9 Public Safety and Residential Street Design

Introduction

A residential street serves a variety of purposes. These include providing access to homes and properties, the delivery of goods and services, the circulation and movement of vehicles, vehicle parking, allowing opportunities for interaction between neighbors, encouraging pedestrian and bicycle travel, and space for neighborhood amenities such as street trees, sidewalks and lighting that add charm and character to the neighborhood. Residential streets are corridors throughout neighborhoods linking properties and providing space for use by motor vehicles, pedestrians, bicyclists, and other uses. Recognizing the various purposes of residential streets, there should be an awareness that streets must function to meet the needs of the neighborhood. The design of residential streets offers opportunities to achieve a balance between motorized traffic and non-motorized travel with the promotion of an attractive and safe residential setting. These opportunities often focus on reducing the predominance of motorized vehicles, and correspondingly reducing vehicle speeds and traffic volumes.

Residential street design concepts that seek to reduce traffic volumes and traffic speeds are the foundation principles of neighborhood "traffic calming." This chapter focuses on balancing the purposes of residential streets and achieving a street environment where motorized and nonmotorized travel modes can harmoniously exist.

This chapter also reviews design opportunities to enhance the residential amenities of existing residential streets and identifies appropriate design criteria for new residential street construction. For existing residential streets, the installation of traffic calming measures may be appropriate to lower traffic speeds and volumes. For new residential streets, and to avoid future traffic speeds and volume problems, it may be necessary to modify existing residential street design and construction standards which balance vehicle mobility with the other purposes of the street. Residential street design has a significant influence on vehicle and pedestrian safety and neighborhood quality, stability and desirability.

Figure 1: Residential streets must serve a variety of purposes.

One definition of transportation is "the movements of goods and/or people from where they are, to where they have a higher value or want to be."[1] An efficient transportation system is a prerequisite for the efficient functioning of many social and economic activities.

Streets and The Neighborhood

The construction of wider and bigger roads has often been a response to meet the demands of the increasing numbers of vehicles within our communities. The construction of wider and bigger roads often means the acquisition of additional road right-of-way (ROW). A lesson learned by many cities is that if insufficient road ROW is available for road widening, additional ROW must be purchased, often at significant costs, which may include the purchase of structures and buildings within the ROW that must then be removed. A national trend has been to build bigger, wider roads to meet the needs of future traffic while still preserving additional ROW. While this may be wise for collector and arterial level roads, it usually only creates additional problems for residential areas. Wider streets mean increased traffic speeds and volumes with accompanying increased traffic noise and the loss of safety in the neighborhood.

A number of surveys indicate that residents believe street noise and heavy traffic in neighborhoods compromise the safety, amenity and quality of the street on which they live.[2] Other problems reported include:[3]

Traffic Accidents –The occurrence of accidents, or the fear of accidents occurring on residential streets in the neighborhood. Residents express a desire for residential streets less prone to accidents.

Noise, Vibration and Air Pollution – These aspects are felt to have a serious negative effect on the quality of life in a neighborhood.

Traffic Speed – Residents object to high traffic speeds because of less safety and increased traffic noise.

Traffic Volume – High traffic volumes are related to other issues including a loss of neighborhood safety and increased noise, vibration and air pollution.

Traffic Composition – As a reaction to noise residents complain specifically of trucks, buses and motorcycles in neighborhoods.

Appearance, Identity, and Maintenance – Increased traffic in residential areas is perceived to detract from the quality and appearance of the neighborhood.

Reduction of Street Activity – With high traffic volumes and associated noise the opportunity for neighbor interaction declines.

Impact on Land Use and Social Stability – High traffic volumes may lead to neighborhood instability and encourage land use changes to commercial and other nonresidential uses.

Neighborhood Crime – Streets with greater auto accessibility may be more susceptible to residential crime.

Figure 2: A major residential street located in Salt Lake City providing center medians, street trees, on-street parking and bike lanes.

Residents' concerns with traffic on residential streets seem to indicate a conflict between the expectations of vehicle drivers on the street and the expectations of those who live on the street.[4] "Residential street designs that promote moving vehicles over the other purposes of the street add to the potential for conflicts between the vehicle and the other residential values and amenities provided by the street."[5]

Balancing the Purposes of Residential Streets

Moving cars and trucks will always be a purpose of roads and highways. However, for residential streets, the recognition should be that cars and people share the space of the street.

The safest way for vehicles and non-motorized travel to exist together is to minimize their interaction using various techniques such as grade separation and other barriers that eliminate interaction between the different travel modes. While philosophically easy, the reality is there will always be a need for interaction. Whether crossing at a signalized intersection, or walking from the store to the car in a parking lot, vehicles, pedestrians and bicyclists will interact. To minimize vehicle, pedestrian and bicyclist conflicts it is necessary to consider and identify conflict solutions at several levels. These may include:

Education

Promotion of the concept that vehicles, non-motorized travel, and residents share the street. This may be achieved through community awareness campaigns including signage, advertising, public radio and television announcements. It is important that drivers of motorized vehicles be aware that others use the street and understand the needs of pedestrians and bicyclists using the street. Similarly, pedestrians and bicyclists must be aware of their environment. Accidents often occur because pedestrians and bicyclists do not obey traffic signals or do not look before crossing. Both groups must be aware of the other.

Minimizing Interaction

By reducing street crossing widths, for example, the interaction time between vehicles and pedestrians is reduced. Studies have shown that shorter crossing distance correlates to fewer accidents. A reduction in street crossing distances can be achieved by reducing the curve radius and cross-section of the residential street.

Visibility

Drivers typically expect pedestrians at intersections. For areas where pedestrians may be present, methods to improve driver awareness and the visibility of the pedestrian are important. While signing is the oldest method to inform drivers of a pedestrian crossing, drivers often become desensitized to signs, reducing their effectiveness. Actuated signage provides a dynamic indication when a

The Institute of Transportation Engineers (ITE) has defined "traffic calming" as "a combination, of usually physical measures, that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users."[8]

pedestrian is in the area. In Boulder, Colorado, for example, dynamic flashing devices located on pedestrian cross walk signs and in-ground pavement lights are activated by pedestrians. Dynamic signage and messaging is effective in improving driver awareness to the presence of pedestrians. Other techniques of dynamic messaging to increase pedestrian visibility and driver awareness include the use of crossing flags by pedestrians and crossing guards.

Reducing Speeds

The ability of a vehicle to stop is related to its speed. If a vehicle's speed can be reduced by 50%, the distance necessary to stop can be reduced by as much as 200%. Reducing vehicle speeds is critical to making residential streets safer.[6]

For residential streets, a variety of options are available to allow a more harmonious environment for both vehicles and pedestrians. There is a need to balance residential traffic flow with local access and non-motorized travel. The approaches to balance the needs of the vehicle with the other purposes of the street often focus on techniques to reduce vehicle speeds and volumes. For residential streets, actions directed at reducing vehicle speeds and volumes are identified as "traffic calming."

Residential Streets and Neighborhood Design - History

Traffic calming is defined as being "any action or program that reduces street traffic and slows vehicles within residential areas and makes neighborhoods safer and more people oriented."[7] Traffic calming seeks to reduce traffic speeds and volumes to an "acceptable level."[9] For the residential street, reductions in vehicle speed and volume can lead to other benefits such as increased pedestrian activity, street safety and street life. Traffic calming techniques focus not only on improving the overall safety and livability of new residential streets, but also on identifying options to improve the safety and residential values of existing residential streets. Traffic calming concepts also encourage nonmotorised mobility in the neighborhood and the replacement of some vehicle trips with non-vehicle trips.

Early traffic calming techniques sought to promote pedestrian amenities and safety. By the 1930's, newly developing residential areas sought to enhance the safety of residents living on the street.[10] Perry, for example, writing in the early 1930's, suggested that "children should never be required to cross a main traffic street on the way to school."[11] By the early 1950's, several communities in the US, including Montclair, NJ,

Grand Rapids, Michigan, and Berkeley, California had installed traffic volume and speed reducing devices to protect residential neighborhoods from increasing vehicle speeds and volumes.[12]

In the 1970's, the Netherlands sought to take back the residential street from the exclusive use of the automobile and identified the concept of "shared space." Shared space is that place where residents and the automobile seek to co-exist.[13]

In the 1970's, Seattle, Washington, commenced experimenting with traffic calming devices in an effort to reduce traffic volumes in residential neighborhoods. Included in this testing was the Stevens neighborhood of Seattle, where various traffic control devices were installed in an effort to reduce cut-through traffic in the neighborhood. With the installation of a variety of permanent traffic control devices the Stevens neighborhood experienced significant reductions in traffic volumes, a fifty-six percent (56%) decrease in neighborhood traffic, and a corresponding and dramatic decrease in neighborhood traffic accidents.[14]

According to the Federal Highway Administration (FHWA), the objectives of traffic calming include:[15]

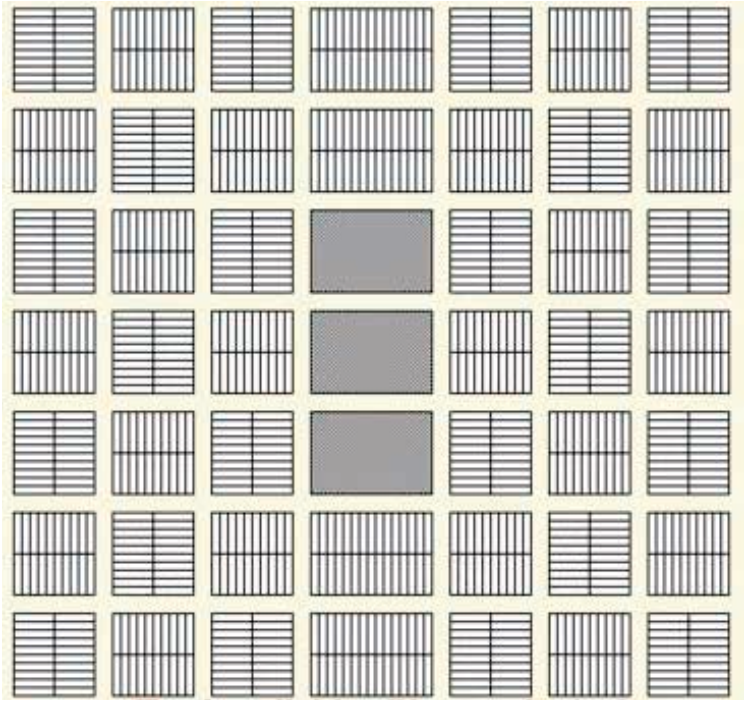
- Reductions in vehicle speeds.
- Safe and pleasant conditions for motorists, bicyclists, pedestrians, and residents.
- Improvements in the environment and livability of neighborhood streets.
- Improvements to the real and perceived safety for non-motorized users of streets.
- Discouraging the use of residential streets by cut through vehicular traffic.

Residential Streets in Utah

Utah communities typically have a street pattern based on the historic grid pattern. As originally planned, the design for Utah communities required that street ROW be 132 feet wide, bordering city blocks of 10 acres, measuring 660 feet square. The community and street pattern required that the length of each block did not exceed five (5) times the street width.[16]

Commencing with Salt Lake City in 1847, these community design

Figure 3



principles have now been applied, in some form, in virtually every Utah community. Although the width of blocks and street rights-of-way (ROW) may vary, the grid street pattern, at some scale, is the predominant development pattern of Utah communities.

The great advantage of the historic grid street pattern is that it disperses traffic and provides many direct routes of travel.[17] Because of these advantages, grid street systems encourage walking and biking. The contemporary residential street pattern in Utah communities today however typically employs large blocks, curvilinear streets, and a branching street pattern. These street systems seek to encourage lower traffic volumes. Both street patterns have advantages and disadvantages for traffic flows, pedestrian and biking activities and neighborhood safety and livability.

Many communities are now seeking to combine the advantages of the grid pattern and curvilinear residential street pattern. A residential street design pattern is emerging that includes the connectedness and direct routes of the grid system with the safety of the contemporary system.[18]

Providing safe residential streets in Utah is particularly important. Utah ranks first in the nation with the highest proportion of children in the population. Approximately 33% of the residents of a community are 0-17 years. The available forms of independent travel for this age group is either walking or biking. If Utah communities do not provide safe routes for walking and bicycling, a large proportion of the population are unsafe as they walk and bike within their community, or they must rely and become be dependent upon parents, or others, for transportation.

Narrower Residential Streets

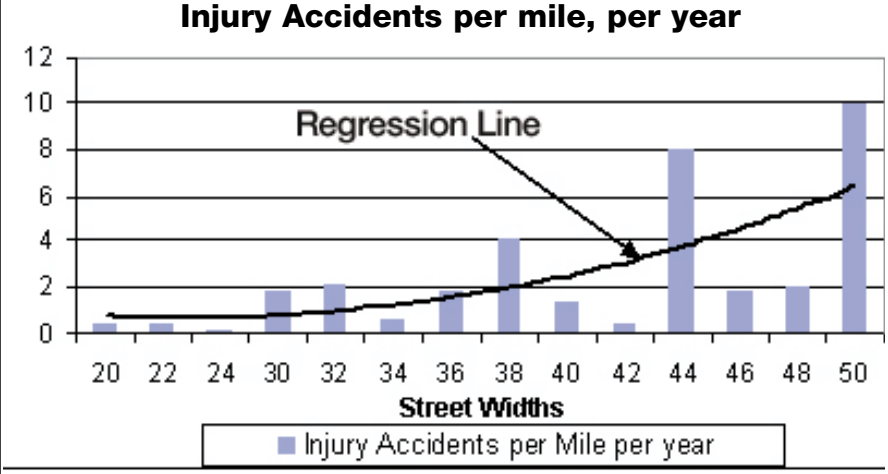
Narrower residential streets than generally accepted today were allowed in Utah communities at an earlier period. Many older, and some of the most desirable residential areas within Utah communities, were laid out with relatively narrow streets. This trend continued up to the early 1940's and 1950's when requirements for wider residential street ROW and pavement widths became the norm.

Several national organizations including the American Society of Civil Engineers, The National Association of Home Builders, and the Urban Land Institute are questioning the wisdom of communities continuing to require wide residential streets. "The tendency of many communities to equate wider streets with better streets and to design traffic and parking lanes as if the street were a 'micro freeway' is a highly questionable practice."[19] The design of a residential street that recognizes the various purposes of the street may occasionally require one driver to slow down or even pull over to let an oncoming vehicle pass. Residential streets should be

designed to have a human scale where pedestrians and residents feel "comfortable" on the street. Residential streets, which define the space for use by vehicles, and which must be crossed by pedestrians, should not be larger than is actually required. Wider streets than required to support local residential traffic also add to the long term street maintenance costs incurred by the community. Existing research demonstrates that vehicle speeds decline as street cross sections are narrowed. Working in the City of Longmont, Colorado, Swift and Associates looked at 20,000 automobile accident reports. The study, "Residential Street Typology and Injury Accident Frequency" determined that "the most significant causal relationships to injury and accident was street width and street curvature."[20] Accidents per mile per year exponentially increased with increasing street widths. Swift and Associates, using the accident information from Longmont, Colorado determined that the safest residential street width is 24 feet (measured from curb face). On the narrower streets, 20 and 22 feet, the number of accidents reported was low, but because a number of these streets were "half streets" other factors potentially contributed to accidents, independent of street width. (The results of the Swift and Associates study for streets narrower than 24 feet remain as inconclusive.) Figure 4 provides a summary of the findings of "Residential Street Typology and Injury Accident Frequency."

Pedestrian activities on narrow streets are also encouraged. "More elderly users, more people out walking pets, and more pedestrians crossing back and forth all attest to a level of comfort with traffic on narrow streets."[21] With the accompanying neighborhood benefits of narrower residential streets and the knowledge that wide residential streets encourage higher traffic volumes and speeds, resulting in less safety on the street, why have communities not universally accepted narrower residential streets? One answer may be that many neighborhood streets are designed for infrequent access by large vehicles, including trucks and emergency vehicles. Other communities may be concerned about encouraging activities on the residential street, including walking, jogging, and bicycling that may raise liability issues. Street designers may also design the residential street from the "center-line out" and often simply run out of available street ROW before bike lanes, sidewalks, landscape areas and other residential amenities are provided.[22]

Figure 4



Swift and Associates, "Residential Street Typology and Injury Accident Frequency."

"Bicycle and pedestrian ways shall be established in new construction projects and reconstruction projects in all urbanized areas with few exceptions." [72]

Recognizing the benefits of narrower residential street designs, communities across the nation are now revising residential street standards to require narrower street pavement widths and designing the street to accommodate everyday use, while still protecting emergency vehicle access.[23] It is interesting to note that with the need remaining to provide emergency vehicle access, residential street designs in British and Australian communities allow, or require, narrower pavement widths and tighter curve radii than typically allowed in US communities.[24]

The benefits to a community of allowing narrower residential streets include:[25]

- Increasing vehicular and pedestrian safety, and encouraging bicycling and walking as a viable transportation method.
- Adding to the safety, amenity and value of the neighborhood.
- Encouraging efficiencies in land use, and allowing areas that would have been paved to provide space for other uses and activities, including landscaping and sidewalks.
- A reduction in water runoff, and pollution, with less hard surfacing.
- A reduction in street maintenance costs.
- Reductions in the initial street construction costs.

Some of the community initiatives for safer residential streets include:

- Requiring narrower pavement widths to create a sense of place.
- Requiring street amenities and furniture, such as benches and pedestrian-scale street lighting.
- Providing wider park strips to encourage the establishment of large street trees.
- Requiring roundabouts at higher volume intersections, and requiring short curve radius, bends, and other slow points in the residential area.
- Providing necessary street connections, bicycle and pedestrian access.
- Establishing maximum block and cul-de-sac lengths.

A consideration of narrower residential streets should occur within the context of total street design, ensuring the purposes of the street continue to be met.

Options for Street Design to Enhance Safety

Peaceful, quiet residential streets and neighborhoods are the desires of citizens. To achieve these goals the design of the residential street should place a priority on moving low levels of traffic in an environment of quiet and safety. Improving the residential amenity of the residential street can be strengthened if it is treated as a residential place, with amenities being provided for

pedestrian use, such as adequate and connected sidewalks, street trees, pedestrian scale signage and lighting, benches and other features. Priority should be given to the non-motorized forms of travel and the residential setting in which the street is located. Any negative effects to the residential setting, as the result of traffic, should only be allowed to the extent such traffic is necessary to support the neighborhood.[26]

A reduction in traffic speeds and volumes is key to making residential streets safer. Traffic calming techniques can assist in achieving traffic speed and volume reductions. Traffic calming techniques can be broadly classified as:[27]

- Physical Methods, including speed bumps, speed tables, traffic diverters, narrower street widths, short road lengths, traffic circles and roundabouts. Physical traffic calming methods are "self-enforcing" and generally do not require enforcement.
- Streetscape Enhancements, that impose the feeling of narrower lane and street widths by the use of street edge and landscaping treatments. Streetscape enhancements, such as street tree plantings, also usually seek to improve the attractiveness of the residential environment and the aesthetic values of the street.
- Regulatory Techniques, such as signs including stop, yield or speed signs. Regulatory techniques provide the advantages of a low capital cost but they require enforcement to be truly effective in reducing traffic speeds.

Examples of Traffic Calming Devices[28]

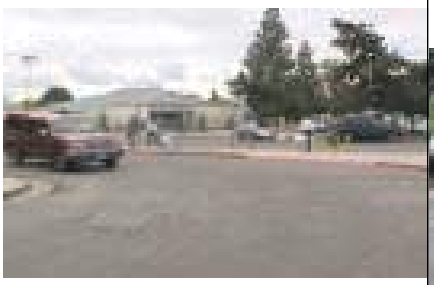
Bike Lanes – A portion of a roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists.

Bulbouts/Neckdowns/Chokers – Curb extensions at intersections that reduce curb-to-curb roadway travel lane widths.

Center Islands – Raised islands located along the centerline of a roadway that narrow the width at that location.

Chicanes/Lateral Shifts – Curb extensions that alternate from one side of the roadway to the other, forming s-shaped curves.

Closures – Barriers placed across roadways to completely close through vehicle traffic.



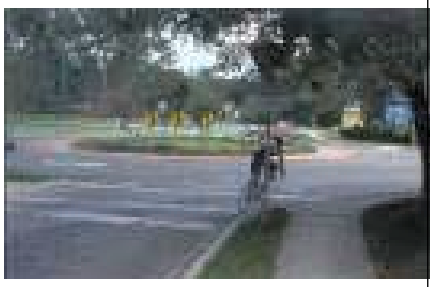
Diverters – Barriers placed diagonally across an intersection, blocking certain traffic movements.

Forced Turn Lanes – Raised islands located on approaches to an intersection that block certain movements.

Median Barriers – Raised islands located along the centerline of a roadway and continuing through an intersection to block cross traffic.

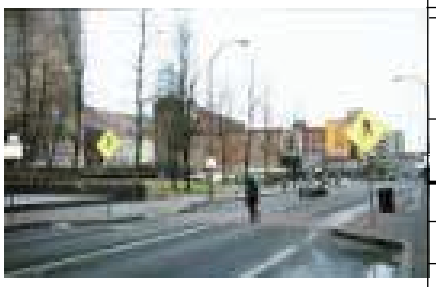
Realigned Intersections – Changes in alignments that convert T-intersections with straight approaches into curving roadways meeting at right angles.

Roundabouts / Traffic Circles – Barriers placed in the middle of an intersection, directing all traffic in the same direction.



Speed Bumps – Rounded raised pavement devices placed across roadways to slow and/or discourage traffic.

Speed Tables/Textured Pavement/Raised Crossings – Flat-topped speed bumps often constructed with a brick or other textured material to slow traffic.



Making Residential Streets Safer

Residential street designs that promote and maintain low traffic volumes and speeds will encourage the safety and attractiveness of residential areas.

Traffic Speeds

Reducing vehicle speeds on residential streets will increase safety on the street. By reducing vehicle speeds, shorter vehicle stopping distances are required and the driver has more time to respond to any vehicle, pedestrian, bicycle or other movements occurring on the street. Slower vehicle design speeds should be required on residential streets in order to encourage a street environment conducive to all forms of transportation, including all non-motorized and motorized transportation modes.

Table 1 highlights required stopping distances at selected vehicle

Table 1: Speed, Reaction Time and Required Stopping Distances

Speed (mph)	Total Perception and Reaction Distance (feet)	Required Stopping Distance (feet)	Total Required Stopping Distance (feet)
10	37	8	45
15	55	18	73
20	73	33	106
25	92	55	147
30	110	86	196
35	128	120	248
40	147	167	314

ITE, "Traditional Neighborhood Development – Street Design Guidelines."

speeds.[29] Stopping distances increase dramatically as vehicle speeds increase. For example, total required stopping distance increases from 106 feet to 248 feet (an approximate 230% increase) when vehicle speed increase by 75% from 20 miles per hour (mph) to 35 mph (Table 1). Clearly, vehicle speed has a significant effect on the safety of both motorized and nonmotorized users on the street.

Traffic Volumes

The number of traffic accidents occurring on the street is closely related to traffic volume. As traffic volume increases, more accidents are expected. For residential streets, traffic volumes should be low to increase safety for all users and the residential qualities of the street.

Transportation is a response to development and therefore traffic volumes increase because of adjoining land uses. Proper land use planning in residential areas understands the land use – transportation relationship. Permitting only land uses and activities on residential streets with low trip generation potentials, limiting street access points, and requiring a street designed for low traffic volumes will protect the functioning of the residential street, minimize neighborhood cut-through traffic, and preserve residential values.

Accidents

During 1999, 83,000 pedestrian-vehicle accidents occurred in the United States, accounting for 12% of fatalities occurring on US roads.[30] Of the 83,000 pedestrian-vehicle accidents in 1999, 20,000 or nearly 24% resulted in incapacitating injuries. Children under 16 years of age killed in pedestrian-vehicle accidents represented 12% of the deaths while the elderly, over 65 years, represented 22% of the deaths occurring in pedestrian-vehicle accidents. Pedestrians struck by a car traveling at 40 mph have a 15% survival rate. At 30 mph survival increases to 55% and a pedestrian struck by a car, moving at 20 mph, has a 95% chance of survival.[31] A reduction in traffic speeds on residential streets has a dramatic influence on pedestrian safety.[32] The influence of traffic speed on street safety is identified in Table 1, related to required vehicle stopping distances.

In Utah for 1991 - 2000, vehicles hit 8,610 pedestrians (54% were children 0-19 years) with 398 pedestrians killed.[33] Approximately 36% of those killed were children 0 - 19 years old. (The loss of children in vehicle – pedestrian accidents in Utah, 1991 - 2000, was twice (2x) the national average.) The majority of the vehicle - pedestrian accidents occur on two (2) lane streets, relatively close to home.

There were 7,755 vehicle - bicycle accidents, 1991 - 2000, in Utah, with 71 bicyclists killed. The majority of bicyclists killed or injured were children (0 - 19 years). Of those injured 68% were children 0 - 19 years.[34]

Fire and Emergency Medical Services

Recognizing the goal of providing low traffic volumes and low traffic speeds on residential streets, residential street designs must continue to allow necessary access for emergency vehicles. Traffic calming measures that are effective in reducing traffic speeds can have the same effect on responding emergency vehicles. The concerns of fire and emergency medical agencies with residential street designs that aim to reduce traffic volumes and speeds can be summarized as: (1) potential effects on response times, and (2) effects on the mobility and maneuverability of fire apparatus at the incident scene.[35]

While recognizing the values of traffic calming for increased safety in neighborhoods, fire departments are concerned about any traffic management action that may slow or inconvenience fire equipment and ambulance services. The larger and heavier vehicles used by fire departments must slow down more than private passenger vehicles and light trucks in order to negotiate a number of traffic calming devices.[36] Traffic calming devices, such as traffic humps and bumps, can also have a slowing effect on ambulances transporting patients.

Impacts on Fire Department Response Times

Fire response time is the time from when the fire call is first received by a dispatcher to the commencement of fire extinguishing operations at the scene.[37] Response time has a relationship to accomplishing actions related to saving lives and limiting property damage. Residential street patterns and designs can affect response times. The results of studies identifying the impacts of traffic calming actions on response times are presented in Table 2.

Communities where residential streets are designed to encourage lower traffic volumes and speeds have found that effects on emergency vehicle response times can be minimized by certain actions.[38] These include:

1] Close consultation with emergency response personnel in any residential traffic plan.

2] Providing that physical barriers are traversable by emergency vehicles.

3] Requiring that any primary response routes remain open.

4] Providing additional fire hydrants within the residential area and adjacent to any physical barriers.

5] Requiring multiple access routes in neighborhood street patterns.

Get to know your Fire Chief! Over the last decade, many designers, engineers, developers, local officials, emergency response personnel, and neighborhood residents have found themselves struggling over seemingly competing objectives when it comes to good street design. Ultimately, however, among the many values at stake in street design, public safety always emerges as the final arbiter. But even within this incontestable objective, a conflict has emerged that has only recently been thoroughly defined and studied, and is starting to be addressed: the seeming conflict lies between the need for rapid emergency responses to any location and acheiveing slow, safe everyday neighborhood streets.[73]

Fire agencies are also concerned with street designs that narrow street pavement widths. Many Fire Departments fear that narrow residential streets will also negatively effect response times and the ability of the Fire Department to establish fire suppression activities at the scene. The Uniform Fire Code, Section 902, requires that "fire apparatus access roads… shall have an unobstructed width of not less than 20 feet."[39] Fire access roads are to be constructed to provide an all-weather surface (*Uniform Fire Code, Section 902.2.2.2*). The Uniform Fire Code, Section 902.2.4.1, provides further clarification and identifies that required fire accesses shall not be obstructed "in any manner, including parking of vehicles." Clearly, the Uniform Fire Code requires that no residential street, providing fire access, would be less than 20 feet wide, and constructed to provide an all-weather driving surface.

Designing the street for the occurrence of on-street parking and assuming a width of a full size car to be 6 feet, a minimum street width of 26 feet (curb face to curb face) is sufficient to accommodate on-street parking and comply with the requirements of the Uniform Fire Code. A residential street pattern designed with low volume streets and multiple accesses to all properties can improve emergency vehicle response times from those achieved with contemporary street patterns with limited access points to properties.

Many Fire Departments are recognizing the value of narrower residential street designs. Boulder, Colorado, for example, has revised their neighborhood street standards to allow residential streets 26 feet wide with on-street parking.[40] In Portland, Oregon, various modifications have occurred to allow residential street designs, identified as "queuing streets," and allowing 26 feet street widths with parking allowed on both sides of the street.[41]

During the study period of "Residential Street Typology and Injury Accident Frequency" there was one serious fire and a number of smaller fires. No injuries or fire equipment access problems were

Table 2: Fire Response Times and Selected Traffic Control Devices

VEHICLE*	DEVICE A Time Delay (seconds)	DEVICE B Time Delay (seconds)	DEVICE C Time Delay (seconds)
Engine 18	1.7	2.3	4.3
Rescue 41	0.0	1.7	2.3
Squad 1	1.0	4.1	2.4
Truck 1	1.4	4.9	6.4
Truck 4	3.4	4.9	6.2
Truck 41	4.8	4.7	5.2

Summarized from *The Influence of Traffic Calming on Emergency Response Times*, ITE Journal, August 1997, Crystal Atkins and Michael Coleman.

Notes:
1. a. Device A = 22 foot Speed Bump; Device B = 14 feet Speed Bump; Device C = Traffic Circle
2. Delay is calculated with the desire to maintain a 30 mph Response Speed.
   Time Delay is the additional time required to respond due to the traffic control device. As a comparison, stop signs can add an additional 6 to 11 seconds to Response Time depending on the type of response vehicle.
3. Table 3 identifies Fire Vehicle Specifications

Table 3: Fire Vehicle Specifications

VEHICLE	TOTAL LENGTH (ft)	WHEELBASE (ft)	WEIGHT (lbs)	HORSEPOWER (HP)
Engine 18	29'10"	15"5"	34,860	185
Rescue 41	21'0"	11"6"	Na	185
Squad 1	27'0"	14'6"	23,170	275
Truck 1	48'0"	21'0"	53,000	450
Truck 4	57'0"	13'0"	53,960	450
Truck 41	37'6"	16'9"	42,100	350

The Influence of Traffic Calming on Emergency Response Times, ITE Journal, August 1997, Crystal Atkins and Michael Coleman.

reported, with the serious fire located on a 28 foot wide street.[42] For the study period there were a total of 227 automotive accidents with injuries reported. "Residential Street Typology and Injury Accident Frequency" identifies that "0.32 automotive injury accidents can be anticipated per year per mile on a 24 foot-wide street, compared to 1.21 on a 36 foot-wide street." "Even if narrow streets did create a moderately greater fire injury risk, they would be safer than wide streets, because the risk of automotive injuries is so much greater than fire injuries."[43]

Police Services

Police Departments usually express no opposition to traffic calming devices and residential streets designs to reduce traffic volumes and speeds because of the corresponding increase in street safety. Sometimes however, concerns are expressed with any physical barriers that minimize or eliminate access. The concerns of police agencies to traffic calming initiatives may be categorized as;

1) Physical barriers increase the difficulty of police surveillance by adding obstacles to access.

2) Traffic barriers hamper police pursuits.

3) Barriers can negatively affect police response times to calls for service.[44]

However, information from Minneapolis, Minnesota, does not support these concerns.[45] In Minneapolis residential blocks with lower accessibility, a characteristic typical of locations where calming is established, experienced lower residential crime rates than residential areas with greater accessibility, with similar crime-related social variables.[46] A study conducted in Berkeley, California, with various traffic calming devices reported that
traffic control devices did not negatively affect police surveillance in residential areas.[47]

Figure 5: Providing emergency vehicle access (25 foot pavement).

Figure 6: Residential street (26 foot pavement).

Figure 7: Residential streets must provide for a variety of vehicles.

Crime

A reduction in neighborhood crime should also be a goal of residential street designs. Studies conducted in Hartford, Connecticut and St. Paul, Minnesota indicates that the incidence of street crime is reduced in neighborhoods with street patterns and designs that reduce traffic volumes.[48]

Crime Prevention Through Environmental Design (CPTED) suggests that crime can be reduced in neighborhoods by designing residential streets to encourage surveillance by residents and others of the street space ("eyes on the street") and to create difficulties for entry and escape from the area. Residential street designs that encourage street activity and resident interaction, minimize neighborhood cut-through traffic, and provide complexity in the street pattern also discourage neighborhood crime.[49]

Noise

Traffic speeds and traffic noise are directly related. Experience indicates that lower traffic speeds will also lower traffic noise.[50] As a rule, resulting traffic noise is related to the square root of traffic speed. Residential street designs that lower traffic speeds will have a significant effect on reducing traffic noise in the neighborhood.

Traffic calming measures designed to reduce vehicles speeds will generally have the effect of reducing neighborhood noise levels. However, increased noise levels have been reported with some vertical deflection devices, such as humps and bumps, due to vehicle noise associated with traveling over the device and vehicle acceleration after the device.

Snow Removal

Some traffic calming actions may have an effect on the winter removal of snow and ice. Coordination with road maintenance and snow removal operators on traffic calming strategies will ensure any negative effects on snow removal are minimized and snow removal operations perform efficiently.

A number of communities, located in snow areas, have successfully incorporated traffic calming measures into traffic management and road maintenance programs.

Effects of the Traffic Calming Devices to Reduce Traffic Speeds and Volumes

While traffic calming is recognized as being a method for reducing speeds and volumes, it is appropriate to consider the effectiveness of the various traffic calming techniques. Some of the very questions of how and where to apply traffic calming were asked and answered in a August, 1997 Institute of Transportation Engineers (ITE) Journal article entitled "Urban Traffic Calming Treatments: Performance Measures and Design Conformance."[51] The article sites the various traffic calming devices and their conformance to the national guidelines from an opera-

Table 4: Influences of Traffic Calming Devices

	DIRECT TRAFFIC EFFECTS						
DEVICES	Volume Reductions	Speed Reductions	Directional Control	Change In Vehicle Mix	Noise	Safety	Emergency & Service Access
Physical Controls							
Speed Bumps	Possible	Inconsistent	Unlikely	Unlikely	Increase	Adverse effects	Some problems
Undulations	Possible	Yes	Unlikely	Unlikely	No change	No problems documented	No problems documented
Rumble Strips	Unlikely	Yes	Unlikely	Unlikely	Increase	Improved	No problems
Diagonal Diverters	Yes	Likely	Possible	Possible	Decrease	Shifts Accidents	Some constraints
Intersection Cul-De-Sac	Yes	Likely	Yes	Possible	Decrease	Shifts Accidents	Some constraints
Midblock Cul-De-Sac	Yes	Likely	Yes	Possible	Decrease	Shifts Accidents	Some constraints
Semi-Diverter	Yes	Likely	Yes	Possible	Decrease	Shifts Accidents	Minor constraints
Forced Turn Channelization	Yes	Likely	Yes	Possible	Decrease	Improved	Minor constraints
Median Barrier	Yes	On curves	Possible	Possible	Decrease	Improved	Minor constraints
Traffic Circle	Unclear	Minor	Unlikely	Possible	Little change	Questionable	Some constraints
Chokers and Road Narrowing	Rare	Minor	Unlikely	Unlikely	Little change	Improved ped. crossing	No problems
Passive Controls							
Stop Signs	Occasional	Site reduction	Unlikely	Unlikely	Increase	Mixed results	No problems
Speed Limit Signs	Unlikely	Unlikely	Unlikely	Unlikely	No change	No change	No effect
Turn Prohibition Signs	Yes	Likely	Yes	Possible	Decrease	Improved	No effect
One-Way Streets	Yes	Inconsistent	Yes	Possible	Decrease	Possible imp.	No effect
Perception Controls							
Transverse Markings	No change	Yes	No effect	No effect	Possible red.	Possible imp.	No effect
Crosswalks	No effect	Unlikely	No effect	No effect	No effect	Ineffective	No effect
Odd Speed Limit Signs	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Novelty Signs	No effect	Undocument.	No effect	No effect	Unlikely	No effect	No effect

Federal Highway Administration, 2000

tional approach. A Federal Highway Administration (FHWA) report on "Improving Residential Street Environments" also addressed the issues of effectiveness.[52] Quantifiable results of the traffic calming impact on speeds, volume and safety are also identified. Table 4 and Table 5 provide information on the effects of various traffic calming devices.

Table 5: Other Characteristics of Traffic Calming Devices

	OTHER CHARACTERISTICS			
DEVICES	Construction Efforts & Cost	Landscape Opportunity	Site or System Use	Maintenance & Operational Effects Index
Physical Controls				
Speed Bumps	Low	None	Both	Snowplow problems
Undulations	Low	None	Both	No problems noted
Rumble Strips	Low	None	Site	Snowplow problems
Diagonal Diverters	Moderate to high	Yes	Usually system	Vandalism
Intersection Cul-De-Sac	Moderate to high	Yes	Both	Vandalism
Midblock Cul-De-Sac	Moderate to high	Yes	Both	Vandalism
Semi-Diverter	Moderate to high	Yes	Both	Vandalism
Forced Turn Channelization	Moderate	Possible	Both	No unusual problems
Median Barrier	Moderate	Possible	Both	No unusual problems
Traffic Circle	Moderate to high	Yes	Both	Vandalism
Chokers and Road Narrowing	Moderate	Yes	Both	No unusual problems
Passive Controls				
Stop Signs	Low	No	Both	No unusual problems
Speed Limit Signs	Low	No	Site	No unusual problems
Turn Prohibition Signs	Low	No	Both	No unusual problems
One-Way Streets	Low	No	Usually system	No unusual problems
Perception Controls				
Transverse Markings	Low	No	Site	No unusual problems
Crosswalks	Low	No	Site	No unusual problems
Odd Speed Limit Sign	Low	No	Site	Vandalism
Novelty Signs	Low	No	Site	Vandalism

Federal Highway Administration, 2000

A similar method for identifying the effectiveness of the various traffic calming techniques is shown in Table 6 provided from the Pennsylvania Department of Transportation.[53]

Table 6: Effectiveness of Traffic Calming Techniques

	Volume Reductions	Speed Reduction	Conflict Reduction	Emergency Response
Horizontal Deflection				
Bulb-out/curb extension	□	▲	▲	□
Chicane	▲	▲	□	▲
Gateway	□	□	□	□
On-street parking	□	▲	□	▲
Raised median island/pedestrian refuge	□	▲	▲	□
Traffic circle	▲	▲	■	▲
Vertical Deflection				
Textured crosswalk	□	□	□	□
Speed hump	▲	■	▲	■
Raised crosswalk	▲	■	▲	■
Raised intersection	□	▲	▲	■
Physical Obstruction				
Semi-diverter	■	▲	▲	▲
Diagonal diverter	■	▲	▲	▲
Right-in/right-out island	▲	□	▲	▲
Raised median through intersection	■	□	▲	■
Street closure	■	▲	■	■
Signing and Pavement Markings				
Speed limit signing	□	▲	□	□
Multi-way stop control	□	▲	▲	▲
Turn prohibitions	▲	□	▲	□
One-way streets	■	□	▲	▲
Commercial vehicle prohibitions	▲	▲	□	□
Roadway narrowing with edge lines	□	▲	□	□
Transverse markings	□	▲	□	□

Minimal or no effect □ Moderate effect ▲ Significant effect ■

Pennsylvania Department of Transportation Traffic Calming Handbook (January, 2001)

Quantifiable benefits of various calming techniques including reductions in speed and volume and accidents are shown. Table 7 shows the benefits from empirical information collected at locations throughout the US.

Table 7: Effects of Traffic Calming Measures on Speed, Volume and Safety

Speed Impacts of Traffic Calming Measures

	Sample Size	85th Percentile Speed Afterward (mph)	Average Change in 85th Percentile Speed (mph)	Average % Change
12' Humps	179	27.4	-7.6	-22%
14' Humps	15	25.6	-7.7	-23
22' Tables	58	30.1	-6.6	-18
Longer Tables	10	31.6	-3.2	-9
Raised Intersections	3	34.3	-0.3	-1
Circles	45	30.2	-3.9	-11
Narrowing	7	32.3	-2.6	-4
One-Lane Slow Points	5	28.6	-4.8	-14
Half Closures	16	26.3	-6.0	-19
Diagonal Diverters	7	27.9	-1.4	-0

Volume Impacts of Traffic Calming Measures

	Sample Size	Average Change in Volume vehicles per day	Average % Change
One-Lane Slow Points	5	-392	-20%
Full Closures	19	-671	-44
Half Closures	53	-1611	-42
Diagonal Diverters	27	-501	-35

Safety Impacts of Traffic Calming Measures – Average Number of Collisions

	Number of Observations	Before Treatment	After Treatment	% Change in Collisions
12' Humps	49	2.7	2.4	-11%
14' Humps	5	4.4	2.6	-41%
22' Tables	8	6.7	3.7	-45%
Circles	17	5.9	4.2 -	29%

Revised from Traffic Calming State of the Practice, ITE/FHWA, August 1999

Residential Street Designs in New Developments

> **Great towns, villages and cities in all parts of the world are based on simple, easily understood principals. The people who built these great places had ordinary minds. They worked as much from common sense and their hearts as anything else. Once we understand these principals, we know what kind of streets to provide.**[73]

Recognizing that residential streets are used for variety of purposes, it could be expected that the design of new residential streets would balance the purposes of residential streets. However, the majority of streets in new residential areas and contemporary street designs require residential streets with the primary goal of moving traffic. Many Utah communities continue to require minimum street pavement widths greater than required to support the needs of local traffic. Many Utah communities typically require street pavement widths of 36 feet, or more, for local residential streets.

The Wilmington Delaware Area Planning Council (WILMAPCO) provides an example of a local initiative to identify a residential street design that recognizes and balances the purposes of the residential street.[54] The Wilmington Delaware Area Planning Council has recommended residential street design standards for communities within their area based on the following design criteria:

- A design speed of 20 mph.
- The residential street design vehicle is a 266-inch wheelbase school bus.
- Local residential street designs should recognize the needs of pedestrians.

Based on these design criteria, Table 8 highlights how the WILMAPCO design standards deviate from the American Association of State Highway and Transportation Officials (AASHTO) guidelines.

Table 8: Wilmington Area Planning Council

Residential Street Design Recommendations

Design Standard	AASHTO Local Urban Street Standard	WILMAPCO Local Street Standard	Rationale for WILMAPCO Standard
Design Speed	20-30 mph	20 mph	20 mph is safe for pedestrians and is acceptable to most residents. 30 mph is not.
Right-of-Way Width	50 feet	41 feet	41 foot right-of-way is consistent with individual cross sectional elements.
Pavement Width	26 feet	18 feet	One clear travel lane is sufficient on streets carrying less than 500 vehicles per day. On street parking on only one side is sufficient with ample off-street parking.
Travel Lane Width	9-12 feet	9 feet	Equals AASHTO minimum.
Pavement Edge Treatment	Normally 4 inch to 9 inch vertical curb	6 inch or 8 inch vertical curb	Greater than AASHTO standard. Higher curb discourages parking on planter strips and enhances pedestrian safety

Design Standard	AASHTO Local Urban Street Standard	WILMAPCO Local Street Standard	Rationale for WILMAPCO Standard
Horizontal Curve Radius	100 foot minimum	90 foot minimum when curve is unsigned. 45 foot minimum curve is signed as a traffic calming measure.	Less than AASHTO standard. Sufficient for the design vehicle.
Vertical Curve Length	60 foot minimum at the 20 mph design speed.	Same as AASHTO when curve is unsigned. When signed as a traffic calming measure and marked - no requirement.	Proposed standard exempts AASHTO standard in traffic calming situations.
Sidewalks	On both sides of streets used to access schools, parks, etc. On one side in other locations.	On both sides of streets with densities 2 plus units per acre. On one side at densities 1-2 units per acre.	A small cost increment to enhance pedestrian amenity.
Sidewalk Width	4 foot minimum	5 feet with planting strip. 8 feet without planting strip.	5 foot width is comfortable for pedestrians walking in pairs and passing other pedestrians. Provides greater separation for traffic with no planter strip.
Planting Strip Width	2 foot minimum	5 foot minimum	Normal minimum to sustain street trees and provides adequate separation between pedestrians and vehicles.
Corner Radius	15 foot minimum	25 feet (local-local) 30 feet (local-collector) 40 feet (local-collector without parking lane.	Greater than AASHTO standard to accommodate design vehicle.

Wilmington Delaware Area Planning Council

Of particular interest in the Wilmington Delaware Area Planning Council (WILMAPCO) recommendations is the recommendation for residential street pavement widths of 18 feet. Designed to accommodate a school bus, this recommended pavement width is nearly half of the pavement widths required by many Utah communities.

Traffic Calming Implementation Strategies

The evidence is that traffic calming has a positive impact on:

- Reducing accidents on residential streets.
- Decreasing traffic speeds and volumes.
- Enhancing pedestrian safety.
- Increasing the residential quality of the neighborhood.

Impacts to noise, crime, and emergency vehicle response times vary by calming technique.

Understanding the benefits and weaknesses of each traffic calming action helps determine which calming approach is most appropriate for a given condition. It is important to:

1] Identify if a problem exists by speed, accident and volume data. A point system such as shown in Table 9 from Pennsylvania Department of Transportation recommends methods that may be applied.[55] Salt Lake City, Utah also has a ranking technique for prioritizing needs throughout the City.

2] Propose and test the calming method with community involvement.

3] Community acceptance of traffic calming measures is often related to achieving other neighborhood goals, including reducing neighborhood crime and noise,

Table 9: Project Ranking System

Criteria	Points	Basis for Point Assignment
Speed	0 to 30	Extend by which 85 percentile speeds exceed posted speed limit; 2 points assigned for every 1 mph.
Volume	0 to 25	Average daily traffic volumes (1 point assigned for every 120 vehicles). Crashes 0 to 10, 1 point for every crash reported within past 3 years.
Elementary or Middle Schools	0 to 10	5 points assigned for each school crossing on the project street.
Pedestrian Generators	0 to 15	5 points assigned for each public facility (such as parks, community centers, and high schools) or commercial use that generates a significant number of pedestrians.
Pedestrian Facility	0 to 10	5 points assigned if there is no continuous sidewalk on one side of the street; 10 points if missing on both sides.
Total Points Possible	100	

Pennsylvania Department of Transportation Traffic Calming Handbook (January, 2001)

minimizing street maintenance costs, and improving neighborhood character and desirability.

Safe Routes to School

It is not long ago when children routinely made their way to school by walking or bicycling. However, because of the lack of safe routes, including the lack of sidewalks and bike lanes, and high traffic volumes and speeds in neighborhoods parents are now reluctant to allow their children to walk or bike to school. For these reasons, many parents drive their children to virtually all activities outside the home, including school. Parents driving children to school may account for up to 25% of neighborhood traffic. Where nearly 7 out of 10 children walked or biked to school in the early 1970's now only 1 out of every 10 children walks or bikes to school. The loss of safety on residential streets has severely eroded the freedoms of children.[56]

Increasing the safety of residential streets through reductions in traffic volumes and speeds, and providing pedestrian and bicycle facilities in street designs, can again encourage children to walk or bike to school. Communities across the nation are embracing "Safe Routes to Schools" initiatives to make streets safer forpedestrians and bicyclists.[57] In Utah, the need for communities and school districts to work cooperatively together to provide safe routes to school is critical. Utah has the highest proportion of any State for school-aged children 5 to 16 years.

Too often school locations are selected without consideration for safe pedestrian and bicycle access. Even years after school construction, children are still required to find their way to school on routes that do not have sidewalks, sidewalks that remain inadequate and unconnected, or sidewalks located immediately adjacent to fast moving traffic. Examples exist of schools sited in locations separated by busy highways and arterial roads from the neighborhoods they serve. To provide convenient and safe walking and bicycling routes to schools will require the coordinated and continued efforts of school districts and local governments.

The laws of the State of Utah, Section 10-9-106(2) and Section 17-27-105(2), Utah Code Annotated (UCA) provide and establish that a school district is subject to a municipality or county land-use regulations, with some prescribed limitations. A municipality, or county, may impose regulations on a school district in order to avoid unreasonable risks to health or safety. For example, a municipality, or county, may require a school district to participate in the cost of a sidewalk, if the sidewalk is necessary for the safety of school children, and is located on or adjacent to school property, or is required to connect an isolated school site to an existing road, Section 10-9-106(2)(b) and Section 17-27-105(2)(b), UCA. A school district is also required to coordi-

nate the siting of new schools with local governments to avoid or mitigate existing or potential traffic hazards and maximize school safety, Section 10-9-106(3) and Section 17-27-105(3), UCA. Additionally school districts are required to notify local governments prior to the purchase of a school site and discuss with the local government (municipality or county) any concerns, including any potential community impacts, Section 53A-20-108(1) and Section 53A-20-108(2), UCA. Clearly, the State of Utah expects, and requires, that school districts and local jurisdictions coordinate and work together to protect the safety of children as they make their way to and from school.

Residential Street Design Standards for Utah Communities

There exists within our communities a variety of residential street types. Some residential streets function to meet the needs of the urban residential neighborhood, while others meet the needs of the suburban neighborhood.

Residential streets are also required to serve residential areas, located within a rural setting.

Figure 8: Routes to school (children must compete with school buses and other vehicles, walking in storm water drainage facilities, to make their way to school).

Recognizing the various roles and purposes of a residential street, the following information is provided, as a discussion guide, for the design and construction of residential streets in Utah communities. The location and design of the residential street is determinative of the attractiveness, functioning and desirability of the residential area. The long-term functionality, safety, and attractiveness of the neighborhood and the street requires the identification of appropriate street design principles and design criteria. Pedestrians, bicyclists, private passenger vehicles, trucks, school buses, emergency vehicles, and others must share the space of the residential street. The needs of the various users of the residential street must be recognized and balanced in the street design.

General Design Principles for Residential Streets

Connected Pedestrian Facilities

Residential streets must provide for pedestrians. All lots and spaces within the neighborhood should be connected via linked pedestrian connections. As a basic design principle, "residential street design and scale should favor the nonmotorist and accommodate the motorist."[58] In his book "Great Streets," Allan B. Jacobs identifies that "every [great] street is one that invites walking."[59] A residential street should invite walking. Significant numbers of neighborhood residents walk for the purposes of exercise and walking is an independent travel mode for children.

Sidewalks, if provided at all on residential streets in Utah communities, are often typically three (3) feet wide. To promote the functioning of the sidewalk for pedestrian activity it is recommended that sidewalks be a minimum width of five (5) feet. Although more expensive than three (3) foot sidewalks, (5) foot sidewalks invite walking and provide a comfortable space for pedestrians, allowing pedestrians to walk together.[60] The more interesting and inviting the street the more pedestrians will use it. Areas of the neighborhood that cannot be accessed via a street with sidewalks can continue the pedestrian network by a trail, eventually being connected back to a residential street with sidewalks.

Bicycle Facilities

Bicycling is a viable form of transportation and must be considered in the design of the residential street. Not only is bicycling a viable travel option for children, but bicycling is one of the most popular forms of recreational activity. On higher volume residential streets bicycle routes may be required to be separated from motorists. On residential streets designed to encourage low traffic volumes and speeds there is usually no need to identify separate bike lanes.[61]

Street Connectivity

To promote neighborhood connections and encourage resident interaction within the neighborhood, residential streets should be connected, as practical. For reasons of neighborhood safety, and to provide necessary motorized and non-motorized circulation, all properties within the neighborhood should be capable of being accessed from multiple directions. Because of site topography, or other site constraints, there may be times when this goal cannot be achieved. This should be the exception rather than the rule. Connected residential streets provide appropriate travel and emergency routes and encourage non-motorized travel. With multiple travel routes available, vehicle trips are spread throughout the neighborhood, and drivers may consider a non-motorized mode of travel mode. The challenge for city planners and street designers is to provide a residential street pattern that allows efficient circulation within the neighborhood while discouraging unnecessary neighborhood cut through traffic.

There will always be significant volumes of traffic in our communities, with the need to move safely and quickly, at higher design speeds than are appropriate for neighborhood residential streets. Highways and arterial and collector roads, with peak hourly traffic flows of 300 vehicles, or greater, will carry significantly more traffic than is acceptable in a neighborhood.[62] These roads act as barriers to nonmotorized travel and should be located on the edges of the neighborhood. The design of the neighborhood streets system should provide efficient connections to the community's collector and arterial road system provided with safe and convenient pedestrian and bicycle crossings.

Design Speed

The goal of residential street design is to balance the purposes of the street. Residential streets must encourage and preserve low vehicle speeds. Low vehicle speeds will be achieved through the selection of street design criteria such as pavement width, curve radii, whether on-street parking is permitted, and other criteria.

Typically, the design speed for a residential street should not exceed 20 mph.[63] Increased vehicle speeds leads to increased vehicle noise and required stopping distances, and sight distances. Table 1 has identified the relationship between vehicle speed and total stopping distance. From Table 1 the total required stopping distance increases by an additional 141 feet from 20 mph to 35 mph.

On residential streets, a design speed of 20 mph should be applied. A maximum design speed of 20 mph encourages a feeling of safety for pedestrians and bicyclists.[64]

"The risk of very serious injury to pedestrians increases dramatically as the speed of the impacting vehicle exceeds 20 mph."[65] Research

has shown that pedestrians are not usually seriously injured when struck by a vehicle moving at less than 20 mph.[66]

Street Width

Conventional traffic engineering requires that vehicles should travel streets without interruption, or with limited interruption. A residential street that balances the purposes of the street, including providing a space where motorized and nonmotorized travel can safely coexist together, will require this premise to be revised. A residential street providing safety, comfort, desirability, and aesthetics for all users will require that vehicles on the street recognize the other users on the street. A street width that balances the needs of all activities on the street, including motorized and nonmotorized travel, must be established.

Examples of attractive and desirable residential streets can be found in many older residential areas of our communities. These areas are often the preferred residential areas over newer subdivisions. Many of the established and older residential areas in Utah communities have street widths much less than 30 feet (curb to curb). These streets also are examples where vehicles recognize other users on the street, and where vehicles must occasionally stop to allow other vehicles to pass. For residential streets, the occasional stop should be accepted by street designers and motorists. The American Association of State and Highway Transportation Officials (AASHTO) accepts that "the level of user inconvenience occasioned by the lack of two moving lanes is remarkably low in areas [of] single family units."[67] Designing residential streets for uninterrupted traffic flows will result in providing a street that is wider than necessary. On such a street, vehicle speeds will be higher than accepted by the other users and residents on the street.

As found by Swift and Associates in Colorado, street width has a significant influence on vehicle speeds, and consequently pedestrian and bicyclist safety.[68] A clear relationship exists between street width and vehicle speeds. Reducing street widths will reduce vehicle speeds and the dominance of vehicles on the street.

Considering the work of Swift, it is recommended that a street pavement width of 26 feet (curb to curb) be considered for residential streets in Utah. This recommendation considers the need for winter snow plowing activities and the requirements for emergency vehicle access. Typically, development requirements work to minimize on-street parking, since single family units regularly provide off-street parking for at least four (4) vehicles (2 garage or carport spaces plus 2 spaces provided in a driveway) and multi-family residential units are regularly required to provide 2 off-street parking spaces per unit, plus additional visitor parking.

Centerline Radius

The Institute of Transportation Engineers (ITE) in "Traditional Neighborhood Development – Street Design Guidelines" identifies a minimum street centerline radius of 89 feet for a street with a design speed of 20 mph.[69] Consistent with this recommendation and the recommendation of WILMAPCO, it is recommended that for residential streets (with a 20 mph design speed) a centerline radius of 90 feet be considered.

Curb Return Radius

"When the curbed street meets another, the curbs at the sides of each street are joined by a curved section of the curb known as the curb return."[70] As the curb return radius increases, the length of the distance at cross-walks increases, requiring additional time for pedestrians to cross. The shorter the curb return radius the shorter will be crossing distances and the more the street intersection will act as a "slowing point" in street design. Communities should consider and select an appropriate curb return radius for residential streets based on traffic volumes, traffic types, sidewalk and park strip requirements, and other street design criteria, and considering the influence curb return radius will have on traffic speeds, turning movements, street safety and street crossing distances.

Street Right-of-Way Width

A typical residential street right-of-way for many for Utah communities is 60 feet. Within this right-of-way. communities may often require street pavement widths well in excess of 30 feet for the "narrowest" residential streets.

Street right-of-way can be considered a function of several street design criteria including pavement width, sidewalk and park strip widths, and utility requirements. With a street pavement width of 26 feet, and including 5-foot sidewalks and 6-foot park strips, existing community requirements of 60 foot street rights-of-way are more than sufficient to accommodate the street design guidelines suggested here.

On-Street Parking

The presence of on-street parking will slow traffic on the street and provides an additional separation between moving vehicles and pedestrians. It is recommended that on-street parking be allowed on both sides of the streets on residential streets with pavement widths of 24 feet or greater. A recommendation to allow parking on residential streets recognizes the fact that single-family homes and multi-family developments, by way of zoning and development requirements provide significant areas, onsite, for the parking of vehicles.

Figure 9: On-street parking (historically parking has been allowed on Utah streets).

Park Strips and Street Trees

Park strips sized to allow the planting and growth of street trees will provide an attractive edge to the street and provides a separation between vehicles and pedestrians. For Utah communities, and recognizing that park strips also function to provide snow storage areas, park strips of not less than six-feet should be provided. For higher traffic volume streets, and to add attractiveness to the streetscape, wider park strip areas may be required. As evidenced in many neighborhoods, street trees enhance the aesthetics and environment of the street, encourage pedestrian activity and add residential amenity, value and desirability to the neighborhood.

Street Lighting

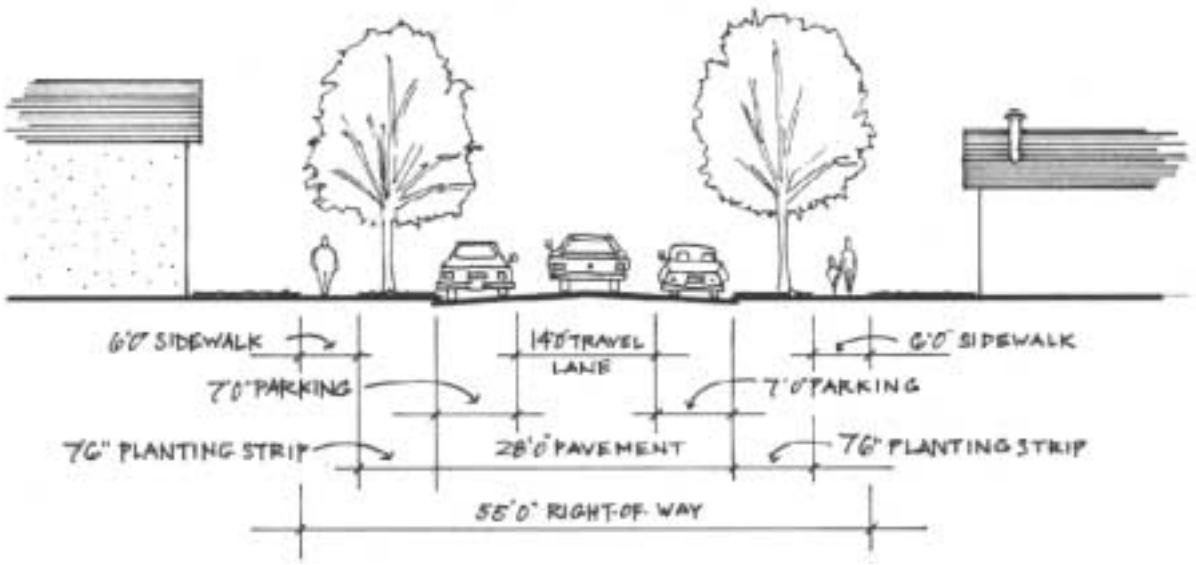
To provide an attractive element to the residential streetscape, as well as providing street and pedestrian lighting, streetlights should not exceed 12 feet in height, and be placed so as to avoid the conventional practice of providing fewer and higher lights with more intense lighting.

Figure 10: Street trees provide character and beauty to a neighborhood.

Table 10: Residential Street Design Guidelines for Utah Communities A Summary

Residential Street Design Criteria	Recommended Standard
Design Speed	20 mph maximum
Street Width (pavement width)	26 - 28 feet maximum
Centerline Radius	90 feet
Parking	Allowed on both sides
Sidewalk Width	5 feet minimum
Park Strip Width	6 feet minimum
Connections	Provide multiple access points. Multiple accesses will provide alternative emergency response routes. As the number of intersections and blocks increase the number of walk trips increase.

Figure 11: Residential Street Design



The residential street design guidelines for pavement width and sidewalk and park strip widths are consistent with suggestions provided by the State of Utah, Governor's Office of Planning and Budget, for residential streets and identified in Figure 11.[71]

Figure 12a: The residential street (designed generally to the suggested standards).

Examples of attractive, safe and functional residential streets can be found in our communities. Figure 12a and 12b present existing residential streets, meeting the residential street design guidelines suggested here, and functioning to provide the purposes of a residential street while adding quality, safety and amenity to a neighborhood. With thoughtful design decisions, and the goal of balancing the needs of the various users on the street, residential streets can once again become attractive and inviting spaces within our neighborhoods.

Figure 12b