Purpose of report: The following recommendations are made to support Columbia, Missouri's desire to increase walkability, livability, active living, active transportation and reduced auto dependency. Three sections are provided. This first provides an overview. Section Two (page 2) offers tools and details. Section Three provides intersection treatments.

Overview

Columbia has the opportunity in rebuilding Stadium and other principal roadways to be pedestrian and bicycle friendly, and to support transit. However, to create such an atmosphere it is essential to focus on highly efficient 4-lane boulevard streets, more connectivity, compact, efficient intersections and to avoid the tendency to add more lanes or more lane width than needed.

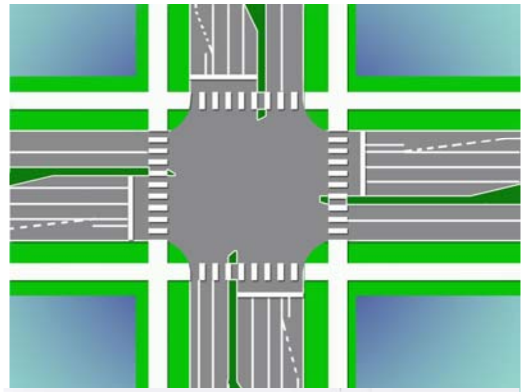
Intersections must efficiently move all forms of traffic. Midblock sections can have fewer lanes. In some cases more efficient intersections, including roundabouts, reduce the need for added lanes used to store vehicles for long signal cycles.

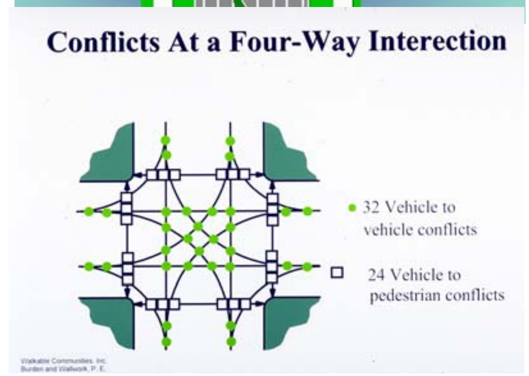
Roundabouts allow motorists to stay in motion, drive slower and get to their destinations in less time. Roundabouts are recommended for a number of single lane locations, as well as some multi-lane roadway sections. Roundabouts should be designed to be bicycle and pedestrian friendly. Entry and exit speeds should be comfortable at 15-20 mph.

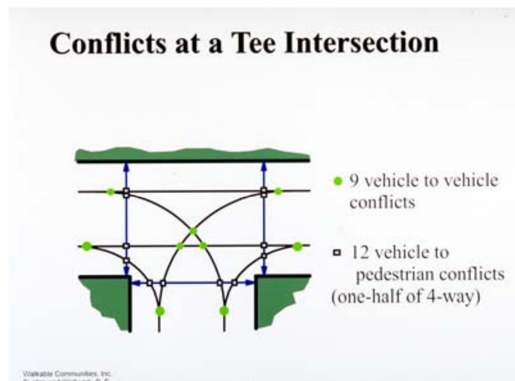
In our field observations it was noted that many people are attempting to walk. Most of the people we observed are staying away from poorly designed intersections, crossing, as best they can, in midblock locations.

The images shown on the following pages are conceptual only. These images illustrate principles that should be followed at specific intersections. Significant follow up work is needed to come up with actual alignments, tapers, and other intersection details. The following general principles apply:

1. Reduce traffic growth by through well connected streets and trails. In general, significant new connections are needed within several miles of freeway entrances. Too much pressure is placed on Stadium to not only load the interstate, but to address the mall and retail power center. This region of town should be designed for greater density, mix of uses, and to strongly support transit, walking and bicycling.
2. Provide more compact intersections by narrowing storage lanes and travel lanes.
3. All measurements shown are curb face to curb face.
4. Boulevards (medians) should be used in locations that permit. Many intersections should be designed for U-turns. These turns can be made back from crosswalks as part of a dedicated left-turn cycle.







5. Provide sidewalks, well designed driveway crossings, shade, rest areas and build to lines to create attractive, functional walkable environments.
6. Design speeds should be set at no more than 35 mph in all developing area collector and arterial roadways, and 25 mph in more settled local street systems. School areas should constrain motorist speeds to 20 mph. In order to achieve these speeds future designs should be based on features creating driver comfort levels consistent with the above speed preferences matched with land uses.

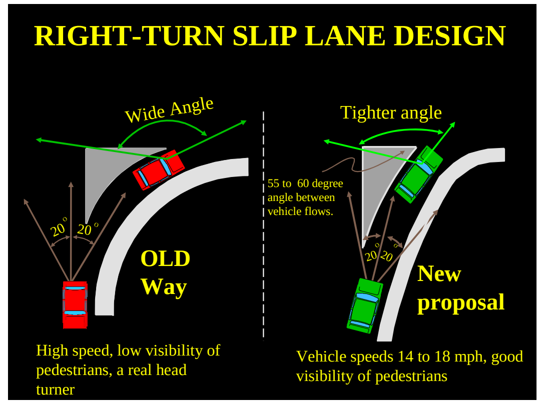
Section Two — Tools

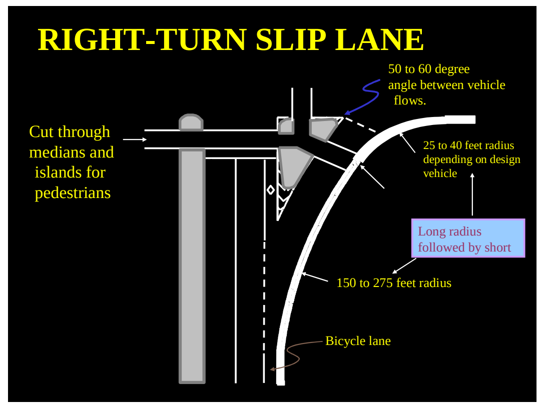
Pork Chop Islands Overly wide intersections discourage pedestrians. Pork chop islands minimize pedestrian crossing times and distances. In some cases crossing distances are reduced from 120-160 feet to 50-60 feet. However, the current design of the majority of Columbia, Maryland's pork chop islands are not friendly to pedestrians, nor as safe as they need to be for pedestrians and motorists.

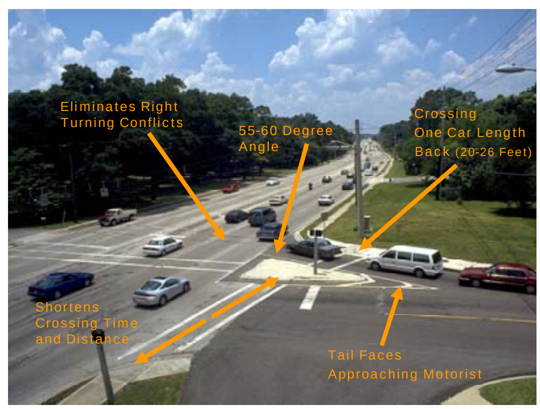
Overview
Columbia has the opportunity in rebuilding Stadium and other principal roadways to be pedestrian and bicycle friendly, and to support transit. However, to create such an atmosphere it is essential to focus on boulevard streets, and to avoid the tendency to add more lanes than needed. By keeping boulevard streets to no more than 4 through lanes it is possible to have more efficient signal cycles. Over building multi-lane roadways forces intersections to fail in directions.

Pork chop island principles:

1. Keep entry angles in the 50-60 degree range (see illustration details). Entry speeds should be kept to 7-11 mph. Increasing the angle encourages speeding and increases crash potential and crash severity.
2. Place pedestrian crossing islands at 45 degree angles approximately 22-26 feet back from the yield line.
3. The tail of the port chop island faces the approaching motorist.
4. Avoiding acceleration lanes out of pork chop islands. In urban spaces these are inappropriate, and often lead to crashes.
5. Create islands with at least 100 square feet of surface. Use non mountable curbing. On smaller islands it is appropriate to eliminate ramps and use a slight crown to drain water in all directions out of ramps.
6. Use tactile surface to denote when a person has reached the edge of each ramp.
7. Activate all crossing cycles for all locations, but create push button controls for those rare times pedestrians need to call up signal cycles.
8. For crossings where yielding behavior may be problematic use raised speed tables on the right side of crossing islands (for right turning vehicles. Use colorized or patterned materials to accentuate the effects of this yield condition.







Crosswalk markings. Well marked crossings are essential to a good walking environment. Crossings should be on all legs of all signalized intersections, with a few limitations. Leaving crossings off of a leg of a intersection forces pedestrians to cross three legs (18 conflicts, versus 6 conflicts). This greatly increases their crossing time, and increases their desire to stay away from the intersection.

Crosswalks should be highly visible all times of the year. When thermoplastic is used it is helpful to add extra glass bead content (increases coefficient of friction as well as night visibility).

Well marked crossings provide these services:
(1) alert motorists to pedestrian conflict areas,
(2) increase potential for motorists to respond to pedestrians.
(3) Enhance motorists recognition of intersections
(4) Assist people with visual impairment in their crossings and
(5) Attract pedestrians to the best crossing places with the most appropriate sight distances and ways to

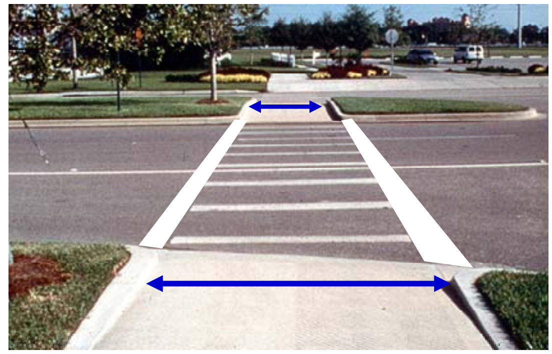
Pedestrian signals
All signalized intersections require pedestrian signal heads **on all crossings**. When signal heads are left out pedestrians do not know when they are permitted to cross streets. In many cases they cannot see traffic signals, nor do they know how much time is left for their crossing.

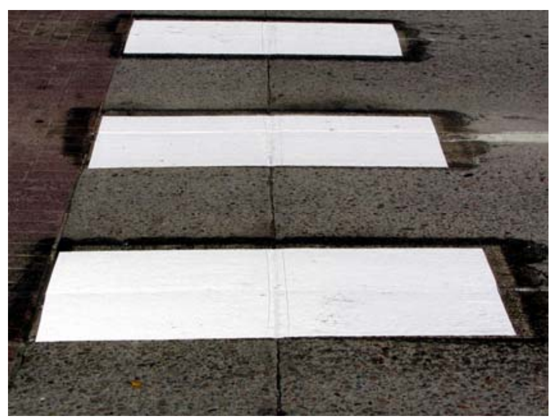
Pedestrian countdown signals
Pedestrian countdown signals are placed at many crossings. Countdown signals end much of the confusion that standard signal heads create (I only had four seconds to cross the street before the hand started to flash at me), and give a clear idea of real time left to complete the crossing.

Stop lines (Stop bars)
Stop lines are most often place 4-6 feet back from marked crosswalks. Lines placed 10-30 feet back from crosswalk markings are an important option. This placement has been shown to reduce the number of motorists that pull forward and end up blocking crosswalks.

Inset markings.
The bottom photo is a new style of inset markings (carefully spaced to allow motorist wheels to pass around the markings). Asphalt or concrete is milled, thermoplastic is placed below plow grade. This style of placement can allow markings to remain strong and visible for years.

Crosswalks and pedestrian signal heads





Median noses at intersections. Median noses keep left turning motorists speeds under control while giving pedestrians a pause between directions of conflict. Noses can be deep (6-12 feet), shallow (2-4 feet) or set behind the crosswalk when no other enhancements are possible. Although it is not possible to get median noses on all legs of all intersections, careful attention to design can get placements in many locations.

Median nose design details

1. Use contrasting color and material that is easily detected by approaching motorists
2. Reinforce first 6-10 feet (some large turning vehicles might cross these noses, especially when poor driving judgments are made.
3. Use reflectors, raised pavement markers (rpm's), snow guides (in cold climates) and ground cover to aid motorists in detection of islands
4. Keep materials trimmed to 2..0 feet or less, to aid in pedestrian recognition.
5. Some signing is acceptable. However signs should not overpower other quality landscaping features
6. Island widths of 8.0 feet or more are preferred. There will be some cases where narrower islands apply. Even a four foot wide island is preferred over no island at all.
7. Use tactile surface to denote when a person has reached the edge.
8. Keep island cuts wide enough to permit two people in wheelchairs to pass one another on the island. A width of 12 feet or more is preferred, especially on arterial and other principle roadways.
9. Provide good lighting.
10. If signals are used, median islands require push button activation systems (buttons or detectors).

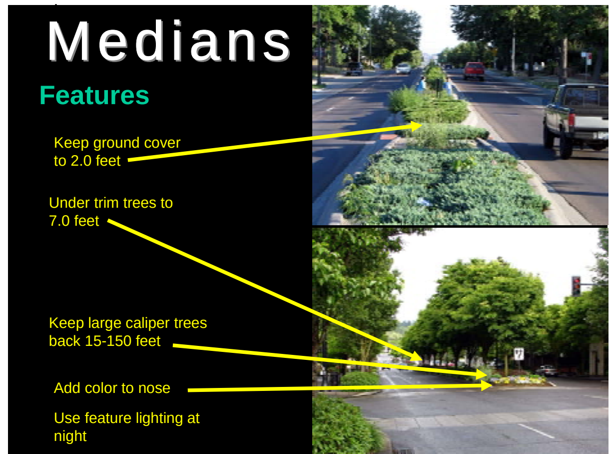
Raised Medians Medians are one of the most valuable roadway performance enhancing tools. They are most often used in rural, suburban and near urban areas. Raised medians have been shown to reduce personal injury crashes more than 50% (compared with two-way-left-turn TWLTL's). increase the carrying capacity of roadways as much as 33%, and serve as an aid for informal pedestrian crossings. Medians are used to replace (TWLTL's). Pedestrians seek means to cross streets each 300-400 feet. Suburban signalized intersections are often spaced 1/4 mile or more apart.

Jumper islands

As medians are added to important areas emergency responders may, at times, be stuck in peak hour congestion at key intersections. Openings known as jumper islands are introduced. The bottom two photos show a jumper island in Bellevue, Washington. A low concrete reinforced island is dropped to about 3 inches in height. Emergency equipment takes advantage of these dropped areas to go contra-flow through the intersection, where they return to the proper flow on the far side of the intersection.

Median island design details

1. Generally non-mountable curbing is used In some cases medians can be raised to 12 or even 16 inches to avoid problems like salt intrusion (snow country).
2. Openings for pedestrians should be placed at cross streets (right-in, right-out only) or at other regular intervals where good sight lines and lighting aid in pedestrian crossings.
3. Median widths of 12 feet (or more) are preferred. When right-of-way or other factors prohibit this width lesser widths are acceptable down to about two feet.
4. Domed medians are effective in hiding asphalt.
5. Ground cover should be maintained to no higher than 24-28 inches. Slow growth, native plantings are preferred.
6. Lighting can be effective, especially on median noses and other gateway locations.
7. Trees provide critical vertical height to aid in detection of medians. Trees require an 8 foot or wider median width (four foot setback). Research shows that medians with trees have less severed crashes than treeless medians.
8. Trees should be undercut 7.0 feet, and set back from principle intersections 150 feet. Thin caliper (4" or less) trees can be placed closer.

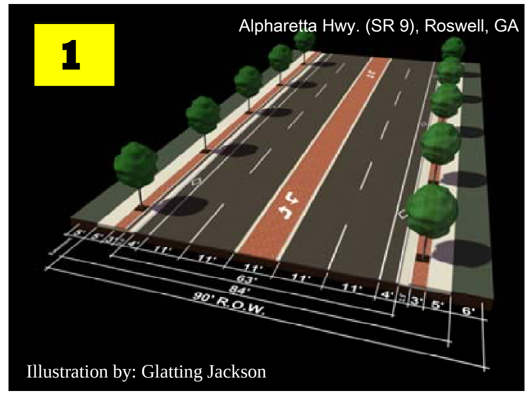


Medians — From suburban to urban

Transitioning to medians. Replacements to TWLTL's can be made in stages. As areas become more urban and driveways are no longer functional or needed medians are extended until they fill entire blocks. Turn pockets are introduced on approach to many signalized and cross intersection. Opportunities for U-turns are created as medians become longer and increase roadway efficiencies and safety.

Incremental median development

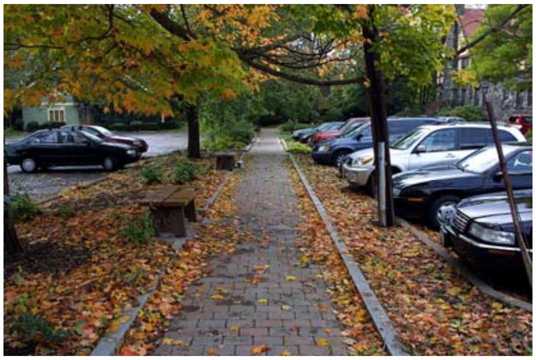
1. **Pigmented center lanes.** During a roadway re-surfacing project the five lane road is visually nar-rowed to four lanes, plus a colorized median. As-phalt, concrete or other durable materials are used. Strong, wide, white stripes accentuate the edge. These stripes can be 8-12 inches wide. Col-orized center turn lanes can be 10 to 12 feet wide, or less in some lower speed areas.
2. **Colorized medians** are adapted as crossing is-lands are inserted. In this low speed environment trees and ground cover help accentuate the pre-ferred low speed of vehicles. Islands can be as little as 60 feet, or as long as needed.
3. **Increased length.** Islands grow in length as right-turn in and right-turn out driveways are created. This adds to the efficiency and safety of intersec-tions. Dense and colorful ground cover is pre-ferred in areas supporting these materials.
4. **Solid medians, or medians with turn pockets.** Eventually solid medians can be provided. The one shown here is used in conjunction with a left turn prohibition. This roadway in Lake Oswego supports more than 30,000 vehicles per day, mov-ing cars at high levels of efficiency and safety.
5. **Left turn lanes.** As medians are extended to the full length of blocks left turn pockets can be placed so that turners do not interfere with other intersection operations (including pedestrian crossings). The turn shown here (Bellevue, Wash-ington) allows vehicles up to and including WB-30 (fire equipment and medium delivery trucks) to complete their turns.



Parking lot connections. Many suburban style parking lots have little or no connectivity to principle streets. Pedestrians filter through hot, often uncontrolled vehicle movements to reach stores.

Parking lot landscaping principles:

1. Create clear, direct connections from key stores to principle streets, and especially to transit stops.
2. Use ground cover and tree canopies to feature and emphasize these connections. Keep ground cover to 2.0 feet, and under trim trees to 7 feet to keep sight lines.
3. Create a minimum sidewalk width of ten feet, and an added setback from parked cars for a combined walkway and planter width of 15-20 feet.
4. On journeys more than 200 feet create sitting spaces, trash receptacles and other appropriate furniture
5. Use speed tables (raised crossings) where motorist cross through connections.
6. Use quality lighting to provide safety and security to connectors.
7. Use contrasting materials to highlight connectors through driving lanes.
8. In hot climates provide shade.



Driveways and other crossings. Transitioning from suburban areas where pedestrians were largely omitted from roadway designs includes changing out driveways. Driveways were often intended to be high speed. Many driveways are overly wide, poorly lit, and pose multiple threats (up to six conflicts). Transitioning to a pedestrian friendly corridor requires the following measures:

Driveway details:

1. Keep entry and exit speeds low. General approach speeds should be 5-8 mph, or less.
2. Speed can be controlled by change in grade (gradual ramps increase speed potential).
3. It is best to use color, patterns and texture to highlight and make clear to motorists that they are intruding into the right-of-way of pedestrians, and that they have a legal duty to allow pedestrians to complete their movements.
4. In some cases tactile areas are used to define edges of safe zones (especially for blind pedestrians).
5. When necessary, sidewalks can be brought down to a lower driveway elevation in order to meet ADA needs. It is often best, however to use planter strips and have all of grade changes in that portion of the right of way occupied by planter strips.
6. Keep driveways well lit, with strong, well defined edges to accentuate crossing areas.
7. Pedestrian crossings of driveways are best when kept to the full width of the sidewalk. A five foot minimum width sidewalk is necessary on long driveways (more than 20 feet).
8. Right-in, right-out (or single direction) driveways are strongly preferred, especially on multiple lane roadways.

Typical Right-In, Right Out Crossing

Bike lanes and desired speed

Bike lanes. Through use of bike lanes it is possible to provide the best flow and interaction of bicyclists with motorists and pedestrians. There are 22 benefits of bike lanes, only two of which are for bicyclists. Bike lanes are recommended on all arterial and collector category roadways. The higher the speed and volume the more important bike lanes become to all roadway users.

Design details and benefits:

1. Bike lanes are measured from the face of curb.
2. Bike lanes are to be 4.0 feet wide, or wider on all roadways where they are used. If gutter pans are seamless with the joint of the roadway, then 4.0 feet is acceptable. If seems are not seamless, then 4.0 feet is measured from the edge of asphalt.
3. When bike lanes are used next to parking their width is increased to 6-7 feet, while parking is reduced to as little as 6-7 feet. All things being equal it is safer for motorists exiting a car and bicyclists for the greater width to be in the bike lane. angles approximately 22-26 feet back from the yield line.
4. Bike lane lines are to be striped to 6” width, or greater. Preferences for an 8-10” wide stripe are encouraged to help calm the speed of adjacent traffic.
5. In some locations where crossing conflicts are common it is useful to use added color to denote these crossing areas (see bottom photo).

Added benefits of bike lanes include:

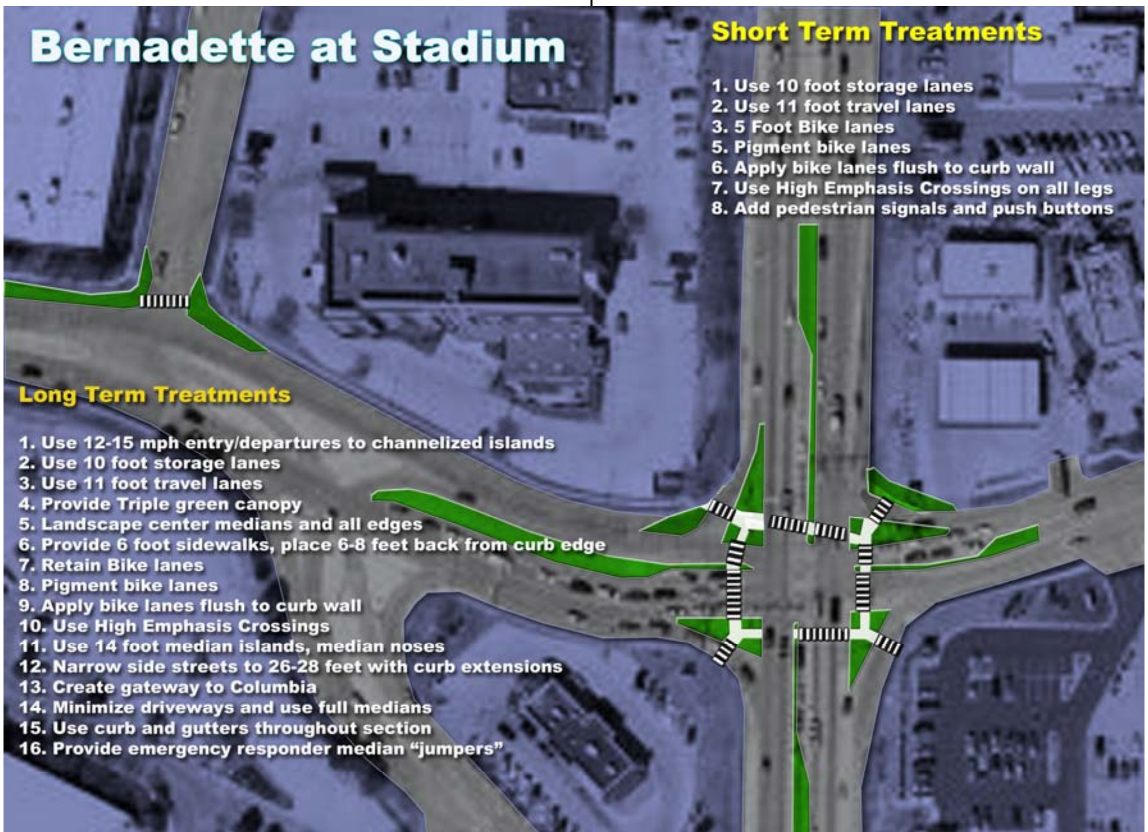
1. increased border width to fixed objects
2. Increased turning radius into and out of intersections and driveways
3. Improved sight distances when exiting driveways
4. Break down lane, place for cars to pull into when emergency response vehicles pass
5. Buffer increases comfort of pedestrians and people exiting parked cars
6. Some effect in traffic calming (narrower lanes can be adopted)
7. Improved operations for trucks and transit

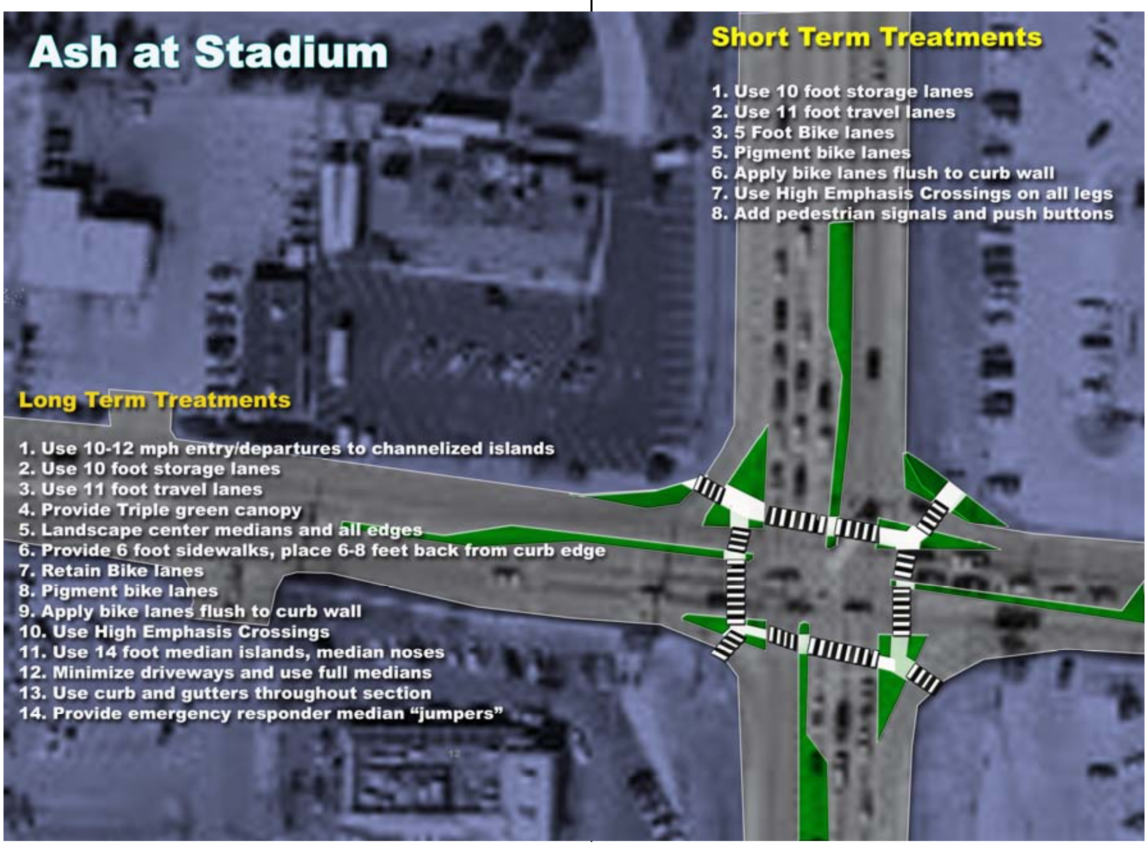
Suggested roadway section: Visual tightening of roadway, includes curb/gutter, median and ten inch edge line. Speeds went from 45+ down to 33-35 mph. (Grandview Drive in University Place, Washington)

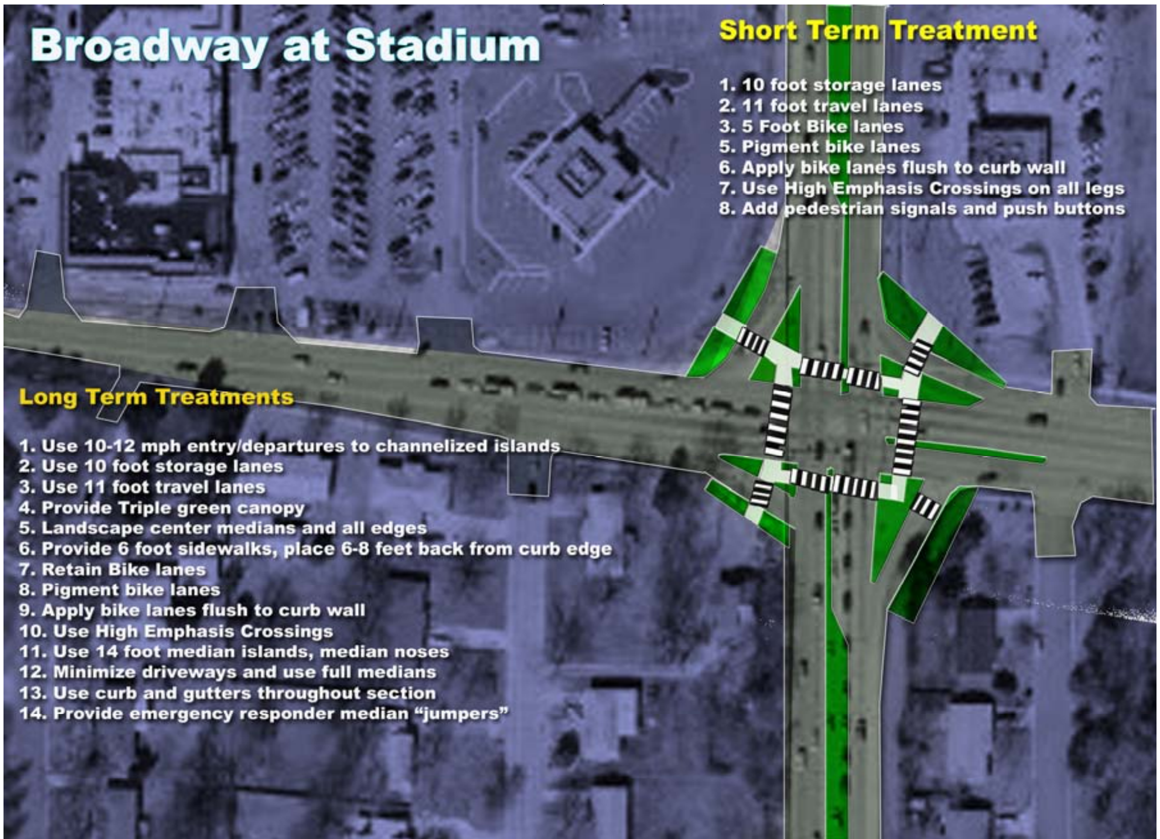
Speed is dictated by comfort. A number of urban area multi-lane roadways are now being built with 10 foot travel lanes. Storage lanes are either 10 feet, or 9 feet. By creating narrower lanes it is possible to get some speed reductions, increased safety due to lower speeds, save on construction and right-of-way costs, reduce drainage and runoff problems, and address ease of getting across streets. Narrower lanes also lead to more compact intersections, making signal cycles more efficient. More compact intersections can lead to improved traffic capacity, especially in high pedestrian areas.

Lane width details:

1. All measurements are measured from face of curb to the center of the each line, or from center of line to center of line.
2. Narrow lanes are not always acceptable to funding agencies, so data needs to be collected on comparable roadways, and on each model roadway where narrower lanes are used.
3. If ten foot lanes are not acceptable to a funding agency, then urban areas (with moderate or low truck volumes) should be built, as a standard, with **no more than** eleven foot lanes.
4. Some industrial and high truck areas (typically above 10% truck traffic) require wider lanes.
5. Keep storage lanes to minimum widths (ten or even nine feet easily accommodate all types of vehicles.
6. Do not add extra space for shy zones to medians. Instead, if required, use a different color material for the gutter pan (coral or bright white are acceptable) then use dark asphalt to keep actual lanes down to 10 feet. Using visual "tightening" of roadway lanes may be acceptable to agencies and have speed reduction impacts.
7. Use broad white stripes to designate turn lanes, bike lanes. An 8-10 inch stripe for these lane lines helps accentuate visual narrowing of roadways, and can help hold down traffic speeds.


Bernadette at Stadium
Short Term Treatments
1. Use 10 foot storage lanes
2. Use 11 foot travel lanes
3. 5 Foot Bike lanes
5. Pigment bike lanes
6. Apply bike lanes flush to curb wall
7. Use High Emphasis Crossings on all legs
8. Add pedestrian signals and push buttons
Long Term Treatments
1. Use 12-15 mph entry/departures to channelized islands
2. Use 10 foot storage lanes
3. Use 11 foot travel lanes
4. Provide Triple green canopy
5. Landscape center medians and all edges
6. Provide 6 foot sidewalks, place 6-8 feet back from curb edge
7. Retain Bike lanes
8. Pigment bike lanes
9. Apply bike lanes flush to curb wall
10. Use High Emphasis Crossings
11. Use 14 foot median islands, median noses
12. Narrow side streets to 26-28 feet with curb extensions
13. Create gateway to Columbia
14. Minimize driveways and use full medians
15. Use curb and gutters throughout section
16. Provide emergency responder median "jumpers"

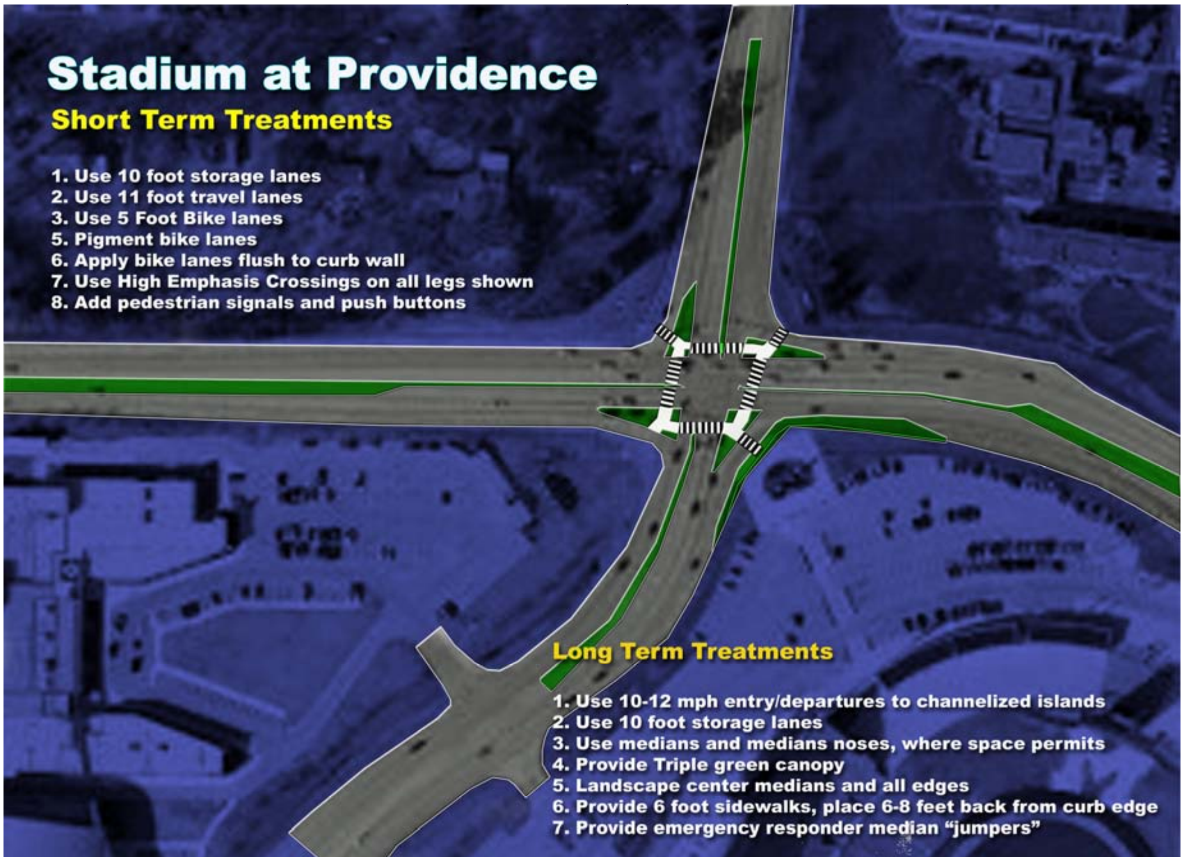

Ash at Stadium
Short Term Treatments
1. Use 10 foot storage lanes
2. Use 11 foot travel lanes
3. 5 Foot Bike lanes
5. Pigment bike lanes
6. Apply bike lanes flush to curb wall
7. Use High Emphasis Crossings on all legs
8. Add pedestrian signals and push buttons
Long Term Treatments
1. Use 10-12 mph entry/departures to channelized islands
2. Use 10 foot storage lanes
3. Use 11 foot travel lanes
4. Provide Triple green canopy
5. Landscape center medians and all edges
6. Provide 6 foot sidewalks, place 6-8 feet back from curb edge
7. Retain Bike lanes
8. Pigment bike lanes
9. Apply bike lanes flush to curb wall
10. Use High Emphasis Crossings
11. Use 14 foot median islands, median noses
12. Minimize driveways and use full medians
13. Use curb and gutters throughout section
14. Provide emergency responder median "jumpers"

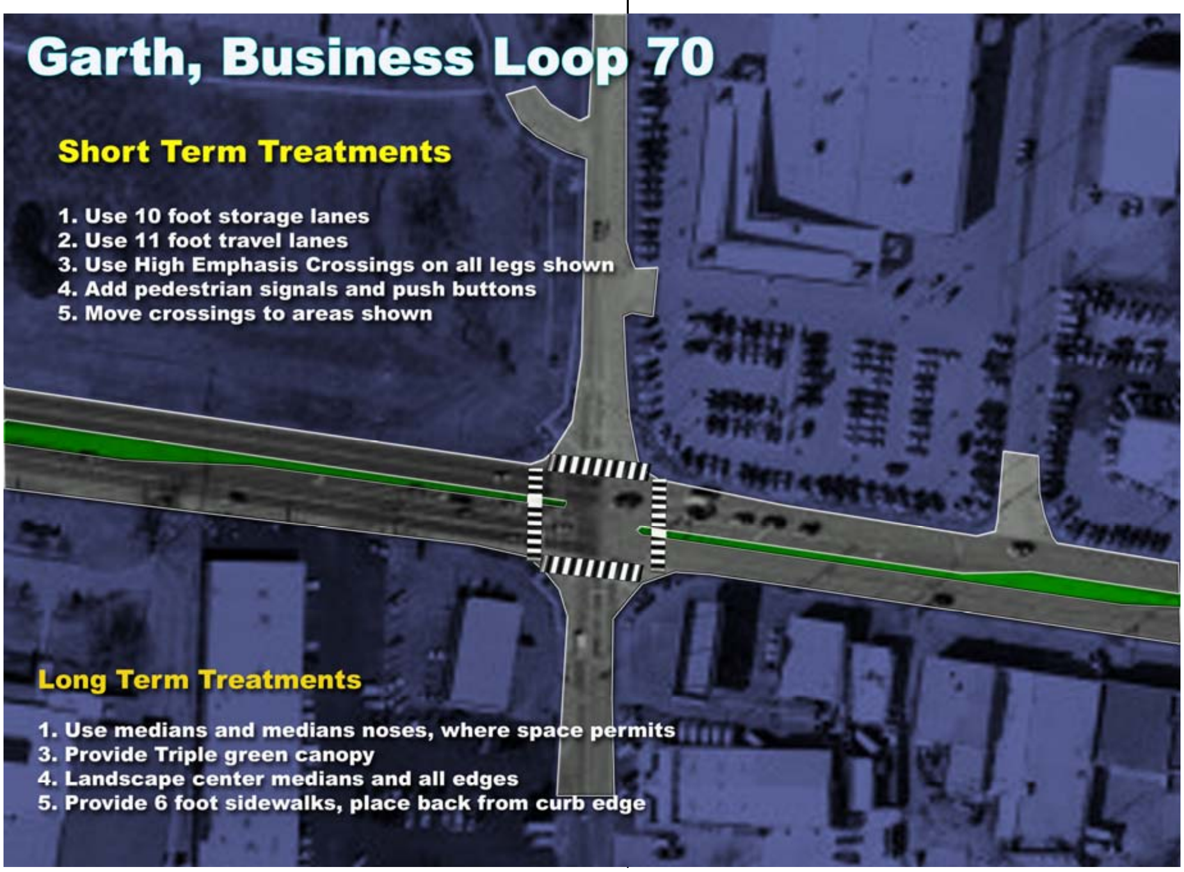

Broadway at Stadium
Short Term Treatment
1. 10 foot storage lanes
2. 11 foot travel lanes
3. 5 Foot Bike lanes
5. Pigment bike lanes
6. Apply bike lanes flush to curb wall
7. Use High Emphasis Crossings on all legs
8. Add pedestrian signals and push buttons
Long Term Treatments
1. Use 10-12 mph entry/departures to channelized islands
2. Use 10 foot storage lanes
3. Use 11 foot travel lanes
4. Provide Triple green canopy
5. Landscape center medians and all edges
6. Provide 6 foot sidewalks, place 6-8 feet back from curb edge
7. Retain Bike lanes
8. Pigment bike lanes
9. Apply bike lanes flush to curb wall
10. Use High Emphasis Crossings
11. Use 14 foot median islands, median noses
12. Minimize driveways and use full medians
13. Use curb and gutters throughout section
14. Provide emergency responder median "jumpers"


Worley at Stadium
Short Term Treatments
1. Use 10 foot storage lanes
2. Use 11 foot travel lanes
3. 5 Foot Bike lanes
5. Pigment bike lanes
6. Apply bike lanes flush to curb wall
7. Use High Emphasis Crossings on all legs
8. Add pedestrian signals and push buttons
Long Term Treatments
1. Use 10-12 mph entry/departures to channelized islands
2. Use 10 foot storage lanes
3. Use 11 foot travel lanes
4. Provide Triple green canopy
5. Landscape center medians and all edges
6. Provide 6 foot sidewalks, place 6-8 feet back from curb edge
7. Retain Bike lanes
8. Pigment bike lanes
9. Apply bike lanes flush to curb wall
10. Use High Emphasis Crossings
11. Use 14 foot median islands, median noses
12. Minimize driveways and use full medians
13. Use curb and gutters throughout section
14. Provide emergency responder median "jumpers"


Rogers, College, Paris
Short Term Treatments
1. Use 10 foot storage lanes
2. Use 10 foot travel lanes
3. Use High Emphasis Crossings on all legs shown
4. Add pedestrian signals and push buttons
5. Move crossings to areas shown
Long Term Treatments
1. Use 10-12 mph entry/departures to channelized island
2. Use medians and medians noses, where space permits
3. Provide Triple green canopy
4. Landscape center medians and all edges
5. Provide 6 foot sidewalks, place back from curb edge


Stadium at Forum
Short Term Treatments
1. Use 10 foot storage lanes
2. Use 11 foot travel lanes
3. Use 5 Foot Bike lanes
5. Pigment bike lanes
6. Apply bike lanes flush to curb wall
7. Use High Emphasis Crossings on all legs shown
8. Add pedestrian signals and push buttons
Long Term Treatments
1. Use 10-12 mph entry/departures to channelized islands
2. Use 10 foot storage lanes
3. Use 11 foot travel lanes
4. Provide Triple green canopy
5. Landscape center medians and all edges
6. Provide 6 foot sidewalks, place 6-8 feet back from curb edge
7. Provide emergency responder median "jumpers"


Stadium at Providence
Short Term Treatments
1. Use 10 foot storage lanes
2. Use 11 foot travel lanes
3. Use 5 Foot Bike lanes
5. Pigment bike lanes
6. Apply bike lanes flush to curb wall
7. Use High Emphasis Crossings on all legs shown
8. Add pedestrian signals and push buttons
Long Term Treatments
1. Use 10-12 mph entry/departures to channelized islands
2. Use 10 foot storage lanes
3. Use medians and medians noses, where space permits
4. Provide Triple green canopy
5. Landscape center medians and all edges
6. Provide 6 foot sidewalks, place 6-8 feet back from curb edge
7. Provide emergency responder median "jumpers"


Garth, Business Loop 70
Short Term Treatments
1. Use 10 foot storage lanes
2. Use 11 foot travel lanes
3. Use High Emphasis Crossings on all legs shown
4. Add pedestrian signals and push buttons
5. Move crossings to areas shown
Long Term Treatments
1. Use medians and medians noses, where space permits
3. Provide Triple green canopy
4. Landscape center medians and all edges
5. Provide 6 foot sidewalks, place back from curb edge