APPENDIX B: ACCESS MANAGEMENT STANDARDS

OREM CITY

ACCESS MANAGEMENT STANDARDS

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INTRODUCTION

Access management is the process of establishing and enforcing road and driveway accesses within the City. This includes establishing the location, number, spacing, type, and design of city streets and accesses to minimize vehicle conflicts and maximize the traffic capacity and safety of a roadway. Unmanaged or unorganized development along travel corridors results in poor, unsafe roadways. There are cases where all landowners along a corridor have access. This occurs when landowners do not develop at the same time. Numerous access points along travel corridors create unnecessary conflicts between turning and through traffic, which cause delays and reduce safety. Numerous benefits are derived from controlling the location and number of access points to a roadway. Those benefits include:

- Improving overall roadway safety
- Reducing the total number of vehicle trips on the roadway
- Decreasing interruptions in traffic flow
- Minimizing traffic delays and congestion
- Maintaining roadway capacity
- Extending the useful life of roads
- Avoiding costly highway projects
- Improving air quality
- Encouraging compact development patterns
- Improving access to adjacent land uses
- Enhancing pedestrian and bicycle facilities

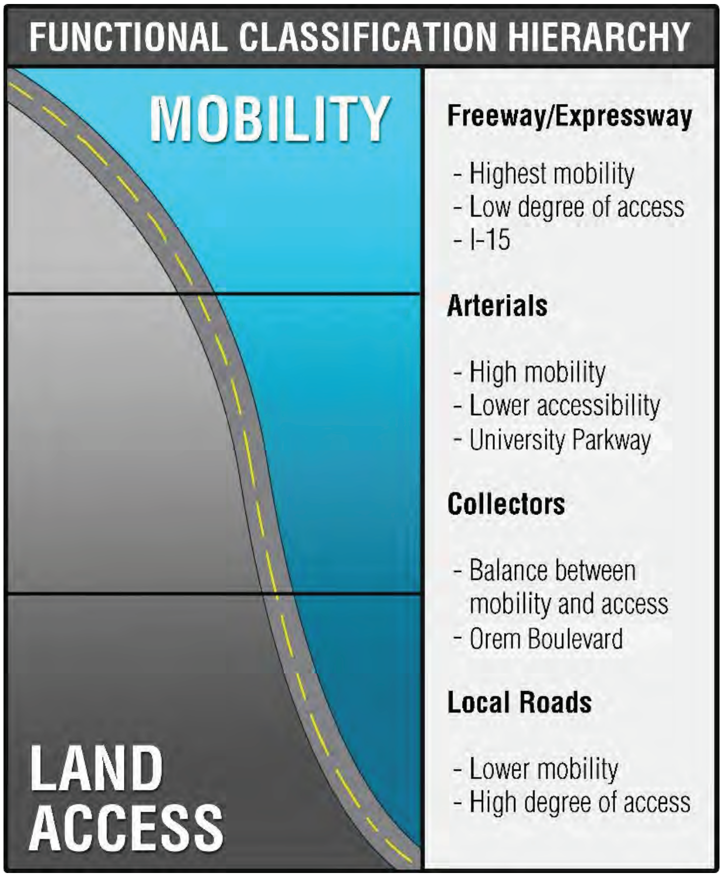
PRINCIPLES OF ACCESS MANAGEMENT

Increasing traffic congestion, improving traffic safety, and minimizing the cost of future road upgrades has generated interest in managing access, not only with the highway system, but on city surface streets as well. Access management is the process that provides access to land development while simultaneously preserving the flow of traffic (mobility) on the surrounding road system in terms of safety, capacity, and speed. Access management attempts to balance the need to provide good mobility for through traffic with the requirements for reasonable access to adjacent land uses.

A very important concept when administering access management standards is to understand that the movement of traffic and access to property are not mutually exclusive. No facility can simultaneously move traffic efficiently and provide unlimited access. **Figure 1** shows the relationship between mobility, access, and the functional classification of streets. The extreme examples of this concept are freeways and cul-de-sacs. Freeways move traffic very well with few opportunities for access, while the cul-de-sac has many opportunities for access, but doesn't move traffic very well. In many cases, accidents and congestion are the result of an imbalance in serving both mobility and access at the same time. A good access management program will accomplish the following:

- Limit the number of conflict points at driveway locations
- Separate conflict areas
- Reduce the interference of through traffic
- Provide sufficient spacing for at-grade, signalized intersections
- Provide adequate on-site circulation and storage

Figure 1: Mobility vs. Land Access Representation



Access management strategies attempt to end the cycle of road improvements followed by increased access, increased congestion, and the need for more road improvements.

Poor planning and inadequate control of access can quickly lead to an unnecessarily high number of direct accesses along roadways. The movements that occur on and off roadways at driveways that are too closely spaced make it difficult for through traffic to flow smoothly at desired speeds and levels of safety. An American Association of State Highways and Transportation Officials (AASHTO) publication states, "*the number of accidents is disproportionately higher at driveways than at other intersections…thus their design and location merits special consideration*." Studies have shown that anywhere between 50 and 70 percent of all crashes that occur on the urban street system are access related.

Fewer accesses, greater separation of driveways, and better driveway design and location are the basic elements of access management. There are fewer occasions for through traffic to brake and change lanes in order to avoid turning traffic when these techniques are implemented uniformly and comprehensively.

Consequently, with good access management, the flow of traffic will be smoother and average travel speeds higher, with less potential for crashes. Before and after analyses by FHWA, show that routes with well managed access can experience 50 percent fewer accidents than comparable facilities with no access controls.

ROADWAY FUNCTIONAL CLASSIFICATION

Access management should recognize that access and mobility are competing functions. This recognition is fundamental to the design of roadway systems that preserve public investments, contribute to traffic safety, reduce fuel consumption and vehicle emissions, and do not become functionally obsolete. Suitable functional design of the roadway system also preserves the private investment in residential and commercial development

Roadway classification simply means using each individual street facility to perform the desired mix of the functions of access or movement. This is accomplished by classifying highways and surface streets with respect to the amount of access or mobility they are to provide and then identifying and using the most effective facility to perform that function.

The functional system of classification divides streets into three basic classes identified as arterials, collectors, and local streets. The function of an arterial is to provide for regional mobility of through traffic. Access to an arterial is controlled to reduce interferences and facilitate through movement. Collector streets provide a mix for the functions of mobility and access, and therefore accomplish neither well. The main purpose of local streets is to provide good access. Each class of roadway has its own geometric, traffic control, and spacing requirements.

ROADWAY NETWORK AND ACCESS MANAGEMENT STANDARDS

The access management concepts and standards presented below are consistent with guidelines established by the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), and the Institute of Transportation Engineers (ITE).

There are a number of access management techniques that can be used to preserve or enhance the capacity of a roadway. Specific techniques for managing access are discussed in this section and illustrated with examples. Not all techniques will apply to every situation. Some of them are more appropriate to less developed rural areas of the City, whereas others are more appropriate in the urban areas. It is up to the City's Planning Board to determine what will work best in each situation while considering future growth and functional goals.

NUMBER OF ACCESS POINTS

Controlling the number of access points or driveways from site to roadway reduces conflicts between cars, pedestrians, and bicycles. Each parcel should normally be allowed one access point, and shared access is required were possible. Provisions can be made in the local land use regulations to allow for more than one access point where special circumstances would require additional accesses. Developers should be encouraged to utilize access from existing side roads or to construct side road instead of direct access to arterial or collector roads.

SPACING OF ACCESS POINTS

Establishing a minimum distance between access points reduces the number of points a driver has to observe and reduces the opportunity for conflicts. Spacing requirements would be based on the classification and design speed of the road, the existing and projected volume of traffic as a result of the proposed development, and the physical conditions of the site. Minimum spacing standards should be applied to both residential and commercial/industrial developments.

To ensure efficient traffic flow, new signals should be limited to locations where the progressive movement of traffic will not be impeded significantly. Uniform, or near uniform, spacing of signals is essential for the progression of traffic. As a minimum, signals should be spaced no closer than one-quarter mile (1,320 feet) for collectors and minor arterials. It may be recommended on major and principal arterial streets that signals be spaced at one-third mile (1,760 feet) to one-half mile (2,640 feet).

Unsignalized driveways are far more common than signalized driveways. Traffic operational factors leading toward wider spacing of driveways (especially medium- and higher-volume driveways) include weaving and merging distances, stopping sight distance, acceleration rates, and storage distance for back-to-back left turns. From a spacing perspective, these driveways should be treated the same as public streets. Sound traffic engineering criteria indicates that 500 feet or more should be provided between full-movement unsignalized accesses.

Restricted access movement (i.e., right-in/right-out access) can provide for additional access to promote economic development with minimum impact to the roadway facility. The spacing requirement of accesses is based on the functional classification of the roadway facility and is shown in Table 1. Access spacing shall be measured from center of access to center of access. The spacing of right-turn accesses on each side of a divided roadway can be treated separately; however, where left-turn at median breaks are involved, the access on both sides should line up or be offset from the median break by a minimum of 300 feet. On undivided roadways, access on both sides of the road should be aligned. Where this is not possible, driveways should have an offset distance based on the roadway classification Table 2. This offset is the distance from the center of an access to the center of the next access on the opposite side of the road.

Table 1: Access Spacing Based on Functional Classification

Functional Classification	Minimum Signal Spacing (ft)*+	Minimum Unsignalized Full-Movement Access Spacing (ft)*	Minimum Right-In/Right-Out Access Spacing (ft)*
Major/Principal Arterial	2,640	660	330
Minor Arterial	1,320	500	250
Collector	1,320	500	250
Commercial Local	1,320	660	330
Residential Local	1,320	125	100
Residential Sub-Local	1,320	100	75

* Distances in table are measured from center to center of driveway.

+ Some existing signals do not comply with spacing requirements. All future signals shall follow spacing requirements. Only through an engineering study and permission form The City of Orem can a signal be spaced below minimum values

Table 2: Minimum Offset between Driveways on Opposite Sides of Undivided Roadway

Functional Classification	Minimum Offset (ft)*
Major Arterial	600 for speed ≥ 45 mph+ and 300 for speeds < 45 mph+
Minor Arterial	220
Collector	200
Commercial Local	200
Residential Local	N/A
Residential Sub-Local	N/A

*Distances in table are measured from center to center of driveway.

+ 85th Percentile Speeds

Note: Values are based on TRB Access Management Guidelines.

MEDIANS

Medians control and manage left turns and crossing movements, and separate traffic moving in opposite directions. Restricting left turning movements reduces conflicts, improves safety and improves traffic flow. According to the FHWA technical report FHWA-SA-10-002, the installation of a non-traversable median reduces crashes by 35% when compared to a two way left turn lane (TWLTL) at 33%. Medians are typically used on roadways with high volumes of traffic and four or more lanes of traffic (i.e., arterial streets).

The use and design of a median is determined by the characteristics of the roadway such as: traffic volumes, speed, number and configuration of lanes, right-of-way width and land uses along the roadway. The need for a median can be identified through engineering review, a traffic study assessing the impact of a proposed project, and should be considered on any roadway that has a speed limit greater than 40 MPH.

In addition, medians are often used in commercial and residential developments to separate lanes of traffic and limit conflicts caused by left turns. Medians can also add to the overall aesthetics of a roadway corridor or a development by incorporating landscaping or other items of visual interest. However, care should be taken to maintain sight distance around the intersection/access locations. It is therefore required that only ground cover plantings in a median be planted within 350 feet of an intersection/access opening. Care should be taken to select landscape materials and location of the materials that will not intrude into the roadway, which could result in a safety problem for the motorist. Also care should be taken in selection of trees that when mature will not be larger than a 4 inch diameter.

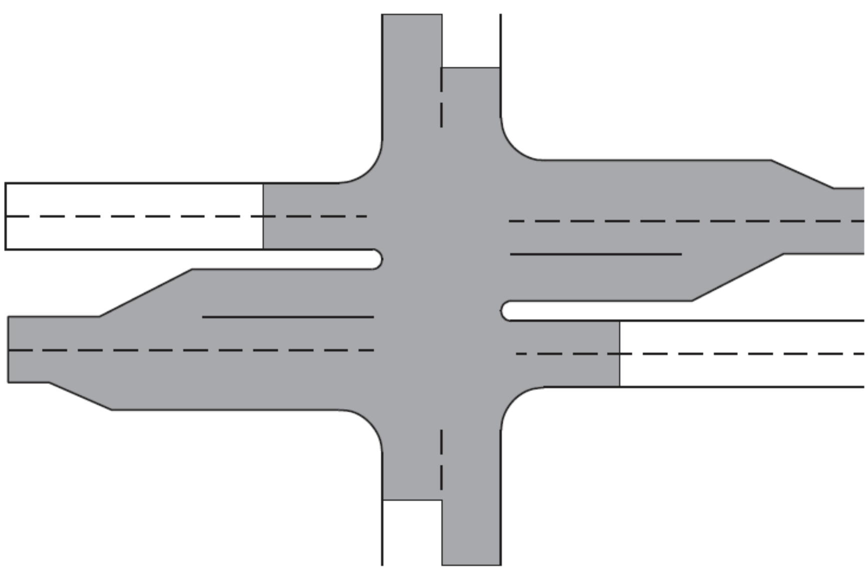
Center Turn Lanes (also known as two way left turn lanes [TWLTL]) can reduce the conflict and delays caused by left turning vehicles crossing on-coming traffic. Left turn lanes also reduce accidents caused by slowing vehicles and traffic passing on the right. Two way left turn lanes should only be used to retrofit areas of existing development. New roads that utilize other access management techniques may not require a two way left turn lane. An engineering analysis should be completed to determine if a TWLTL is needed. Median openings are provided at all signalized at-grade intersections. They are also generally provided at unsignalized junctions of arterial and collector streets. They may be provided at driveways, where they will have minimum impact on roadway flow. The spacing of median openings for signalized driveways should reflect traffic signal coordination requirements and the storage-space needed for left turns. Minimum desired spacing of unsignalized median openings at driveways shall be based on the left turn storage requirements. In AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition*, it suggests that left turn storage lengths require a traffic analysis which calculates the length based on the number of turning vehicles arriving in an average two-minute period within the peak hour with space with at least two passenger cars required. Median openings for left-turn entrances (where there is no left-turn exit from the activity center) should be spaced to allow sufficient storage for left-turning vehicles. Guidance is also found in the AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition* in Chapter 9.

Left-turn ingress or egress requires a median opening when traffic traveling in opposing directions is separated by a barrier median. Median widths in Orem vary from 30 inches to 14 feet. A minimum of a 14 foot median is desirable in order to provide for an adequate left turn lane at intersections. Typically, median widths at intersections are 30 inches formed by two 15 inch curbs back to back with a plowable (tapered) end. Proper signage shall be installed at all median ends.

CORNER CLEARANCE

Corner Clearance is the distance between a driveway and an intersection. Providing adequate corner clearance improves traffic flow and roadway safety by ensuring that the traffic turning into or out of the driveway does not interfere with the function of the intersection. Local regulations should require that driveways be located a minimum distance from an intersection based on roadway classification and speed. Any new access opening shall not be located within the functional area of the intersection as shown in Figure 2.

Figure 2: Functional Area of Intersections



Corner Clearance shall be based on an engineering study that includes the following distances illustrated in Figure 3 and Table 3.

Figure 3: Corner Clearance Type

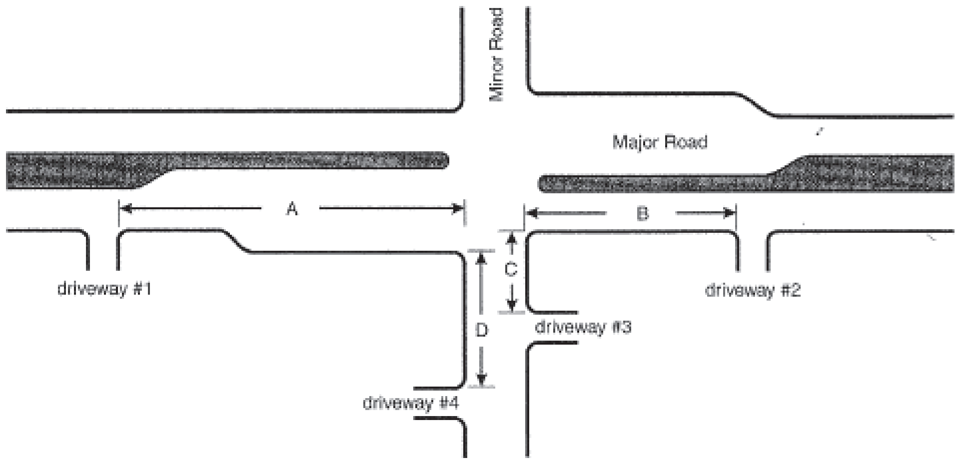


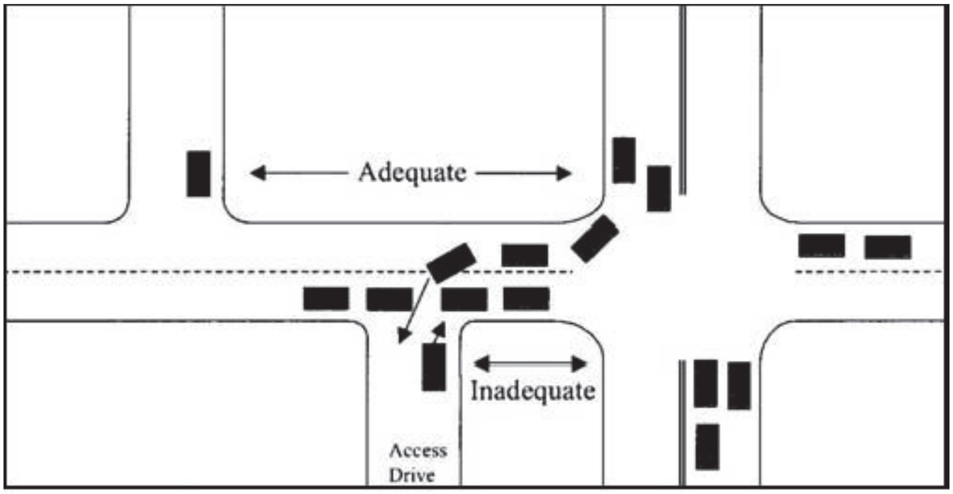
Table 3: Corner Clearance Criteria

A- Approach side on the major roadway	Equal or exceed the functional distance of the intersection d1+d2+d3 (based on engineering study). d1= Distance traveled during perception d2= Distance traveled while driver decelerates to a stop d3= Storage length
B- Departure side on the major roadway	Residential Roadways 260 feet* Collector Roadways 305 feet* Arterial Roadways 380 feet*
C- Approach side on the minor roadway	Shall be a minimum of 100 feet
D- Departure side on the minor roadway	Shall be a minimum of 120 feet

* Based on a spillback rate of 15% from TRB Access Management Manual

Figure 4 shows a representation of inadequate corner clearance if the guidelines in Table 3 are not followed.

Figure 4: Inadequate Corner Clearance



WIDTH OF ACCESS POINTS

In addition to limiting the number of access points, the width of the access point should be restricted based on the use of the site in question. Residential driveways should be limited to a maximum width of 40 feet at the edge of pavement. Please refer to the ***Orem Municipal Code Chapter 16*** for more information on the width of access points.

TURNING RADIUS

The turning radius of a driveway or access road affects both the flow and safety of through traffic as well as vehicles entering and exiting the roadway. In general, the larger the turning radius, the greater the speed at which a vehicle can turn into a site. An excessively small turning radius will require a turning vehicle to reduce speed significantly to make the turn, therefore backing up the traffic flow or encroaching into the other lane. An excessively large turning radius will encourage turning vehicles to travel quickly, thereby creating hazards to pedestrians. Either of these situations increases the potential for accidents.

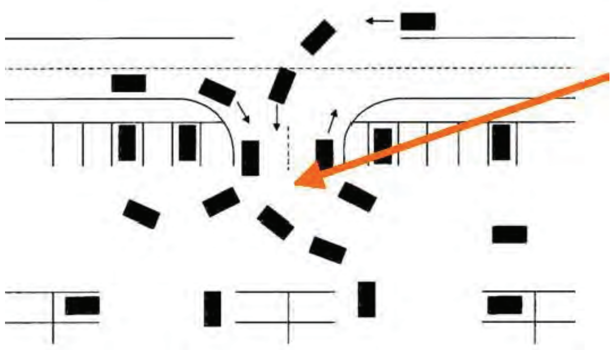
The speed of the roadway, the vehicle class and volume, pedestrian safety, and the site land use should be considered when evaluating the turning radius. Proposed uses that would require deliveries by large trucks (such as major retail establishments and gas stations) should provide larger turning radii to accommodate such vehicles. Other uses such as banks, offices, or areas with high pedestrian traffic could adequately be served with smaller turning radii based on the type of traffic they would generate.

THROAT LENGTH

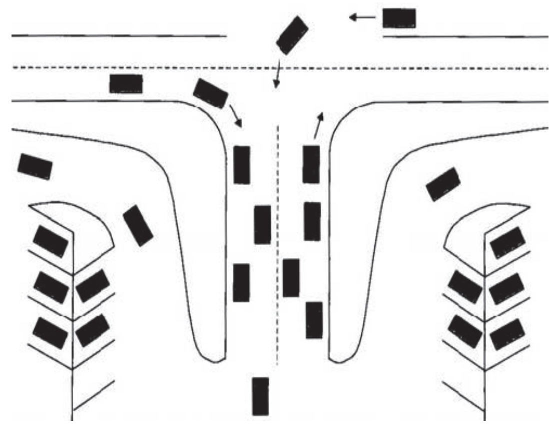
Throat Length is the length of the driveway on a developed site that is restrictive of turning traffic measured from an intersection access. Driveways should be designed with adequate throat length to accommodate queuing of the maximum number of vehicles as defined by the peak period of operation in the traffic study. This will prevent potential conflicts between traffic entering the site and internal traffic flow. Inadequate throat length may cause turning traffic to back up onto the road thereby affecting traffic flow and increasing the potential for accidents. The minimum throat length for an access into a minor commercial property is 50 feet. For major commercial development FHWA recommends a minimum throat length of 150’ for a major driveway entrance, with 300’ desirable. **Figure 5** shows both a poor and good example of driveway throat length.

Figure 5: Driveway Throat Length Examples

Poor Throat Length



Good Throat Length



DRIVEWAY PROFILES

The slope of a driveway can dramatically influence its operation. Usage by large vehicles can have a tremendous effect on operations if slopes are severe. The profile, or grade, of a driveway should be designed to provide a comfortable and safe transition for those using the facility, and to accommodate the storm water drainage system of the roadway. In ***NCHRP Report 659: Guide for the Geometric Design of Driveways***, it states that a minimum slope of 2% is required for water runoff with a maximum slope of 8% for icy/snowy conditions. Please refer to NCHRP Report 659 for additional information on driveway design.

SHARED ACCESS

Access points shall be shared between adjacent parcels to minimize the potential for conflict related to close driveway proximity. Shared access can be used effectively for both residential and nonresidential developments. Since the issues surrounding shared access for residential and nonresidential development are slightly different, they are discussed separately.

RESIDENTIAL ACCESS

Residential subdivisions located along arterial or collector roadways should be required to construct an internal road system rather than be developed along the existing roadway frontage or a single access cul-de-sac. Subdivision proposals should encourage a coordinated street network by providing rights-of-way or stubs for the extension of streets to adjacent parcels. This will prevent the proliferation of driveways on arterial and collector streets and provide for an interconnected street network.

Shared driveways shall also be used to minimize the number of curb cuts in residential districts, particularly along rural arterial and collector roads. If access is necessary from an arterial or collector then shared driveways is required. Shared driveways serving more than two homes will be built to fire lane standards.

COMMERCIAL ACCESS

Joint driveways providing access to adjacent developments, and interconnections between sites, are required for all development proposals on arterial and collector roadways. Interconnections between sites can eliminate the need for additional curb cuts, thereby preserving the capacity of the roadway by reducing the number of conflicting movements on the main road. This is particularly important for commercial/industrial sites and should be used to encourage the development of internal or collector roadway systems servicing more than one parcel or establishment. Future roadway rights-of-way should also be provided to promote interconnected access to vacant parcels or to facilitate the consolidation of access points for existing developments.

Pedestrian access between developments will allow people to walk between establishments, thereby reducing the number of vehicle trips. Every opportunity should be taken to provide for interconnections between existing and future developments for both vehicles and pedestrians.

ALIGNMENT OF ACCESS POINTS

Street and driveway intersections represent points of conflict for vehicles, bicycles and pedestrians. All modes of travel should be able to clearly identify intersections and assess the travel patterns of vehicles and pedestrians through the intersection. To minimize the potential conflicts and improve safety, intersections and driveways shall be aligned opposite each other wherever possible and intersect roadways at a 90 degree angle. Good driveway alignment will provide vehicles, bicycles, and pedestrians with a clear line of sight and allow them to traverse the intersection more safely.

SIGHT DISTANCE

Sight distance is the length of the road that is visible to the driver. A minimum safe sight distance should be required for access points based on the roadway classification. The American Association of State Highway and Transportation Officials (AASHTO) publication, *A Policy on Geometric Design of Highways and Streets* contains recommendations for sight distance based on the roadway design speed and grade. Providing sufficient intersection sight distance at the driveway point for vehicles using a driveway to see oncoming traffic and judge the gap to safely make their movement is essential. Intersection sight distance varies, depending on the design speed of the roadway to be entered, and assumes a passenger car can turn right or left into a two-lane highway and attain 85 percent of the design speed without being overtaken by an approaching vehicle that reduces speed to 85 percent of the design speed. The table below gives intersection sight distance requirements for passenger cars. Sight distances should be adjusted with crossroad grade in accordance with AASHTO policies and are shown in Table 5.

Table 4: Intersection Driveway Sight Distance

Design Speed (85^{th} %) (mph)	Sight Distance Required (ft)**
30	335
35	390
40	445
45	500
50	555
55	610
60	665
65	720

*Based on a 2 lane roadway (for other lane configurations, refer to AASHTO for adjustments). Drivers' eye setback is assumed to be 15 feet measured from the edge of traveled way.

Normally, intersection sight distance will govern the required sight distance for the driveway but it is also important to verify that the main roadway have sufficient stopping sight distance. For example, a driver of a vehicle approaching an intersection should have an unobstructed view of the entire intersection including any traffic control devices and sufficient length along the intersecting highway to permit the driver to anticipate and avoid potential collisions. The safe stopping sight distance should be reviewed to make sure that the approaching vehicle has a clear view of the roadway in the area of the access. Sight distance may be more of a consideration in rural areas because of higher speeds and rolling/hilly terrain. Table 5 gives the safe stopping sight distance that should be provided for a driver on the roadway to have a clear view of the access/driveway. In making this determination for stopping sight distance, it should be assumed that the approaching driver's eye is 3.5 feet above the roadway surface and that the object to be seen is 2 feet above the surface of the road. For horizontal or vertical curves, the stopping sight distance is addressed by an onsite evaluation.

Table 5: Safe Sight Distances on Grades

Design Speed (85^{th} %) (mph)	Safe Stopping Sight Distance (ft)			
	Downhill Grades		Uphill Grades	
	-3%	-6%	3%	6%
25	158	165	147	143
30	205	215	200	184
35	257	271	237	229
40	315	333	289	278
45	378	400	344	331
50	446	474	405	388
55	520	553	469	450

TURNING LANES

Turning lanes remove the turning traffic from the through travel lanes. Left turning lanes are used to separate the left turning traffic from the through traffic. Right turn lanes reduce traffic delays caused by the slowing of right turning vehicles. Designated right or left turn lanes are generally used in high traffic situations on arterial and collector roadways. A traffic impact study will identify the need for and make recommendations on the design of turning lanes or tapers based on the existing traffic volumes, speed, and the projected impacts of the proposed use. At all signalized intersections, both a left and right turning lane will be implemented.

STORAGE LENGTH

The length of the turning lane shall be determined by an intersection traffic analysis based on the number of vehicles arriving in the turning lane during a two minute period within the peak hour. The minimum length shall be the space for two passenger vehicles (50 ft.) and for areas with more than 10 percent truck traffic it shall be the space for one passenger vehicle and one truck (75 ft.). For signalized intersections, the storage length shall be 1 ½ times the average number of vehicles that would queue per cycle during the peak hour based on design year volumes.

LANE WIDTH

Turning lanes shall be a minimum of 12 feet in width. Any exception will require approval from the City Engineer.

LEFT-TURN LANES

The provision of left-turn lanes is essential from both capacity and safety standpoints where left turns would otherwise share the use of a through lane. Shared use of a through lane will dramatically reduce capacity, especially when opposing traffic is heavy. Left-turn lanes shall always be provided at a signalized intersection.

RIGHT-TURN LANES

Right-turn lanes remove the speed differences in the main travel lanes from right turners, thereby reducing the frequency and severity of rear-end collisions. They also increase capacity of signalized intersections and may allow for more efficient traffic signal timing.

PEDESTRIAN AND BICYCLE ACCESS

An aspect of access management is reducing the number of vehicle trips. This can be accomplished by providing safe and appealing pedestrian access within developments and between adjacent developments.

All new development and redevelopment of existing sites should address pedestrian and bicycle access to and within the site. Sidewalks should be provided in all urban residential subdivisions in or adjacent to commercial or industrial developments. Sidewalks and other pedestrian facilities should comply with the Americans with Disabilities Act (ADA) Standards for Accessible Design. Crosswalks should be clearly marked and located in appropriate areas. Paint or paving materials can be used to delineate crosswalks. In addition to traditional brick, an alternative involves imprinting the asphalt with a brick design and then painting the crosswalk.

Parking lot designs need to address pedestrian access to the site and circulation within the site. Five foot wide sidewalks or striped pedestrian crossings should be provided from adjacent sites through parking lots to promote safe pedestrian access. Safe and appealing pedestrian circulation systems allow people to park their cars once and walk to different establishments, resulting in a vehicle trip reduction. Joint and cross access between developments can provide opportunities for shared parking.

GRADE SEPERATIONS

Interchanges in an access management context provide several important functions. Interchanges maximize movement along expressways and principal arterials.

More specifically, a grade separated interchange may be appropriate in the following situations:

1. where two expressways cross, or where an expressway crosses arterial roads;
2. where principal arterials cross and the resulting available green time for any route would be less than 40 to 50 percent;
3. where an existing at-grade signalized intersection along an arterial roadway operates at level of service (LOS) F, and there is no reasonable improvement that can be made to provide sufficient capacity;
4. where a history of accidents indicates a significant reduction in accidents can be realized by constructing a grade separation;
5. where a new at-grade signalized intersection would result in LOS E in urban and suburban settings and LOS D in rural settings;
6. when the location to be signalized does not meet the signal spacing criteria and signalization of the access point would impact the progressive flow along the roadway;
7. where a major public street at-grade intersection is located near a major traffic generator and effective signal progression for both the through and generated traffic cannot be provided; and
8. where the activity center is located along a principal arterial, where either direct access or left turns would be prohibited by the access code, or would otherwise be undesirable.

Minimum interchange spacing along various roadways should be as shown in **Table 8**. Spacing may be closer where access is provided to or from collector-distributor roads. Privately-developed interchanges should become part of a regional transportation plan to ensure they are consistent with local and regional plans.

Table 6: Minimum Interchange Spacing Guidelines

Functional Classification	Minimum Interchange Spacing for Urban/Suburban Areas (miles)	Minimum Interchange Spacing for Rural Areas (miles)
Freeway	1	3
Expressway	1	2
Principal Arterial	1	2

One of the main goals of the Transportation Master Plan is to estimate traffic growth and provide for adequate facilities as the need arises. The safe traffic operations of these future facilities are of equal importance. As a result, all of these facilities should be constructed and maintained to applicable design and engineering standards such as those set forth in Orem City ordinances, AASHTO "Policy on Geometric Design of Highways and Streets," and the Manual on Uniform Traffic Control Devices (MUTCD). This includes implementing applicable Americans with Disabilities Act (ADA) standards and school zone treatments.

RESIDENTIAL DRIVEWAYS ON MAJOR STREETS

Due to population growth, geometric limitations, right-of-way, or funding, residential driveways are sometimes found on collector or arterial streets. If residential driveways have to be on a collector or arterial street, it is recommended to require circular driveway or a turn-around where vehicles don't have to back out on to the street. Backing maneuvers into busy streets can be very dangerous, as this is not a typical action drivers expect. Any new development should restrict any residential access on collector or arterial roadways.

OFFSET INTERSECTIONS

Offset intersections often have negative impacts on traffic flow and can potentially create capacity problems at intersections where the left turn storage areas overlap, forcing queued vehicles into through traffic lanes. Aligning access on both sides of the street will minimize conflict points in the roadway and provide safer and more efficient traffic flow. Offset intersections should be avoided wherever possible and should never be approved with new development.

INTERSECTION IMPROVEMENTS

Proper intersection design will typically facilitate larger traffic flows without widening existing roadway cross-sections. This can minimize impacts to adjacent properties. Therefore, emphasis was placed on identifying critical intersections during the traffic modeling process.

Intersections are a critical element to future roadway functionality and should provide sufficient turn lanes and adequate turn pockets to accommodate vehicle queues. In the future, many intersections throughout the City may require signalization in order to maintain a desirable LOS. Stop signs and traffic signals should not be used when not warranted per the MUTCD. Studies have shown that in areas where intersection control has been installed and not warranted, a higher percentage of the motoring public will disregard the control measure and create a more unsafe condition.

As in the case with the typical roadway cross sections, typical intersection configurations are a helpful planning tool when preserving right-of-way and for project cost estimating. This section includes some typical intersection treatments, including expanded right-of-way requirements, turn pocket configurations, and taper lengths. Each intersection must be considered separately but the guidelines in the following sections should be followed.

At intersections, additional right-of-way may be necessary to include any additional dedicated turning lanes. With the inclusion of additional dedicated turn lanes, the shoulders are reduced to 2 feet and the median or TWLTL is used as one dedicated left turn lane. All intersections should be individually analyzed to determine the correct number of dedicated turn lanes. Table 9 shows the additional right-of-way necessary depending on the functional classification of the approaching roadways based on number of additional turning lanes.

Table 7: Additional ROW at Intersections

Intersection Approach Functional Classification	Left Turn Lanes	Right Turn Lanes	Additional ROW (ft.)
Principal Arterial	2	1	20
Major Arterial	2	1	20
Major Arterial	1	1	8
Minor Arterial	1	1	8
Minor Arterial	1	0	0
3 Lane Urban Collector	1	1	8
3 Lane Urban Collector	1	0	0
2 Lane Urban Collector	0	1	8
2 Lane Urban Collector	1	0	8

TRAFFIC SIGNALS

Traffic signals should not be installed unless at least one or more of the nine traffic signal warrants (as outlined in the MUTCD with exception to Warrant 6) have been met. Even if warrants are met for a particular intersection, justification for installation should still be based on information obtained through engineering studies and comparisons with the requirements set forth in the MUTCD. As stated in the MUTCD, "*the satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal*." The nine warrants outlined in the MUTCD include the following:

- Warrant 1: Eight-Hour Vehicular Volume
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing (Railroad)

Traffic signals may be warranted at the intersection of any two roadways depending upon the parameters outlined above. The design of the signal and intersection will depend primarily on the amount of traffic passing through the intersection during the peak times of day. Design parameters that are essential to a well-designed signalized intersection include lane configuration, turn radii, turn pocket lengths, and taper lengths. Each of these parameters is a function of the road classification, peak hour volumes, and design speeds.

STOP SIGNS

The MUTCD should be used as the standard for determining how and when a stop sign is installed. As stated in the MUTCD, "*Stop signs should be used if engineering judgment indicates that one or more of the following conditions exist:*

- *Intersection of a less important road with a main road where application of the normal right-of-way rule would not be expected to provide reasonable compliance with the law;*
- *Street entering a through highway or street;*
- *Un-signalized intersection in a signalized area; and*
- *High speeds, restricted view, or crash records indicate a need for control by the stop sign*."

The number of vehicles that are required to stop should be minimized, if at all possible, to preserve capacity and functionality of the roadway network; therefore, when deciding which road to stop, the street carrying the lowest volume of traffic should be chosen. Less restrictive traffic control such as a yield sign can be used as an alternative to stop signs, if at all possible, to minimize delays. Yield signs should also be installed per the MUTCD guidelines. Stop signs should not be used to control speed, but to designate right-of-way at intersecting roadways.

4-way stop control may be used as a safety measure at intersections where the volume of traffic is approximately equal for all approaches and where safety is of concern, or as an interim measure where a traffic signal is justified and has yet to be installed. Engineering judgment and the guidelines outlined in the MUTCD as well as the Utah State policy should be used to determine the appropriate application of stop and yield signs.

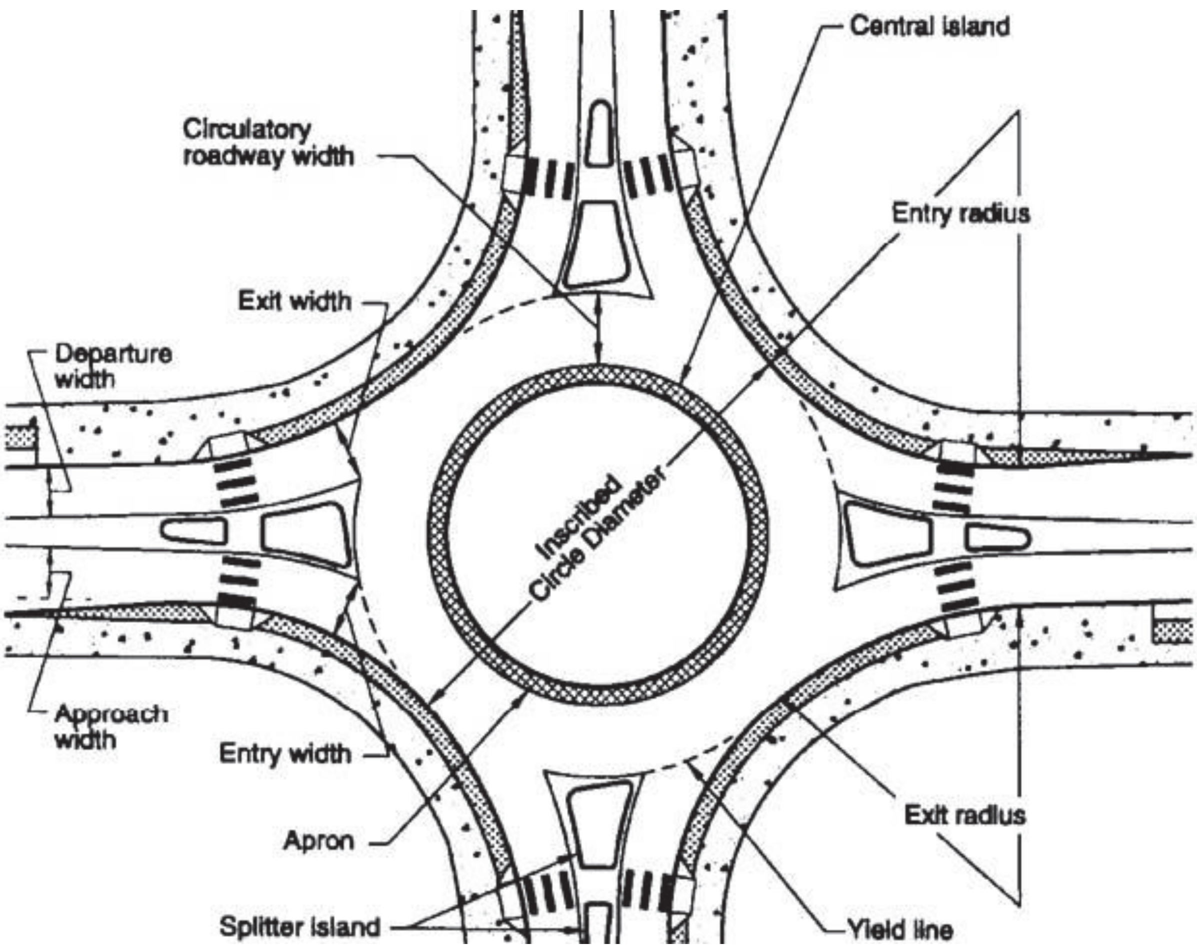
ROUNDABOUTS

Many communities in the United States are beginning to embrace the concept of roundabouts. A roundabout is an intersection control measure used successfully in Europe and Australia for many years. A roundabout is composed of a circular, raised, center island with deflecting islands on the intersecting streets to direct traffic movement around the circle. Traffic circulates in a counter-clockwise direction making right turns onto the intersecting streets. There are no traffic signals; rather, entering traffic yields to vehicles already in the roundabout.

Advantages of roundabouts include reduced traffic delays, increased safety, and reduced number of conflicts. Roundabouts can improve safety because the number of potential impact points and conflict points the driver must monitor are substantially reduced over a conventional four-way intersection. Properly designed roundabouts can also accommodate emergency vehicles, trucks, and snow plowing equipment. The roundabout nearly eliminates "T-bone" accidents at intersections.

Unlike the typical New England "traffic circle" or "rotary," design standards for roundabouts are very specific and FHWA has prepared a design guide for modern roundabouts in the United States (http://www.fhwa.dot.gov/publications/research/safety/00067/00067.pdf). Development of a roundabout will only occur as a result of an intersection study performed by a qualified Traffic Engineer and when the minimum capacity and design criteria are met. The FHWA has determined that the maximum flow rate that a roundabout can accommodate depends on the geometric elements (circle diameter, number of lanes, etc.), the circulating flow (vehicles going around the circle), and entry flow (vehicles entering the circle). A single lane roundabout can accommodate up to 1,800 vehicles per hour and a double lane roundabout can accommodate up to 3,400 vehicles per hour. **Figure 7** shows an example of a typical single lane roundabout design.

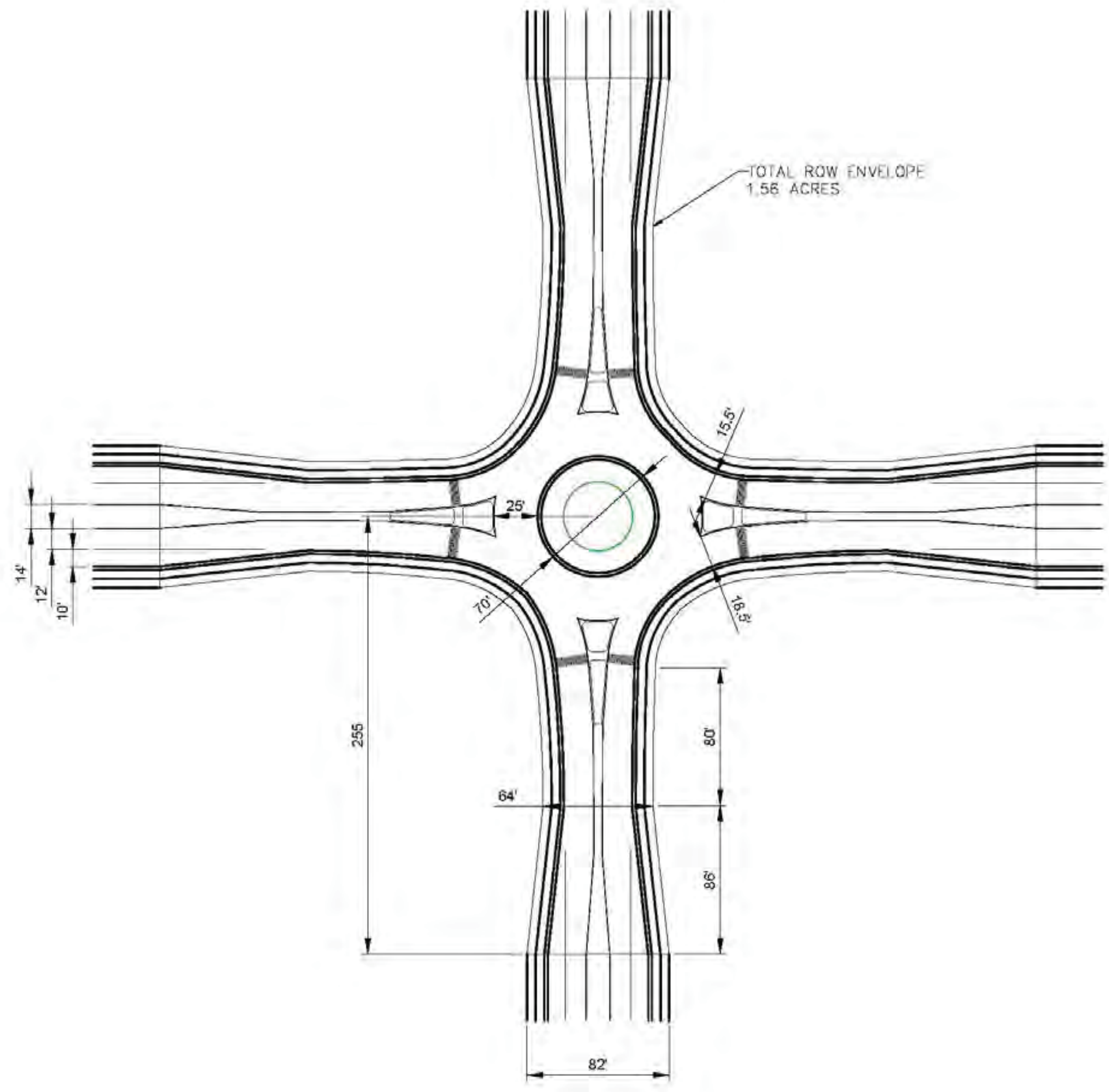
Figure 6 Typical Roundabout Design



The Mississippi DOT claims in their report, ***Performance Evaluation of Roundabouts for Traffic Delay and Crash Reducitons in Oxford, MS*** that roundabouts reduce average delay by 24 percent. The FHWA indicates in its report ***Roundabouts: An Informational Guide*** that the number of personal injury accidents and property damage-only accidents decreased 51 percent and 29 percent, respectively, when roundabouts replaced all way or two way stop controlled intersections.

Figure 8 shows a typical roundabout design with right-of-way envelope area and dimensions. Caution must be taken to design each roundabout in the City on a case by case basis, the information provided here is for illustrative and planning purposes only.

Figure 7 Roundabout Design with Right-of-Way



There are numerous reasons for selecting a roundabout as a preferred alternative, with each reason carrying its own considerations and trade-offs. Below are some potential applications for roundabouts[1]:

[1] Source: NCHRP Report 672, Roundabouts: An Informational Guide Second Edition

- New Residential Subdivisions

  Developers have begun to use roundabouts in residential subdivisions with increasing frequency. Roundabouts provide a variety of operational and aesthetic benefits and create a sense of place that is attractive to developers and homeowners.
- Urban Centers

  Roundabouts may be considered an optimal choice in situations where existing or planned access-management strategies along a corridor facilitate U-turn movements at nearby intersections.
- Suburban Municipalities and Small Towns

  Smaller municipalities are often ideal locations to consider roundabouts. Right-of-way is often less constrained, traffic volumes are lower, and the aesthetic opportunities for landscaping and gateway treatments are enticing. Existing operational and/or safety deficiencies can also often be addressed. Roundabouts can also be less costly to maintain than typical intersections.
- Rural Settings and Small Communities

  Safety may often be the driving factor over capacity in making a roundabout an appealing choice. Within small communities along an extended highway, a roundabout is ideal for supporting speed reductions.
- Interchanges

  Situations where an intersection ramp terminal has the potential for a high proportion of left-turn flows from the off-ramps and to the on-ramps may be ideal candidate for a roundabout.
- Commercial Developments

  Roundabouts in commercial developments provide for a central focus point for a development and enhance aesthetic qualities. They are also capable of processing high volumes of traffic.
- Unusual Geometry

  Intersections with unusual geometric configurations, intersection angles, or more than four legs are often difficult to manage operationally. Roundabouts are a proven traffic control device in such situations, effectively managing traffic flows without the need for costly expenditures on unique signal controller equipment or unusual signal timing.
- Closely Spaced Intersections

  Roundabouts balance traffic flows and manage queue lengths between closely spaced intersections.

The City of Orem will consider roundabouts as an intersection alternative at specific locations, pending more detailed traffic analysis, as needs arise through the development process. It is required that all roundabouts be designed and/or reviewed by qualified engineers.