HOUSTON-GALVESTON AREA COUNCIL
PO Box 22777 • 3555 Timmons Lane, Suite 120 • Houston, Texas 77227-2777• 713/627-3200

July 20, 2010

The Honorable Charles Jessup
Mayor
City of Meadows Place
One Troyan Drive
Meadows Place, Texas 77477

Dear Mayor Jessup,

The City of Meadows Place requested the Houston-Galveston Area Council's (H-GAC) assistance in the review of potential use of traffic circles on South Kirkwood Road between West Airport and West Belfort Boulevards. Please find enclosed a review prepared for H-GAC by the Texas Transportation Institute (TTI). TTI is an internationally recognized transportation research organization affiliated with Texas A&M University.

Based on both information provided by Meadows Place and collected by TTI researchers or H-GAC, TTI analyzed this corridor and has provided information about its current and expected future operational characteristics with both current stop sign controlled intersections and with the installation of roundabouts. In summary, TTI found:

- Traffic volumes at the four stop sign controlled intersections exceed engineering design criteria (also known as "warrants") for the use of stop signs. Stop signs are not appropriate traffic control devices given current and future expected traffic volumes.
- Traffic delay and the number of traffic stops could be reduced by the use of single lane roundabouts at one or more of the four stop sign controlled intersections on S. Kirkwood, reducing travel time and vehicle emissions.
- Pedestrian safety did not appear to be a significant issue as very few pedestrian or cyclists were observed using any of the four intersections on Kirkwood between West Belfort and West Airport;
- Vehicular volume on S. Kirkwood between West Belfort and West Airport is "metered" or constrained by the capacity of these two intersections. Therefore, the replacement of the existing four way, stop sign controlled intersections with either roundabouts or traditional traffic signals is unlikely, by itself, to increase vehicle travel on this section of Kirkwood.

Based on the analysis performed by TTI, the application of roundabouts to this area could decrease stops, reduce delay and the likelihood of rear end collisions and increase vehicular capacity (despite the loss of one travel lane through the roundabouts).

We appreciate you looking to H-GAC for information and guidance. If we can be of further assistance in the future, please do not hesitate to contact me at 713-993-4585.

Sincerely,

Alan Clark
Director, Transportation and Air Quality

AC/lm

Enclosure

Cc: The City of Meadows Place Aldermen

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July 6, 2010

MEMORANDUM

TO: Rebecca Blatnica
Houston-Galveston Area Council

FROM: Robert Benz, P.E.

SUBJECT: South Kirkwood Traffic Operations Assessment

The Texas Transportation Institute (TTI) is often asked to perform independent, third-party, review of various transportation related topics. In May of this year, the Houston-Galveston Area Council engaged TTI to perform a cursory review of the existing traffic operations and proposed roundabout alternative for the section of South Kirkwood Road between West Airport Boulevard and West Bellfort Street in the city of Meadows Place. This technical memorandum provides a brief summary of our scope, our analysis, and what we found.

Background

The section of study was on South Kirkwood Road between West Airport Boulevard and West Bellfort Street, just north of US 59 (see Figure 1). In this area, South Kirkwood Road is a four-lane boulevard section with curb and gutter drainage and 28-30 foot wide landscaped median with 100 foot wide right-of-way. This consists of two-24 feet wide sections of pavement, 30 foot landscaped median, and 11 feet wide area on both sides of the roadway for utilities and sidewalks (see Figure 2). Figure 3 shows a picture of the typical existing cross section.

South Kirkwood is classified (and functions) as a principal arterial. However, in the section of South Kirkwood of interest are intersections with four local streets (Scottsdale Drive, Dorrance Lane, Brighton Lane, and Brook Meadow Lane) at a separation of about 280-300 feet that employ all-way stop control. Four all-way stop controlled intersections within 850 feet on a principal arterial is a unique situation in the greater Houston region and has been subject to some question about the benefits of its continued operation with current traffic control.

Plans are underway for the city of Meadows Place, in conjunction with the Fort Bend Mobility Bond Program, to reconstruct South Kirkwood Road in the study section. The city has examined several alternatives to the existing design, one alternative being to reduce the cross-section from four lanes to two and use a series of modern roundabouts at the Scottsdale Drive, Dorrance Lane, Brighton Lane, and Brook Meadow Lane intersections instead of all-way stop control.

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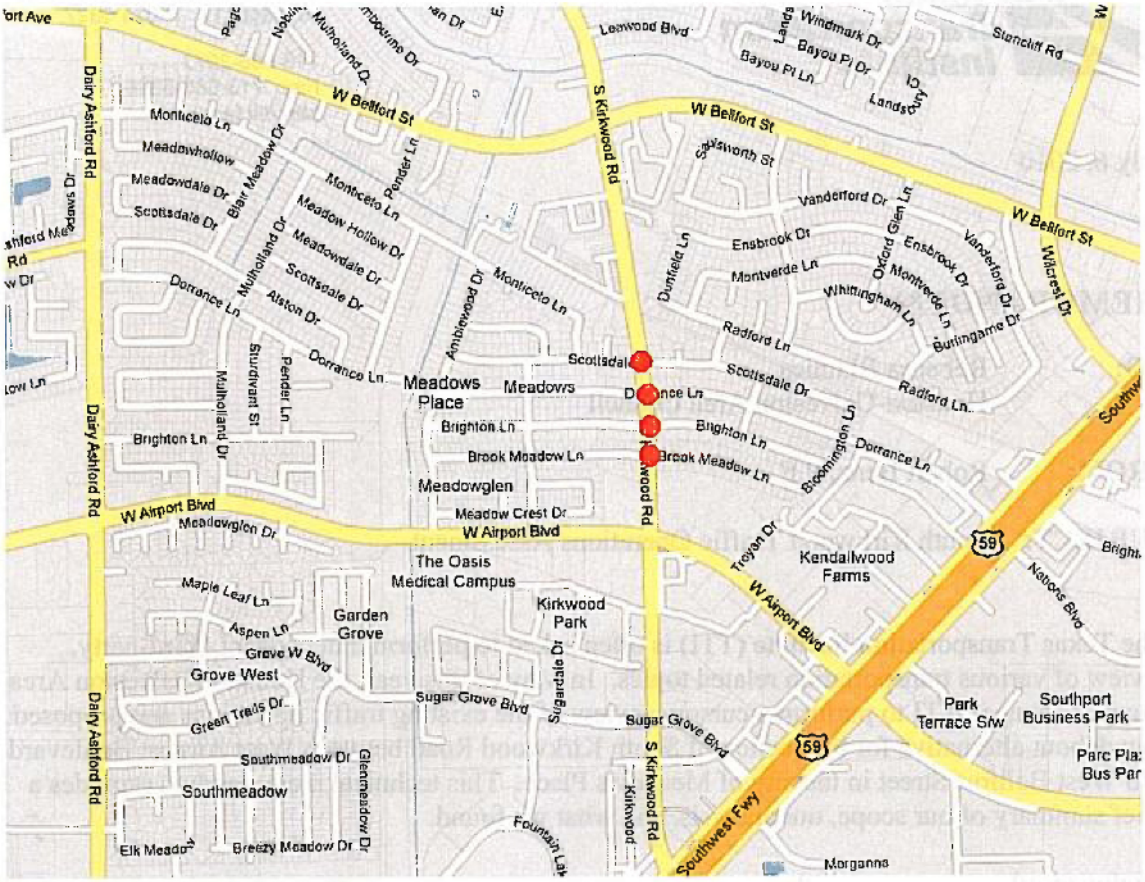

Figure 1. Project Area Reference Map

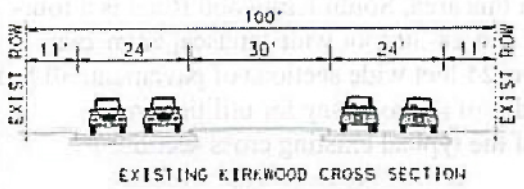

Figure 2. Cross Section of Existing Conditions

Figure 3. Picture of Typical Section of ROW in Meadows Place

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The roundabout alternative has been presented to the public in several forums, has been highlighted in the media, and citizens have voiced their concerns at city council meetings. Community concerns about the roundabout alternative include:

- Pedestrian safety,
- Traffic safety,
- Cut through traffic,
- Parking restrictions,
- Speeding through the residential neighborhood,
- Reducing the number of lanes from four to two will increase congestion (now and in the future),
- Traffic signals at West Airport and West Bellfort will distribute traffic so that there are fewer gaps for cross-street traffic to move onto and across South Kirkwood,
- Emergency vehicle detour routing, and
- Installation of roundabouts may isolate residents from one side of the subdivision to the other (since crossing South Kirkwood may be perceived to be more difficult with roundabouts as opposed to stop signs).

Members of city council have provided information attempting to address citizen concerns but some amount of consternation remains. The City has conducted public meetings to capture community concerns and has enlisted the assistance of the Houston-Galveston Area Council (H-GAC) to review previous engineering studies. In response, H-GAC has enlisted the assistance of TTI for assistance in planning and facilitating the alternatives' process and to review previous engineering analyses.

What We Did

TTI was engaged to gather and review existing traffic data, examine current operations in the field, review the intersections with respect to current traffic control (and current traffic control warrants & guidelines), and perform a review of previous traffic simulation efforts.

Review Traffic Data & Conduct Site Visits

TTI gathered information from H-GAC and the City of Meadows Place. Data gathered included:

- Peak hour turning movement counts
- 24-hour tube counts
- Traffic simulation files and output
- Planning-level traffic volume count projections
- Geometric Information and design vehicle turn radii

Field visits to the site were made during the weekday morning and afternoon peak periods to assess existing traffic conditions. TTI research staff moved through the corridor in vehicles and as pedestrians in order to make observations about traffic conditions. General notes on vehicle speeds, operational characteristics, pedestrian, and bicycle activity were taken. In addition, TTI

staff discussed the perceived efficiency of traffic operations with the school crossing guard stationed at Dorrance Lane.

Review Existing Traffic Control Guidelines

A review of the Manual on Uniform Traffic Control Devices (MUTCD) warrants for stop controlled intersections was conducted and the following statements are provided for guidance:

- MUTCD Section 2B.04.05 clearly states that STOP or YIELD sign should not be used for speed control.
- MUTCD Section 2B.04.08 indicates that a YIELD or STOP sign should not be installed on the higher volume roadway unless justified by an engineering study.
- MUTCD Section 2B.07.01 states that multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal.
- The MUTCD provides additional guidance: the decision to install multi-way stop control should be based on an engineering study. The following criteria should be considered in the engineering study for a multi-way STOP sign installation:

  A. Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.
  B. A crash problem, as indicated by 5 or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right- and left-turn collisions as well as right-angle collisions.
  C. Minimum volumes:
     1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and
     2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but
     3. If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the above values.
  D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

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The Texas laws for parking can be found in the Driver's Handbook published by the Texas Department of Public Safety. See Chapter 7. You are not allowed to park within 20 feet of a crosswalk at an intersection. You may not park within 30 feet upon the approach to any flashing signal, stop sign, yield sign, or other traffic control signal located at the side of a roadway.

Review Previous Traffic Operations Simulations

A review of the traffic operations data and the existing Synchro traffic simulation models were conducted. The City of Meadows Place had conducted previous traffic simulations of the proposed roundabout scenario, and this portion of our work was to examine those simulations and ensure that the assumptions made during them were appropriate.

Traffic simulation models were provided to TTI with updated 2010 traffic counts and existing traffic signal timings. The traffic simulation included the stretch of South Kirkwood Road between (and including) West Airport Boulevard to West Bellfort Street. The simulation also included the four all-way stop intersections at Scottsdale Drive, Dorrance Lane, Brighton Lane, and Brook Meadow Lane.

Two scenarios were examined: 1) the existing configuration with four all-way stop signs, and 2) the proposed roundabout configuration. TTI staff simulated traffic operations with both existing signal timings and for timings that had been optimized for cycles and splits (optimal, least-delay, allocation of time to various directions).

TTI research staff verified the traffic simulation model network geometry, traffic volumes, and simulation parameters. In evaluating the traffic volumes, TTI assumed the West Airport Boulevard and West Bellfort Street signalized intersections to somewhat meter the volumes on South Kirkwood Road. This was an important assumption as the simulation of possible future traffic growth was completed. Traffic volumes at the Airport and Bellfort intersections were increased up to 50% of existing levels, and the resulting throughput on South Kirkwood found by balancing traffic volumes on the northbound and southbound directions from the inputs. Using this method, we assumed that no significant traffic growth would occur on cross-streets of the four current stop sign intersections along South Kirkwood as these neighborhoods and surrounding land are largely fully developed.

Once the traffic volumes were balanced four individual scenarios were simulated, all for the weekday PM peak hour:

- Existing all-way stop control with existing 2010 traffic volume
- Existing all-way stop control with 50% additional traffic volume
- Proposed roundabout scenario with existing 2010 traffic volume, and
- Proposed roundabout scenario with 50% additional traffic volume.

For the two simulations with increased traffic volumes, the traffic signal parameters at the West Airport Boulevard and West Bellfort Street intersections with South Kirkwood Road were optimized to better represent how traffic signals would be set to operate to accommodate the higher traffic volumes. The SimTraffic module of Synchro suite of simulation tools was used to simulate the network 30 times to gauge the stability of the models.

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Review of Proposed Roundabout Design Elements
Based on a review of the diagrams provided, it appears that most vehicles could be accommodated by the geometry offered by either the roundabout or stop sign traffic control. Fire apparatus, transit vehicles, buses, and larger vehicles could be accommodated by the proposed roundabout design. Bicycles and pedestrians could also be accommodated with proper design.

The proposed modern roundabout would have flared approaches on South Kirkwood and would be controlled by yield sign control. The proposed design is to have the existing four lane section reduced to two lanes with a roundabout at each of the four existing all-way stop intersections.

The new South Kirkwood Road cross-section would have two 14 foot wide travel lanes that could accommodate bikes using the wide outside lane, with sidewalks and green space occupying the remaining right-of-way as shown in Figure 4. The design of the roundabout would include a 10 foot radius planting ring, a 28 foot radius apron (inside curb), and an outside radius of approximately 43 feet. These design parameters appear to meet the Federal Highway Administration's (FHWA) guidelines for roundabout design and result in a configuration designed for 25 mph.

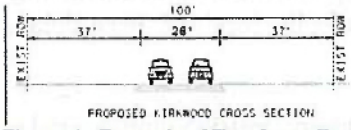

Figure 4. Example of Two Lane Cross Section.

Review of Crash Data
TTI staff obtained crash data for the study section. Results of this review included:

- There appear to be a total of 30 crashes which occurred in the five years from 2003 to 2007,
- Twenty-six (26) crashes were rear end type,
- Four (4) crashes involved a left turning vehicle,
- Zero (0) crashes were classified as serious,
- Eight (8) were noted to have possible injury,
- About half of the crashes occurred during the PM peak period with others scatted throughout the day,
- No late night or early morning crashes were noted,
- Fifteen (15) of the crashes reported were at the Scottsdale Drive at South Kirkwood intersection, and
- Nine (9) crashes reported were at the Dorrance Lane at South Kirkwood intersection.

What We Found
This section describes our observations and results of our review, analysis of data, and traffic operations simulation.

Existing Traffic Operations

Use of new, up-to-date traffic counts enabled TTI staff to revise the previous simulations and examine the results with more clarity. In order to conceptually link the existing operations and the simulation, the site visits were used to verify that traffic operations as simulated would have a high probability of replicating the existing and proposed configurations. We noted the following:

- Traffic in the area could be characterized as moderate for a principal arterial and vehicles were arriving in platoons generated by the metering of traffic at signals at West Bellfort Street and West Airport Boulevard. We did observe some drivers "racing" between stop signs and others who rolled through some of the stop signs.

- There does not appear to be sight distance restrictions to warrant the existing all-way stop signs.

- The majority of the crashes appear to be rear end crashes that may be a result of the increased number of stops required by the all-way stops on South Kirkwood. However, we also did not recognize any existing right-angle crash history that might result in a higher frequency if the all-way stops are removed.

- During the site visits TTI staff did not personally observe children walking to school. We did notice several waiting for the bus or carpool. We did observe several adults walking along South Kirkwood Road and the cross-streets during our visits. Researchers informally spoke with the morning crossing guard at Dorrance Lane who indicated that typically less than five children use the crossing to walk to school. We did not observe pedestrian crossing volumes to warrant additional pedestrian traffic control measures per current FHWA guidelines for uncontrolled crossings.

- The study location does not appear to meet the guidance for all-way stop control as suggested in the MUTCD, however a through traffic study with crash data is suggested and consideration should be given to what future conditions could hold.

Traffic Simulation

Using simulation techniques, TTI research staff attempted to quantify several measures of effectiveness (delay, stops, average speed, fuel consumption, and emissions, among others) for all the four simulated scenarios. TTI also qualitatively observed the traffic and queuing patterns from the simulated animations.

It was apparent that the traffic signals at the West Bellfort Street and West Airport Boulevard intersections meter the flow of through traffic on South Kirkwood Road in most of the scenarios. We did note that the metering effect appears more significant at the West Airport Boulevard at South Kirkwood Road intersection as the intersection begins to reach capacity with the 50% additional volume scenario. The metering effect was more pronounced when traffic was increased by 50% as many of the westbound to northbound right turning traffic were blocked due to excessive queuing. Improvements to the West Bellfort Street and West Airport Boulevard

intersections that may improve the flow of peak traffic may result in slightly higher traffic intensity on Kirkwood due to reduced metering impact of the signals.

The simulation of the roundabout option indicates that with existing levels of traffic volumes, the overall delays at Scottsdale Drive, Dorrance Lane, Brighton Lane, and Brook Meadow Lane decrease by about 50% when compared to the stop sign control. When the traffic volumes were increased by 50%, the delays at these intersections are estimated to decrease by close to 60% with roundabouts as compared to all-way stop control.
Perhaps the most telling benefit to the roundabout installation is in the reduction of stops. The roundabouts scenario with both existing and increased traffic resulted in an estimated 95% reduction in the total number of stops made at the four intersections. Fewer stops reduce delay and emissions that may contribute to a reduction in air pollution.

It is fairly simple to rationalize the impact of the roundabouts on reducing delay on South Kirkwood itself, but TTI staff also analyzed the impact of the roundabout vs. all-way stop control on cross street delay at the four existing all-way stop intersections. We noted the following:

- With the existing traffic conditions the average delay per vehicle and stop delay per vehicle on each of cross streets decreased when stop signs were replaced by roundabouts.

  For example at Dorrance, the average delay per vehicle experienced by the cross street traffic decreased by 33% with roundabout control. However, the magnitudes of these changes are very low. The stop delay per vehicle as experienced by the cross street traffic decreased from 3.6 sec to 0.9 sec when stop signs were replaced by roundabouts. These delays represent a level of service of "A" regardless of the traffic control.

- In the simulations with a 50% increase in traffic volumes:

  - Estimates for delays at the Brook Meadows Lane intersection showed a minor increase in the average cross street delay/vehicle (from 5.5 seconds/vehicle with stop control to 8.2 seconds/vehicle). Other intersections still had a modest decrease in the cross street delay when roundabouts replaced the stop signs even with 50% increase in traffic.

  - delays at the West Bellfort Street and West Airport Boulevard signalized intersections increase in both the all-way stop and the roundabout scenario and result in an increase in the overall network delays. A reason for the increased delay at signalized intersections in the roundabout scenarios could be due to the vehicle arrival pattern at the signalized intersections from the Kirkwood approach.

What It Means
There are some very clear conclusions from our review of the existing and proposed configurations, but there are just as many conclusions that might remain subject to conjecture, depending on the stakeholder's perspective.

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Of the things of which we are most certain:

- It appears that none of the existing all-way stop control on the South Kirkwood Road at Scottsdale Drive, Dorrance Lane, Brighton Lane, and Brook Meadow Lane intersections warrant all-way stop control based on the volume portions of MUTCD warrants.
- There are no geometric limitations that make all-way stop control warranted, including limited sight distance or roadway curvature.
- There are likely not enough pedestrian trips across South Kirkwood Road to meet any applicable local FHWA guidelines for marked crosswalks, additional warning signs, or other more restrictive levels of traffic control specifically intended for pedestrians.
- All-way stops at the Scottsdale Drive, Dorrance Lane, Brighton Lane, and Brook Meadow Lane increase stop delay along South Kirkwood Road, but also increase vehicle emissions from idling and acceleration.
- Regardless of all-way stop or roundabout configuration, delays for traffic to cross or enter South Kirkwood Road from Scottsdale Drive, Dorrance Lane, Brighton Lane, and Brook Meadow Lane will be relatively low (Level of Service "A" per Highway Capacity Manual)

Table 1 below is a summary of alternatives and an assessment of the benefits compared relative to the existing four stop signs. The arrows indicate a relative measure, for example removing the four stop signs and replacing them with round abouts will significantly reduce the number of stops, reduce delay and increase throughput. However, reducing the number of stop signs only has one down arrow so it has less of an impact on the number of stops.

Table 1. Alternative Traffic Control Compared to Existing Traffic Control

Alternative	Stops	Delay	Throughput
Existing - Four Stop Signs	↑	↑	↓
Proposed - Four Roundabouts	↓↓	↓	↑
Alternative - Reduce Number of Stop Signs	↓	↓	↑
Alternative - Remove Four Stop Signs	↓↓	↓↓	↑↑
Alternative - Two Roundabouts, Remove All Stops	↓↓	↓	↑

On an engineering level, it appears that both the existing configuration and proposed roundabout configuration will be able to function based on the data, field observation and simulation. Both appear to be viable options, but the positives and negatives of each configuration will have to be considered before making a decision to move forward.

While many of the concerns raised by citizens about the roundabout configuration are valid, the engineering data does not provide evidence that any of their concerns comprise, in whole or part,

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any fatal flaw in the roundabout concept. This effort set out to address as many of the concerns of the public as possible within the time and budget allowed, and this was done to a specified level in this text.

However, there is uncertainty with the roundabout configuration because it is not a traditional, typical solution for mitigating the existing conditions on South Kirkwood. That being said, it does appear that the roundabout solution would work on a traffic operations basis. Uncertainty enters into the decision making process as risk – but most of the risk is financial and environmental (with respect to the community's perceived needs) than engineering risk in this case. Perhaps a very intensive multi-criteria decision making exercise is in order for the proposed options for South Kirkwood Road.

If the existing series of all-way stops remains in-place, the existing perceived benefits (slower speeds, more gaps in traffic for cross-street traffic) and disbenefits (increased delay, stops and air pollution, and legal status of the traffic control) of the treatment will continue. However, drivers do not expect four all-way stop sign controlled intersections within 850 feet on a principal arterial, so from this perspective driver expectation is violated. In addition to the mobility and driver expectation impacts, violations and citations relating to unwarranted regulatory traffic control devices, if contested in court, may be dismissed on legal grounds.

In addition to the two proposed scenarios investigated - 1) doing nothing (keep the roadway cross-section and four stop signs as-is) and 2) reconstructing with roundabouts at all intersections - a more complete list of potential alternatives could include:

- Reduce the number of stop signs, potentially one at the north and south end of the development;
- Remove all stop signs;
- Reconstruct with roundabouts at selected intersections (potentially just the north and south end of the development);
- Apply appropriate traffic calming techniques suitable for roadways that function as arterials (bulb outs for parking, chokers, chicanes, street trees, textured pavement and gateways).

Public input and education is critical before, during, and after implementation projects and it is important that citizen concerns be addressed in the decision making process. Regardless of which strategy is ultimately implemented (including doing nothing new) it is suggested that an education aspect (including training for school-aged children in local schools on safely navigating intersections, roundabouts, or other features as pedestrians and bicyclists) be included as part of any future project. This public issue is similar to issues that have presented challenges before. It is important to consider the three "E's": Education, Enforcement, and Engineering in these types of processes and decision-making exercises.

Yes, we will

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