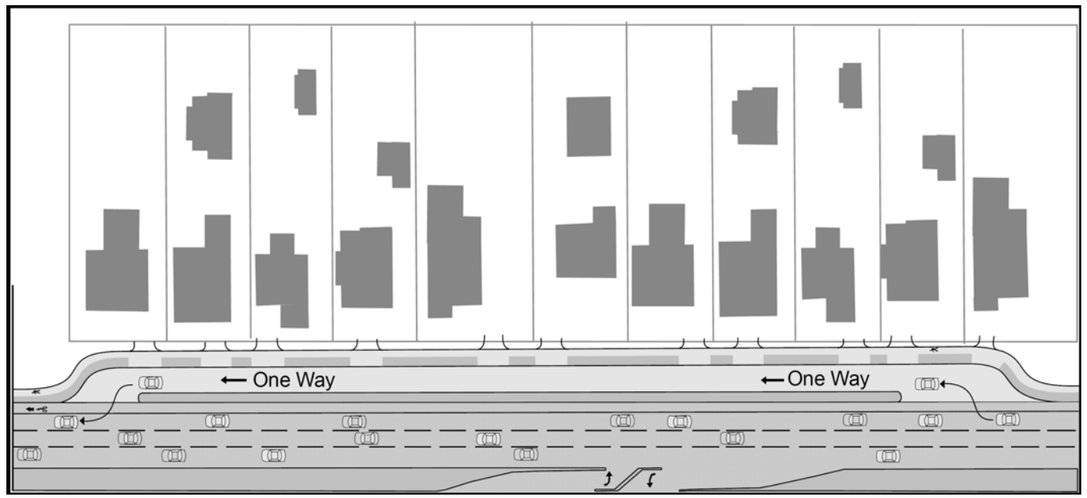


Figure 31: Local Access Lanes

5.8.6 Driveway Design

Driveways are the physical interface between a property and the roadway. In addition to proper spacing and location of driveways, proper driveway design and on-site development is critical to effective access management. The basic elements of driveway design are driveway width, curb radius, and throat length

Driveway Width: *Transportation Access Management Guidelines for the City of Tucson, Revised July 2010* identifies a maximum driveway width of 35-feet for commercial/business access. The Grant Road Improvement Plan recommends narrower driveways to enhance the pedestrian environment, wherever feasible and compatible with expected driveway operations.

Curb Radius: Preferred curb radii will depend on the type of vehicles to be accommodated at the driveway opening. *Transportation Access Management Guidelines for the City of Tucson, Revised July 2010* identifies a minimum curb return radius of 25-feet. The Grant Road Improvement Plan recommends a reduction of minimum curb radius to 15-feet at locations where truck traffic is minimal. Driveway entrances with truck traffic will generally be maintained at 25-feet.

Throat Length: The driveway throat should be of sufficient length to enable the intersection of the driveway and abutting roadway and the on-site circulation to function without interference with each other. Drivers entering the site should be able to clear the intersection of the roadway and the driveway before encountering any intersections that are part of on-site circulation. Inadequate throat length results in poor access circulation in the vicinity of the access drive. This produces congestion and high crash rates on the abutting streets as well as on site. Pedestrian/vehicular conflicts may also result from confusion caused by the complex pattern of over-lapping conflict areas.

The exit side of an access connection should be designed to enable traffic leaving the site to do so efficiently. Stop-controlled connections should be of sufficient length to store three passenger cars (one passenger car = 20 feet). **Figure 32** illustrates the recommended practices for designing driveway throat lengths.

On Grant Road, right of way constraints constrain or prohibit the opportunity for sufficient throat length with exception to large commercial centers. However, the throat length should be maximized to the extent feasible. As parcels redevelop along Grant Road, the minimum throat length should be 60', as illustrated in **Figure 32.**

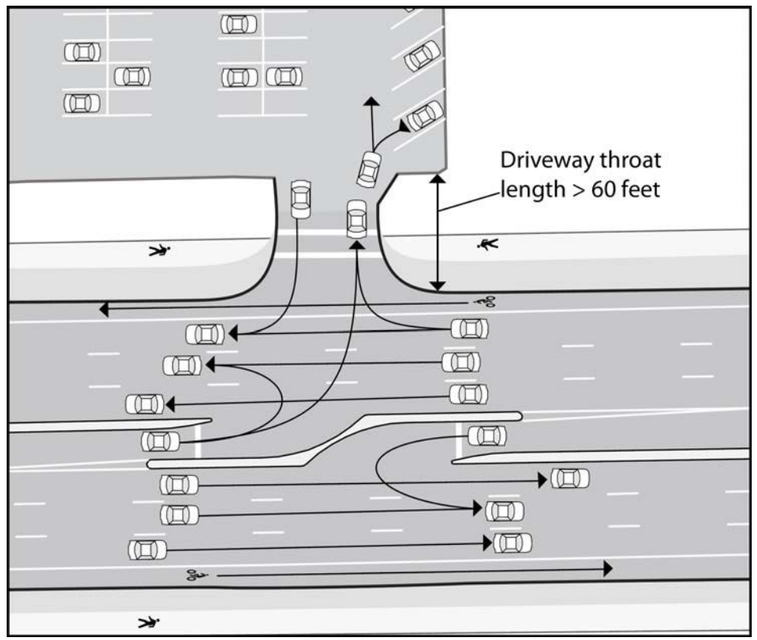


Figure 32: On-Site Driveway Throat Length Requirements

5.8.7 Recommended Access Management Practices

Table 6 summarizes City Access Management Guidelines that will be applied to Grant Road. The Design Team recognizes that the current land use configurations on Grant Road will not allow for full implementation of these guidelines in the near-term.

The Design Team recommends future collaboration with property owners to achieve implementation as practical. Full implementation can also be achieved in collaboration with redevelopment opportunities.

Table 6. Grant Road Access Management Design Criteria

Access Management Element	Design Criteria
Driveway Spacing	The Grant Road plan will comply with the existing City of Tucson access management policy, *Transportation Access Management Guidelines for the City of Tucson, Revised July 2010* for driveway spacing standards: • Entrance and exit driveways are limited to two per 300-feet of frontage along any major roadway. • The nearest pavement edges will be spaced at least 80-feet apart. • All new development and redevelopment should promote sharing driveways or cross access agreements to limit the number of driveways.
Corner Clearance	A minimum of 150-feet, measured at the curb line, shall separate the nearest pavement edge of any entrance or exit driveway and the curb line to any signalized intersection.
Driveway Width	Maximum driveway width of 35-feet for commercial/business access. The Grant Road Improvement Plan encourages narrower driveways to enhance the pedestrian environment, wherever feasible and compatible with expected driveway operations.
Driveway Radius	Preferred curb radii will depend on the type of vehicles to be accommodated at the driveway opening. Curb radius will be 15' at locations where truck traffic is minimal. Driveway entrances with truck traffic will generally be maintained at 25-feet.
Driveway Profile	Driveway should be designed to provide a comfortable and safe transition for those use facility, and to accommodate the storm water drainage system.
Driveway Throat Lengths	The storage distance from curb to on-site circulation should be a minimum of 60 feet.

5.8.8 Other Access Management Planning and Design Considerations

Grant Road Mobility, Access, and Streetscape Workshops were held in fall 2009. The workshops offered participants an opportunity to provide input to the Citizen Task Force and to the Project Team on design features and policies for mobility, access, and streetscape elements for the Grant Road Improvement Plan. Input received at the Mobility and Access Workshops were used to refine preliminary roadway design plans, roadway access management policy, and specific streetscape design features that are included in the 30 percent construction plans (**Appendix A**). Participants provided input related to several feedback themes that will require consideration as Grant Road final design continues:

- Property impacts: Participants expressed concern over business access and signage. In addition, participants are interested in traffic management and business access during construction.
- Neighborhood Access and Traffic Management: There were several requests for traffic calming on the following neighborhood streets:

  - Park Ave
  - Streets accessing Grant Road from the southeast corner of Grant and Euclid, from Los Betos
  - Spring St and Cherry Ave between Norris and Campbell Ave
  - Water St, between Norris and Campbell
  - Copper St (Campbell to Country Club)
  - Loretta Dr (Campbell to Country Club)
  - Goyette (Alvernon to Swan), Vista del Monte Neighborhood Association
  - Estrella Ave (Oracle to Stone)
  - Treat Ave
  - Northway/Grant Rd
  - Vine Ave (if Vine is closed)

Input received at the Mobility and Access Workshops was explored and considered in the development of the 30 percent construction plans (**Appendix A**). Input received at the Mobility and Access Workshops related to traffic calming in neighborhood streets will need to be considered in as Grant Road improvements enter final design and construction. Streets on which traffic calming and mitigation was requested include the following:

5.9 Property Impact Mitigation

The City of Tucson recognizes that the Grant Road improvements will have a significant impact on existing businesses and properties. Consistent with Grant Road Guiding Principles of "provide information and technical assistance to residential and business property owners directly impacted by the Grant Road Plan", the City of Tucson directed the planning team to work with individual property owners for whom the Grant Road improvements will significantly impact right of way, circulation, and access.

Beginning in January 2009, the design team collaboratively contacted and collaboratively worked with property owners to further investigate right-of-way, access, and parking impacts, and identify strategies that would lessen the impacts while achieving the guiding principles of the Grant Road improvements. Considerations included review of:

- New right of way impacts to their property
- Changes to access (driveways location)
- Impacts to parking, and identification and review of possible parking solutions
- Impacts to signs

The Design Team contacted over 150 property owners and developed over 100 conceptual mitigation plans for individual properties. This process provides significant benefit to both the City, the planning team, and to the property owners. Property owners have an increased understanding of impacts to their property, and how the impacts may be mitigated. If the roadway impacts are significant enough that the property will be a full acquisition or the impacts cannot be mitigated, the advance notification to property owners enables them to make informed business decisions.

This process has been a key component to the successful development of an access management policy for Grant Road. Working with property owners, spacing between driveways that directly access Grant Road has increased to 80 feet for 95percent of the driveways. Many of the site plans include relocation and consolidation of driveways, and implementation of shared access and cross access. In many cases, parking impacts were mitigated through site reconfiguration and on-street parking.

Property impact mitigation planning has allowed for a transparent process between the property owners and the City of Tucson. and provides property owners with a better understanding of options they can consider to mitigate impacts and avoid possible relocation. The process may result in a cost savings for right of way acquisition from property impacts can be mitigated so that property owners addressed can remain onsite.

The locations of driveways and access points to properties are shown in the 30 percent construction plans (**Appendix A**). The locations of driveways and access will reflect the input received during the property impact mitigation process, as well as input received during Mobility and Access Workshops that were held in November 2009.

5.10 Right of Way

5.10.1 Right of Way Width

137-Foot Typical Section: The 137-foot street section (**Figure 33**) is applied to segments of Grant Road where access to land uses is not a major requirement or to segments where access control strategies can be applied to minimize the adverse impacts of access on Grant Road operations and safety. The 137' section consists of:

- 17-foot median
- 11-foot travel lanes
- 6-foot bicycle lane, with a 1-foot buffer between the travel lane and the bicycle lane
- 20-foot pedestrian realm, including a continuous 8-foot sidewalk and landscaped 12-foot buffer

The 137-foot street section is considered as the minimum street section and reducing the median width, travel lane width, and bike lane width should not be considered. However, minor reductions in the 20-foot pedestrian realm can be considered to avoid or minimize impacts to private property.

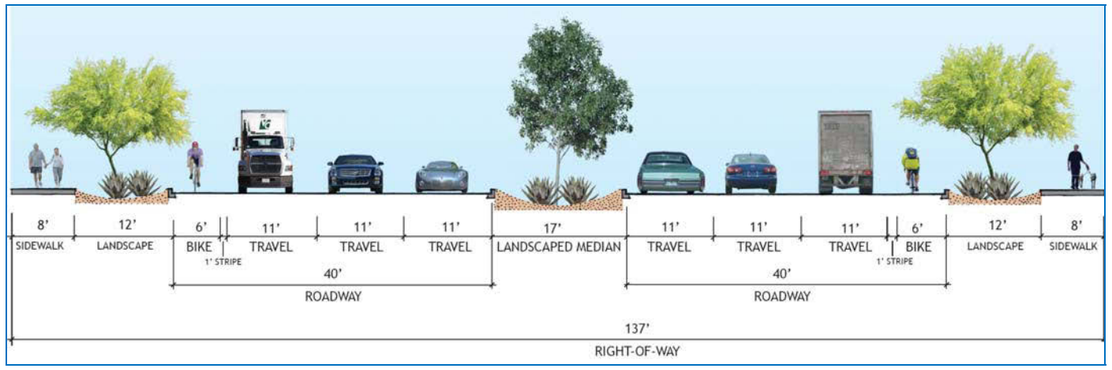


Figure 33: 137-foot Typical Street Section

160-Foot Typical Section: The 160-foot street section (**Figure 33**) is applied to segments of Grant Road where access to land uses is a major requirement and segments where access control strategies cannot be implemented to minimize the adverse impacts of direct access to Grant Road. Its primary application is for areas where residential uses front onto Grant Road both to provide for access (curb cuts and on-street parking) as well as to provide additional separation and buffering from the through traffic lanes. It may also be used in locations where the nature of businesses that front onto Grant Road support a more active retail frontage that would be well-served by on-street parking and the buffering from Grant Road through traffic. The 160-foot section consists of:

- 17-foot median
- 11-foot travel lanes
- 6-foot bicycle lane, with a 1-foot buffer between the travel lane and the bicycle lane
- 20-foot pedestrian realm, including a continuous 8-foot sidewalk and landscaped 12-foot buffer
- 43-foot local access lane, side median, and pedestrian area consisting of a 10-foot side median, 10-foot one-way local access lane, 7-foot parallel parking lanes, and a 16-foot pedestrian areas that includes a sidewalk and landscaped buffer

The 160-foot street section should be considered as the minimum street section and reducing the center and side median widths, travel lane width, bike lane width, and local access lane and parking lane widths should not be considered. However, minor reductions in the 20-foot and/or 16-foot pedestrian realm can be considered to avoid or minimize impacts.

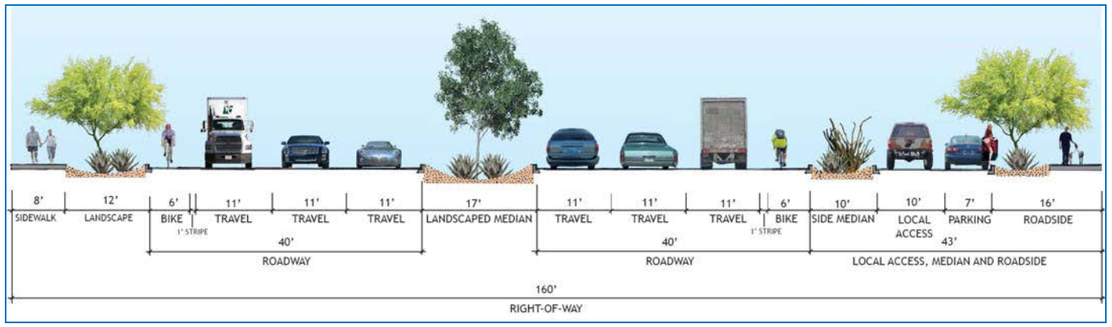


Figure 34: 160-foot Typical Street Section with Local Access Lane

5.10.2 Design Considerations

Cut and fill slopes will represent a significant design considerations that will need to be addressed in final design. Various options have been developed to address cut/fill slopes, while maintaining the desirable landscape and pedestrian amenities. Options include:

- Slope grading on full property acquisitions
- Variable sidewalk grade

- Seat walls at right of way line for cut conditions
- Walls at street side of sidewalk or at right of way line for fill conditions

Details of walls and seat walls as right of way treatments are provided in the landscape sheets of the 30 percent construction plans. An example of a seat wall for a cut condition is shown in **Figure 35** and **Figure 36.**

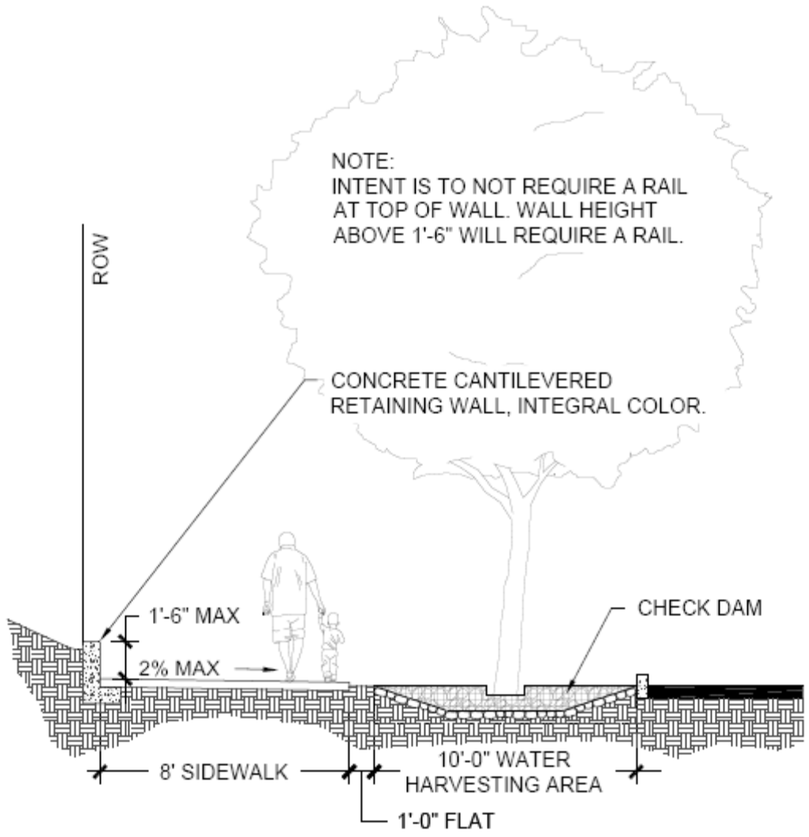


Figure 35: Example Right of Way Treatment, Cut Condition

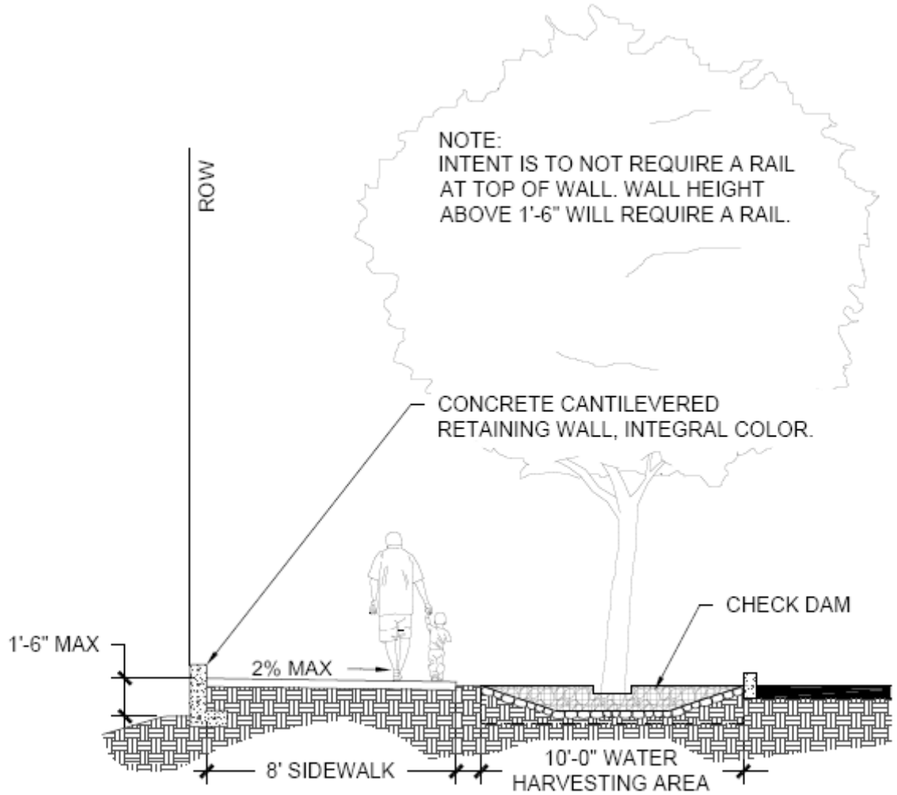


Figure 36: Example Right of Way Treatment, Fill Condition

5.11 Drainage

The Grant Road Drainage Report documents the findings of the hydrologic and hydraulic characteristics of the respective watersheds and infrastructure affecting Grant Road between Oracle Road and Swan Road. The report also provides a review of existing *Tucson Stormwater Management Study (TSMS)* data, roadway hydrologic data, existing and proposed drainage infrastructure, and serves as documentation of all the design flow rates tributary to the Grant Road project that will be used to size the recommended drainage improvements included in the roadway design.

The primary purpose of Grant Road improvements recommended drainage facilities are to improve the collection and conveyance of storm water along Grant Road to meet the City of Tucson's drainage design criteria.

Grant Road roadway geometry, as depicted in the 30 % construction plans (Appendix A), was analyzed to verify that cross drainage was capable of being conveyed across Grant Road within the City of Tucson's drainage design criteria. In almost all locations, offsite roadway crossing capacities have been increased, while the capacities of cross streets to the north and south remain the same. It should be noted that the majority of cross street conveyance capacities are exceeded by the offsite peak flow rates. Improvement of these conditions requires the upsizing of the major offsite drainage systems, which is beyond the scope of Grant Road improvements. As such, cross drainage will remain deficient.

5.11.1 Offsite Flows

Project area watersheds are bounded by the Santa Cruz River to the west and the Rillito River to the north. The project's general topography slopes from south to north with approximately 120 feet of vertical fall in some of the larger watersheds. There are six major offsite watersheds. Four watersheds (Christmas Wash, Alvernon Wash, Creekside Wash, and Swan Road Wash) intersect the project and drain to the Rillito River to the north, while two watersheds (Grant Road Wash and Flowing Wells Wash) drain to the west into the Santa Cruz River. The Grant Road Improvement Plan project limits intersect these six major watersheds upstream from their ultimate discharge points (Rillito River and Santa Cruz River).

The hydrology for the greater Tucson area has been studied in the *Tucson Stormwater Management Study (TSMS)*, and the resulting recommendations were presented in *Phase II, Stormwater Master Plan* (Simons, Li & Associates, 1992-1995). The TSMS Study developed concentration points or nodes within the Grant Road project limits. These concentration points will be used as design discharges and are shown in Table 7**.**

Table 7. TSMS Nodes

TSMS Node	Location	Watershed	Wash	100-Year Discharge (cfs)	Date Verified
DD-N0010	Grant Rd @ Oracle Rd	Grant Road Wash	Grant Road Wash	1141	4/01
DG-N0020	Warren Ave @ Spring St	Flowing Wells Wash	No Name	627	6/05
DG-N0030	Grant Rd @ Highland Ave	Flowing Wells Wash	No Name	593	6/05
DG-N0040	Grant Rd @ Mountain Ave	Flowing Wells Wash	Mountain Avenue Wash	348	6/05
DG-N0110	Water St @ Wilson Ave	Flowing Wells Wash	No Name	1019	6/05
DG-N0120	Grant Rd @ Treat Ave	Flowing Wells Wash	No Name	419	6/05
GL-N0070	Country Club @ Seneca St	Christmas Wash	Christmas Wash	1291	Draft
GG-N0016	Grant Rd @ Belvedere Ave	Alvernon Wash	Midway Wash	1275	6/01
GG-N0035	Grant Rd @ Columbus Blvd	Alvernon Wash	Columbus Wash	813	6/01

Table 7. TSMS Nodes (continued)

TSMS Node	Location	Watershed	Wash	100-Year Discharge (cfs)	Date Verified
GG-N0055	Grant Rd @ Alvernon Way	Alvernon Wash	Alvernon Wash	1923	6/01
GD-N0010	Grant Rd @ Swan Rd	Swan Road Wash	Swan Road Wash	522	Draft

In addition to the TSMS data, additional confluence points have been identified as needing design flow rates. The Design Team completed an analysis of the project's tributary watersheds to fully comprehend and compare (with respect to TSMS) results.

5.11.2 FEMA Floodplain

Portions of the Grant Road study area are located within a FEMA designated 100-year floodplain. All the floodplains cross Grant Road at a nearly perpendicular or oblique angle. These crossings include Wilson Avenue Wash, Alvernon Wash, Midway Wash, and Columbus Wash.

Table 8 provides a summary of the FEMA Floodplains along Grant Road. Exhibits of the existing FEMA floodplains are available in the *Grant Road Preliminary Drainage Report.*

Table 8. FEMA Floodplains Affecting Grant Road

FEMA Panel	Map Number	Revision Date	Location	FEMA Floodplain	Zone
1639K, 1643 K, 2227K	04019C1639K, 04019C1643K, 04019C2227K	8-Sep-99	Wilson Avenue	Wilson Wash	Zone AH: 100-year flood depths of 1-3 feet (usually areas of ponding); base flood elevations determined.
1643K, 2231K	04019C1643K, 04019C2231K	8-Sep-99	Alvernon Way	Alvernon Wash (street Wash)	Zone AH: 100-year flood depths of 1-3 feet (usually areas of ponding); base flood elevations determined.
1644K, 2232K	04019C1644K, 04019C2232K	8-Sep-99	Columbus Blvd	Columbus Wash	Zone AE: 100-year base flood elevations determined.

Any modifications or revisions to the Grant Road roadway profile may be considered an impact to established floodplains. City of Tucson and Pima County regulatory limits state that no encroachment may increase base flood (100-year) water surface elevations of regulatory floodplains by more than one tenth of a foot. Encroachment and impacts of the Grant Road improvements into the floodplain will need to be considered during final design. It is recommended that proposed improvements are designed such that the base flood water surface elevation does not increase; also known as a "no-rise" condition.

5.11.3 Roadway Flows/Storm Drain

The majority of Grant Road within the project limits relies on street washes with minimally sized storm drain systems that convey stormwater to their ultimate discharge locations.

Street hydraulics are a large part of the overall stormwater conveyance system considering the undersized storm drain systems and the large watershed areas that drain across the Grant Road. Within the Grant Road Improvement Plan limits, street washes are the primary conveyance system with storm drain infrastructure in place at several locations. A large regional infrastructure improvement would be required to improve Grant Road and cross streets to meet the City of Tucson's drainage design criteria and is not included as part of the Grant Road Improvement Plan. As such, the intent of 30 percent design is to minimize impacts of the street washes that cross Grant Road.

The Grant Road Improvement Plan will include raised medians. In areas that contain large cross drainage flows, medians will consist of curb cuts and erosion measures to allow flow to travel across the roadway without impeding the flow or ponding on the upstream side of the median.

Existing storm drains along Grant Road are limited to Estrella Avenue west to the Santa Cruz River, and Columbus Boulevard east to Swan Road. There are several storm drain systems within the project area along north-south streets, Mountain Avenue, Wilson Avenue, Tucson Boulevard, Country Club Road, Edith Boulevard, Palo Verde Avenue, Alvernon Way, Goyette Avenue, and Swan Road.

Grant Road preliminary plans include extensions to existing storm drain systems. The criteria used for these potential storm drain extensions was the availability of north-south cross drainage infrastructure and the existing Grant Road vertical profile. Where north-south storm drain infrastructure exists and the existing roadway profile for Grant Road permits positive drainage, potential storm drain within Grant Road can be placed and will be analyzed per City of Tucson design standards.

In areas with no major north-south drainage, no storm drain extensions are possible due to no existing outfall. City of Tucson expressed concern that the existing infrastructure was at capacity and any additional discharge would create problems with the system. The existing storm drain and roadway sections were analyzed to identify the areas that have insufficient and sufficient capacity. Identification of these areas will define the areas that future storm drains can be placed.

Storm drain extensions will be analyzed to ensure the roadway discharge peaks will not interfere with the offsite discharge peaks. The storm drain extensions will improve only the drainage along Grant Road and will not affect upstream or downstream existing conditions or properties. In a few locations, these storm drain extensions will catch offsite discharge. Any offsite discharge collected will not be diverted from its original watershed.

The Grant Road Improvement Project will include raised medians along the entire corridor. In areas that contain large cross drainage flows, medians will consist of curb cuts and erosion measures to allow flow to travel across the roadway without impeding the flow or ponding on the upstream side of the median.

City of Tucson drainage design criteria for local, collector and arterial roads is the 10-year storm event for pavement drainage and sizing of storm drains. For arterial roadways (e.g. Grant Road), runoff from the 10-year storm must be contained between the curbs of the road cross section and at least one travel lane in each direction must be free from flooding. All storm drains will be designed to contain the 10-year storm between the combined street-gutter and storm drain system.

5.11.4 Channels and Detention/Retention Basins

There are very few channels and detention/retention basins along Grant Road. As Grant Road is in a highly developed and urbanized area, new channels will be kept to a minimum. Channels will be limited to roadside and median ditches and will be utilized for pavement drainage only. No significant offsite channels are anticipated with this project.

No regional detention or retention basins are anticipated within the project due to the lack of available areas and the large flow volumes received from upstream watersheds. Smaller local retention basins will be identified to support any water harvesting that will be incorporated with the project.

5.11.5 Erosion Control

Erosion control will be required within areas with excessive erosion possibilities. Erosion control will be determined by the FHWA Hydraulic Engineering Circular No. 14.

In areas in which the median needs to be depressed to account for cross drainage across Grant Road, erosion control measures will need to be considered to protect the roadway pavement. In these areas, concrete header and/or riprap will be used to mitigate any erosion. Outlets of culverts, storm drains and channels will be analyzed to ensure no erosion to downstream properties will occur.

5.12 Traffic Signals and Traffic Operations Technology

The Task Force, at their July 12, 2008 meeting, endorsed the design team recommendation to construct both traditional intersections and indirect left turn intersections on Grant Road.

5.12.1 Signalization

There are fifteen signalized intersections within Grant Road improvements (**Table** 7**)**. Of these fifteen intersections, seven have indirect left-turn both intersection control for east and west bound traffic. The signalized turnaround intersections will be controlled by traffic signals which are tied to the signal of the main intersection. A pedestrian crossing (Pelican) is provided at each indirect left-turn turnaround. The other eight signalized intersections consist of four Toucans and four traditional intersections.

Table 9. Locations of Traditional Enhanced and Indirect Left Turn Intersections

Intersection Treatment	Locations	
Traditional Signalized Intersection	• Park Ave • Mountain Ave	• Tucson Blvd • Columbus Blvd
Indirect Left Turn Signalized Intersection (with traditional intersection approaches on the north and south intersecting streets)	• Oracle Rd • Stone Ave • 1st Ave • Campbell Ave	• Country Club Rd • Alvernon Way • Swan Road
Toucan Bicycle Crossing	• 6th/Fontana • Treat Ave. • Palo Verde Blvd. • Dodge Blvd.	

Signalization at the four traditional signalized intersections will consist of a standard 4-phase signalization.

Traffic signal phasing at the indirect left turn intersection will consist of elimination of left turns from east bound and west bound Grant Road to north-south cross streets. Elimination of left turns from Grant Road to north-south cross streets eliminates the number of signal phases, thereby increasing the efficiency of the intersection and improving the level of service.

A typical six-lane arterial intersection requires longer cycle lengths to provide adequate time for each movement while the indirect left turn intersection will allocate more time to through volumes. The traffic signals located at the turn-around will have the same cycle lengths as the main intersection. As a result of the removal of the left turn phase at the main intersection, the bandwidth along Grant Road is anticipated to be up to 50 to 60 seconds in both directions in the peak hours.

Discussions with City staff indicated a desire for left turn movements at the indirect left turn intersections to operate as permissive/protected, if site distance is adequate. The 30 percent construction plans depict a permitted/protected configuration for the turn-around at the indirect left turn traffic signals. The permitted phase employs a flashing yellow arrow for the turn-around movement. The protected phase employs a green arrow for the turn-around movement.

A potential signal phasing plan is shown in **Figure 37.** Coordination will improve the bandwidth and reduce the number of stops for drivers. Discussions with City of Tucson traffic signal technicians identified a need for separate cabinets and signal controllers at each of the three intersections. Communications conduit will interconnect each of the cabinets to allow for direct communications.

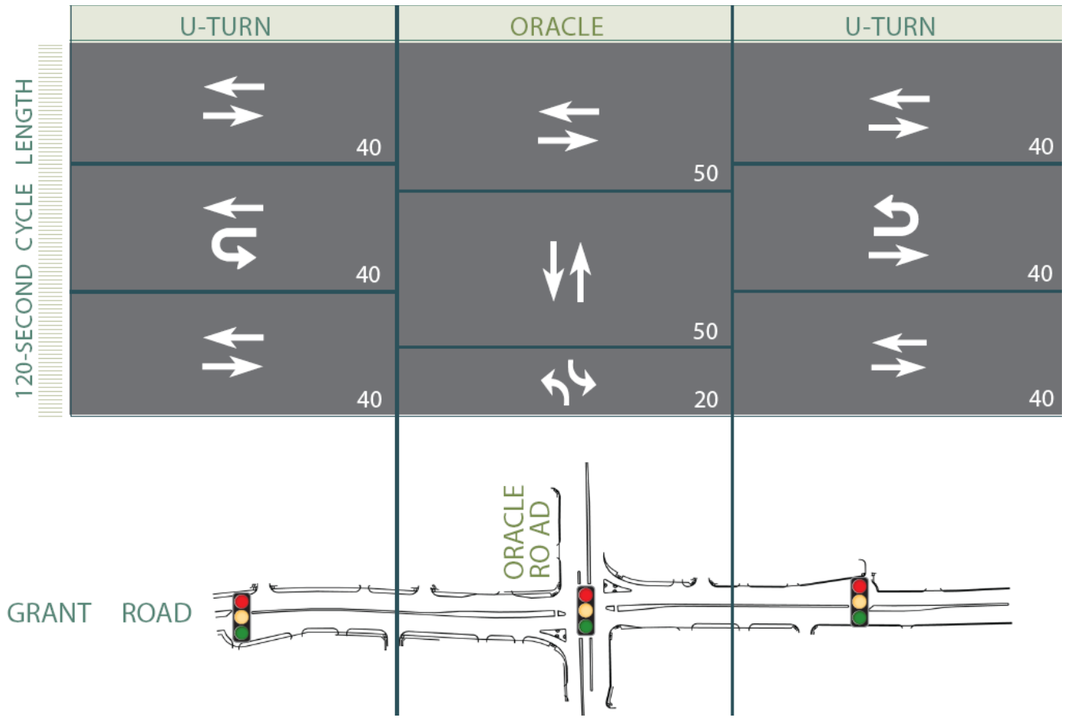


Figure 37: Sample Traffic Signal Phasing

5.12.2 Traffic Operations Technology

The Grant Road Design Team met with City traffic engineering staff and representatives of Pima Association of Governments, Intelligent Transportation Systems (ITS)- Technology and Operations Program to discuss potential ITS investments that should be considered in Grant Road improvements. Discussion items included the following:

- Pan/tilt/zoom cameras should be provided at each signalized intersection. The PAG ITS Strategic Deployment Plan identifies installation of pan/tilt/zoom cameras at major intersections as a recommended mid-term (2010-2014) project. Pan/tilt/zoom cameras facilitate traffic operations analyses and incident detection.
- Each Grant Road signalized intersection should be equipped with standard emergency vehicle pre-emption systems used throughout the City.
- Provisions should be made to facilitate fiber optic cable throughout the improvements. At minimum, each Grant Road reconstruction project should include conduit for future fiber optic cable and conduit for future power. Conduit infrastructure should include two, 2–inch conduits, and one, 4-inch conduit along Grant Road. Conduit infrastructure should be designed and installed consistent

with the *City of Tucson, Department of Information Technology, Tucson Regional Communications and Networking Standards, April 2007.*

- Each Grant Road reconstruction project should coordinate with the planned Regional Transportation Data Network. (RTDN). The RTDN, upon implementation, will provide a regional communications network for transportation.
- All signalized pedestrian (Pelican) signals and bicycle (Toucan) signals within the project should be connected into the City's traffic signal system. via Ethernet radio. Ultimately, these will be connected via the fiber optic cable.
- Dynamic Message Signs (DMS) should be considered at key traveler decision points within each Grant Road reconstruction project limits. The DMS installed on Grant Road should be fully controllable by operators located at the City of Tucson. City staff suggested that a DMS should be considered east and west of Oracle Road on Grant Road. Other key intersections at which DMS may be considered include Alvernon Way and Campbell Avenue.

5.13 Utilities

The Grant Road Utilities Memorandum summarizes utility conflicts, and includes the following information:

- Results of coordination with utility companies during this phase of the project.
- Information on policies and procedures for utility relocations for each utility provider.
- Information about planned utility improvements and/or expansions for each utility provider.
- Research on the feasibility of undergrounding utilities.

Arizona Blue Stake was contacted to identify the utility owners in the study area. Utility companies and agencies that were identified through field research and Arizona Blue Stake reporting within the Grant Road study area are listed in **Table 10**.

Table 10. Utilities Companies and Agencies with Utilities within Grant Road Study Area

Company	Facility
AT&T	Phone
COT Facility Design and Maintenance	Electric, Water, Gas, Sewer
COT DOT Traffic Signal Division	Traffic signal, Lighting, Irrigation
COT I-net Fiber	Fiber Optic
COT Parks and Recreation	Electric
Cox Communications	CATV & Fiber Optic
MCI (Verizon)	Fiber Optic
Pima County Wastewater	Sewer
Qwest Local Networks	Telephone & Fiber Optic

Table 10. Utilities Companies and Agencies with Utilities within Grant Road Study Area (continued)

Company	Facility
Southwest Gas	Gas
Tucson Electric Power	Electric Power
Tucson Water	Water & Reclaimed Water
Time Warner Telecommunications	Fiber Optic & Coaxial Cable
AT&T OSP Engineering	Fiber Optic
Xspedius Communications (owned by Time-Warner Telecommunications)	Communications & Fiber Optic

Utility owners were contacted to discuss the project status, and to obtain information on policies and procedures for relocations, plans for utility improvements and upgrades, and potential for participating in a joint utility corridor.

The relocation of most utilities can take place within 3 months after receiving a request by the City of Tucson to prepare relocation plans and begin relocations. Some large and/or higher volume facilities are subject to schedule and installation restrictions.

Detailed utility information is included in the Utilities Memorandum. For each of the utilities identified, the following information is provided:

- Existing Facilities
- Future Plans for Improvements
- Utility Conflicts
- Policies and Procedures for Addressing Conflicts
- Addressing Redevelopment in the Corridor
- Project Coordination

5.13.1 Utility Relocation Considerations and Costs

Of particular interest to Grant Road Task Force is the opportunity to relocate and/or underground aerial electrical lines. There are approximately 3.5 miles of Tucson Electric Power Company (TEP) overhead power lines along the project. Based on information from the TEP, a brief summary of relocation alternatives and corresponding advantages and disadvantages of each alternative are outlined in **Table 11.**

Possible locations for placement of the overhead power line within the project cross section are:

- Off the corridor - This is something TEP is willing to look at with the City's support.
- Within the pedestrian realm - This is a desirable location for TEP.
- In the center median - It was determined that this option would require additional analysis. It was noted that there are many sections along the median where there are turn lanes within the median,

reducing the true width to 6-feet, making it only feasible for the 46kV line with the longer spans. There are also plans for shade trees in the median.

- Along back of lots - This may be a costly alternative due to additional costs required for corner poles and/or guy systems at the turns. The 46kV line would require a minimum 18-ft easement for access and blow-out (distance wire sway in the wind).

Since a funding source for utility relocation or undergrounding could not be identified, TEP will provide cost estimates for relocation of the power lines to above ground locations.

Table 11. Utility Undergrounding Alternatives

Alternative	Advantage	Disadvantage	Comments
Underground both the 46kV and 14kV Lines	Better visual aesthetics and fewer restrictions to plant palette	Cost (RTA will not pay for undergrounding)	An overview of construction costs for undergrounding the 46kV line, assuming there are no prior rights are: • General 46kV Underground Costs: $1,000,000 per mile: $800,000 per mile for civil work (3-6" ducts encased in red colored concrete), $200,000 per mile for TEP items (Conductors, riser poles, other equipment) • General distribution system underground costs ($100/ft): $50/ft for civil work (conduits and trenching), Easements for equipment and underground lines, $50/ft for TEP items (conductors, equipment)
Relocate the 46kV Lines Overhead and Relocate the 14kV Lines Underground	Longer spacing between poles (up to 700 ft), less wires on pole, shorter poles	Additional cost to underground TEP distribution and other utilities, additional easements required for ground mounted equipment, restrictions to plant palette from overhead lines	
Relocate the 46kV Lines and 14kV Lines Overhead	Minimal additional costs, easier construction and sequence	Aesthetics, restrictions to plant palette	

5.13.2 Funding Opportunities for Undergrounding Utilities

The Regional Transportation Authority Funds cannot be used for undergrounding utilities. It is the policy of the RTA Board that with respect to utilities, reimbursable items for regionally funded projects are limited to utility relocations in specific cases where prior rights or agreements are in effect. However, several sources of funding from federal, state, and local agencies, in addition to special assessments, can help pay for utility relocation.

State and Local Sources -

- Local and state community improvement grants are another method of funding smaller scale undergrounding projects. Some states consider utility burial an aesthetic improvement akin to landscaping and allow communities to apply for funding to bury utilities as part of downtown and Main Street improvement grants.
- Special Assessment Districts – An Assessment District is a financing tool used to fund the cost of a construction project over a period of time. With an assessment district costs are apportioned to each parcel within the project boundary based upon the value of the special benefit conferred on that parcel. Special Assessment bonds are issued by the City on behalf of improvement districts created for a specific purpose, such undergrounding utilities. Special assessment areas are usually created through a petition by the majority of property owners in an area. Property owners in the designated districts are proportionately assessed for the principal and interest costs of repaying the bonds. The City, as trustee for improvement districts, is responsible for collecting the assessments levied against owners of property within each improvement district and for disbursing these amounts to retire the bonds issued to finance the improvements. The City of Tucson administers special improvement districts in accordance with the provisions of Arizona Revised Statute Chapter 4 of Title 48 which governs these types of taxing districts. It should be noted that all engineering fees for the undergrounding would need to be a part of an assessment district. There has not been an assessment district implemented in the City recently.

5.13.3 Joint Trenching

If utilities are placed in a joint trench, a number of utility providers can share relocation costs. The Western Underground Committee has published a guide to provide a joint use trench costing formula. A summary of this formula is provided as follows:

- Each utility shall determine the width and depth of a trench required for that utilities facility alone.
- The minimum separation between utilities sharing the joint use trench shall be 12 inches.
- The proportion of the total trenching cost applicable to each of the utilities occupying a joint use trench should be determined.