

Chapter 9. CIRCULATION AND CONNECTIVITY

9.1 Purpose and Intent

The purpose of this section is to support the creation of a highly connected transportation system within the Town in order to:

- provide choices for drivers, bicyclists, and pedestrians;
- promote walking and bicycling;
- connect neighborhoods to each other and to local destinations such as schools, parks, and shopping centers;
- reduce vehicle miles of travel and travel times;
- increase effectiveness of municipal service delivery; and
- free up arterial capacity to better serve regional long distance travel needs.

It is the intent of this UDO to build streets that are integral components of community design. Streets must be pedestrian in nature and shall be designed with sufficient detail to complement the architectural detail of neighborhoods and commercial centers. In addition to the standards of this Chapter, streets shall also conform to the provisions of Chapter 17.

9.2 Arterial and Collector Plans

- A. Conformity:** The street layout in any development shall conform to the arrangement, width and location of public streets indicated on the regulating Arterial and Collector plans for the area. (*See Arterial Map, Appendix A; Collector Map, Appendix B*). Whenever a tract of land included within any proposed development plan embraces any part of the arterial or collector systems as designated on the Town Arterial or Collector plans, the development shall be required to dedicate and plat the arterial or collector right-of-way, and shall be responsible for the cost and the installation of the improvements in accordance with the Town's standards for streets.

Developments which embrace only one (1) side of an existing or planned arterial or collector right-of-way will only be required to dedicate and plat additional right-of-way for that portion of street with which the development has frontage, and shall be responsible for the cost and the installation of the improvements in accordance with the Town's standards for streets.

- B. Street Stubs:** New developments are required to stub streets to the outer perimeter boundaries of the development based on the criteria below. If the street in question meets at least two (2) of the criteria, then the street must be built to an appropriate collector street standard.
1. The street intersects directly with an arterial street and provides access to an area with an overall density of ten (10) dwelling units per acre, or provides access to more than 150 dwelling units.
 2. The street by its general configuration, in relationship to the existing development of the area, in effect serves a collector function.
 3. The street extends into an undeveloped area in such a manner as to serve a future collector function.
 4. The street serves as primary access to a significant nonresidential, institutional, or recreational land, as well as, an access to a residential area of 20 or more acres.

- C. Street Design:** New developments that provide new streets that are not identified on the regulating Arterial and Collector plans for the area, but meet any of the following criteria must be built to an appropriate collector street standard.
1. The street intersects directly with an arterial street and provides access to an area with an overall density of ten (10) dwelling units per acre, or provides access to more than 150 dwelling units.
 2. The street by its general configuration, in relationship to the existing development of the area, in effect serves a collector function.
 3. The street extends into an undeveloped area in such a manner as to serve a future collector function.
 4. The street serves as primary access to a significant nonresidential, institutional, or recreational land, as well as, an access to a residential area of 20 or more acres.

9.3 Conformity to Adopted Plans

All site and subdivision plans shall conform to the arrangement, width and location of public transportation elements indicated in appendices A through C as approved by the LURB and adopted by the Town Council as well as meet the requirements of the Long-Range Transportation Plan for the Capital Area Metropolitan Planning Organization (CAMPO) as adopted by the CAMPO Transportation Advisory Committee and the North Carolina Department of Transportation.

Whenever a tract of land included within any proposed development plan embraces any part of the arterial or collector systems as designated on the Town Arterial or Collector plans (*appendices A and B*), the development shall be required to dedicate and plat the arterial or collector right-of-way, and shall be responsible for the cost and the installation of the improvements in accordance with the Town's standards for streets.

Developments which embrace only one (1) side of an existing or planned arterial or collector right-of-way will only be required to dedicate and plat additional right-of-way for that portion of street with which the development has frontage, and shall be responsible for the cost and the installation of the improvements in accordance with the Town's standards for streets.

9.4 Traffic Impact Analysis (TIA)

- A. Purpose:** TIAs are used to evaluate whether or not the scale of development is appropriate for a particular site and what improvements may be necessary, on and off the site, to provide safe and efficient access and traffic flow. It is an essential part of the development review process to assist developers and government agencies in making land use decisions involving annexations, subdivisions, rezoning, special land uses, and other development reviews.

As a specialized study that evaluates the effects of a development's traffic on the surrounding transportation infrastructure, the TIA helps identify where the development may have a significant impact on safety, traffic and transportation operations, and provides a means for the developer and government agencies to mitigate these impacts.

- B. Threshold:** A TIA, meeting the requirements of Section 16.9, is necessary in the following instances:

1. For any proposed rezoning, preliminary subdivision or master plan, if the nature of the proposed rezoning or development is such that the number of trips it can be expected to generate equals or exceeds 150 new peak hour trips; or

2. When the Administrator determines:
 - a. That a new project's traffic will substantially affect an intersection or a roadway segment already identified as operating at a failing level of service (LOS), or
 - b. That a project may create a hazard to public safety, or
 - c. That a project will substantially change the off-site transportation system or connections to it.

9.5 Vehicular Connectivity

Traffic studies have shown that highly connected street networks provide much greater traffic throughput and mobility for a community, at less cost. A high degree of connectivity should occur not only at the level of arterials, but also on collector, local and other secondary roads. Such connectivity vastly improves a street network's performance. The street pattern should not force short trips of one (1) or two (2) miles onto arterials; it should be possible to make trips of this sort by using collector or other secondary streets. With a highly connected street network, cross-town trips should be possible using fairly direct secondary roads.

A. General Street Layout

In general, streets should be designed and located so that they relate to the topography, preserve natural features such as streams and tree growth and provide for adequate public safety and convenience for motorists, cyclists and pedestrians alike. To accomplish this, local public and private streets may incorporate traffic calming devices in conformance with the Town's "Traffic Calming Policy" as most recently adopted by the Town Council.

The proposed street layout shall also be coordinated with the existing street system of the surrounding area. Where a through street or a series of streets establishes a connection between two (2) public streets, such street shall be a public street.

B. Street Classification

The Town shall make the final determination of the classification of streets in a proposed development based on guidance from the Comprehensive Plan. Street classifications are defined in Section 17.3.

C. Street Stubs

1. **Continuation of Adjoining Street Systems:** Vehicular connections from adjacent property (*street stub-outs*) must be utilized unless the Administrator deems the connection impractical due to topographic conditions, environmental constraints, property shape or property accessibility.
2. **New Street Stubs**
 - a. **Development Perimeter and Surrounding Parcels:** New developments are required to stub streets to the outer perimeter boundaries of the development so as to ensure access of surrounding properties to a public right-of-way and in accordance with appendices A and B.
 - i. Whenever connections to existing or proposed streets on adjoining property are required, the street right-of-way shall be extended and the street developed to the property line of the subdivided property (*or to the edge of the remaining undeveloped portion of a single tract*) at the point where the connection to the existing or proposed street is expected.
 - ii. Where land is subdivided into parcels and tracts larger than ordinary building lots, such parcels and tracts shall be arranged in a phasing plan so as to allow for the opening of future streets and logical further subdivision.
 - iii. The Town may require temporary turnarounds to be constructed at the end of such streets pending their extension. Where a temporary turnaround is required that precludes the completion of street right-of-way improvements to the property line, please see Section 17.2B2.

- iv. The Town may require extension of a stub or connection where necessary to permit the convenient movement of traffic between residential neighborhoods or to facilitate access to neighborhoods by emergency service vehicles or for other sufficient reasons.
- b. If the street being stubbed meets at least two (2) of the following criteria, then the street must be built to an appropriate collector street standard:
 - i. The street intersects directly with an arterial street and provides access to an area with an overall density of ten (10) dwelling units per acre, or provides access to more than 150 dwelling units.
 - ii. The street by its general configuration, in relationship to the existing development of the area, in effect serves a collector function.
 - iii. The street extends into an undeveloped area in such a manner as to serve a future collector function.
 - iv. The street serves as primary access to a significant nonresidential, institutional, or recreational land, as well as an access to a residential area of 20 or more acres.

D. Block Length

Maximum block lengths inside proposed developments shall be in accordance with lengths shown in the following table. Short block lengths are intended to create a better pedestrian-scaled environment. The Administrator may allow a deviation from this requirement if it is determined that this requirement is impractical due to topographic conditions, environmental constraints, property shape or property accessibility.

	OSP	RR	GR-3 GR-8	UR-12 RMX	NMX	TC	HB MI
Block Length <i>(Maximum)</i>	n/a	1500 ft	1000 ft	800 ft	660 ft	660 ft	n/a

E. Cul-de-sacs

Permanent cul-de-sac streets and dead-end streets are discouraged in the design of street network systems, and they should only be used when topography, the presence of natural features, and/or vehicular safety factors make a vehicular connection impractical. Where cul-de-sacs or dead-end streets are unavoidable, developments shall incorporate provisions for future vehicular connections to adjacent, undeveloped properties, and to existing adjacent developments where existing connections are poor. No system of multiple branching cul-de-sacs from a single junction with a connected street network is permitted, unless the Administrator deems it allowable due to environmental constraints.

Any permanent dead-end streets or cul-de-sac shall comply with the length limits (*as measured along the street centerline*) shown in the following table, and shall be provided with a turnaround at the closed end of the street as set forth in the Town’s *Standard Specifications and Details Manual*.

	OSP	RR	GR-3 GR-8	UR-12 RMX	NMX	TC	HB MI
Cul-de-Sac Length <i>(Maximum)</i>	n/a	500 ft	300 ft	200 ft	Not Allowed	Not Allowed	n/a

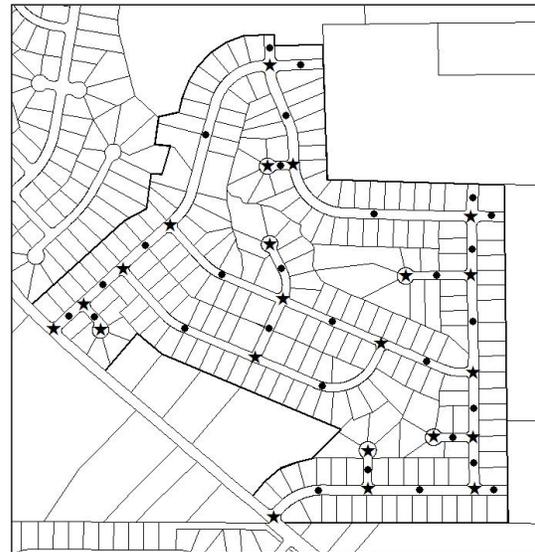
F. Second and Additional Points of Access Required for Residential Developments

At a minimum, a second point of open and functioning vehicular access from the existing public street system (*not a stub-out*) is required for developments that exceed 100 residential units, and a third shall be required for developments that exceed 500 residential units. These second and third points shall be open and functioning prior to the issuance of the 101st and 501st Certificate of Occupancy respectively for the development. The number of further open and functioning vehicular access points shall be controlled and determined by the development’s Town-approved TIA (Section 16.9). If a TIA should establish a higher standard for the number of open and functioning vehicular access points from the existing public street system, the requirement of the TIA shall prevail. The requirements herein shall not preclude a development from also meeting the following connectivity index required in Section 9.4(E). For purposes of this section, a median-divided vehicular access point counts as a single vehicular access point. This section does not preclude developments from connecting to existing street stubs and/or street stub right-of-ways abutting their property.

G. Connectivity Index

A Connectivity Index shall be used to determine the adequacy of street layout design. This is calculated as the ratio of the number of street **links** (*road sections between intersections*) in the project’s street layout divided by the number of street **nodes** (*intersections and cul-de-sac heads*). For comparison purposes, a perfect grid has a Connectivity Index of 2.00 or higher, while a conventional cul-de-sac subdivision is often 1.00 or less.

The accompanying illustration exhibits a connectivity index of 1.32 (*links are shown as circles and nodes are shown as stars*). Street links on existing adjacent streets that are not part of the proposed subdivision are not included in the connectivity index calculation. The illustration has 29 links and 22 nodes for an index of $29 / 22 = 1.32$



Any development shall be required to achieve a Connectivity Index as shown in the following table.

	OSP	RR	GR-3 GR-8	UR-12 RMX	NMX	TC	HB MI
Connectivity Index (Min.)	n/a	1.30	1.40	1.40	1.50	1.60	n/a

Administrator-Awarded Modifications: The Administrator may award reductions to the minimum index value if it is determined that more than 60 percent of any “side” of a development (*four [4] sides total*) faces impracticalities for connectivity to adjacent properties due to the presence of controlled-access highways, railroad rights-of-way, NRBs or existing developments that have not provided street stub-outs for connection purposes. In addition, the Administrator may award bonuses to a development’s index score where pedestrian greenways are provided to link any cul-de-sac to another street or cul-de-sac within the development.

Administrator-Awarded Reductions		Administrator-Awarded Bonuses	
	Value		Value
Controlled-Access Highway, Railroad Right-of-Way or Adjacent Developments with No Street Stub-Outs	- 0.05	Pedestrian Greenway (A minimum of a 20' easement with a 6' path)	+ 0.03
Neuse River Buffer (NRB)	- 0.03		

H. Cross Access

All developments featuring on-site parking lots shall be designed to allow for cross-access to adjacent properties to encourage shared parking (*Section 10.3D(2)*). When cross access is deemed impractical by the Administrator on the basis of severe topography, environmental constraints or vehicular safety factors, the requirement may be deviated from provided that appropriate bicycle and pedestrian connections are provided between adjacent developments or land uses. Development plans shall provide cross-access easement and complete the connection if completing the link can derive an immediate benefit. If no immediate benefit can be derived, development plans shall provide cross access and construction easements and arrange the site design so when the adjoining property owner extends the connection to the property line, the link will be completed. If the link is to be completed in the future, the grade of the connection, parking, landscaping, and other improvements must be set to allow for extension into the adjacent property.

I. Bicycle Amenities

In North Carolina, a bicycle has the legal status of a vehicle and is permitted to operate on any roadway where NC Board of Transportation policy does not expressly prohibit non-motorized vehicles (*i.e. interstates and other fully-controlled, limited access highways*). In addition to the preceding requirements of this Section:

1. Except for Main Street cross-sections with on-street parking (*see Section 17.3A(3)*), bicycle amenities in the form of bike lanes—four (4) feet in width (*excluding curb and gutter*) and five (5) feet when adjacent to on-street parking—or wide outside lanes (*15-foot minimum*) with sharrow pavement markings shall be incorporated in the design of all arterials, collector streets and roads with bicycle routes identified on *Appendix C: Town of Knightdale Bike Route and Greenway Plan*; and
2. Bicycle parking shall be provided according to the requirements established in sections 10.3C and 10.7.



9.6 Pedestrian Circulation & Connectivity

In order for walking to be a viable transportation choice for local trips, circulation routes must be safe, convenient and highly connected. Pedestrian circulation and connectivity should primarily take place adjacent to planned streets within the right-of-way; however, a considerable amount of pedestrian activity also takes place on site, where vehicle speeds are lower but the numbers of potential conflict points are much higher. As such, the following standards shall be met when designing a connected pedestrian circulation system:

- A. All pedestrian walkways shall be designed to comply with the design standards outlined in chapters 10 and 17.
- B. Pedestrian crossings shall be made safer for pedestrians whenever possible by shortening crosswalk distances with roadway designs including, but not limited to, curb extensions, reduced curb radii, and the elimination of free right-turn lanes. Traffic calming devices may only be installed according to the Town’s “Traffic Calming Policy” as most recently adopted by the Town Council.
- C. Pedestrian walkways shall form an on-site circulation system that minimizes the number of points of conflict (*where pedestrian networks and bicycle/vehicle networks intersect*) between pedestrians and vehicles, particularly where pedestrians access on-site parking and building entrances.
- D. Pedestrian walkways shall connect building entrances to one another and from building entrances to public sidewalk connections and existing or planned transit stops.
- E. All developments that contain more than one (1) building shall provide walkways between the principal entrances of the buildings.
- F. Multi-purpose paths, whether required by Appendix C or built to satisfy the recreational requirements of Chapter 7, shall connect to the street system in a safe and convenient manner. These paths should be used to enhance pedestrian and bicycle travel where the existing circulation system does not serve these patrons well.

9.7 Access Management

A. Number of Driveway Access Points

1. Single-Family Residential Lots In General:

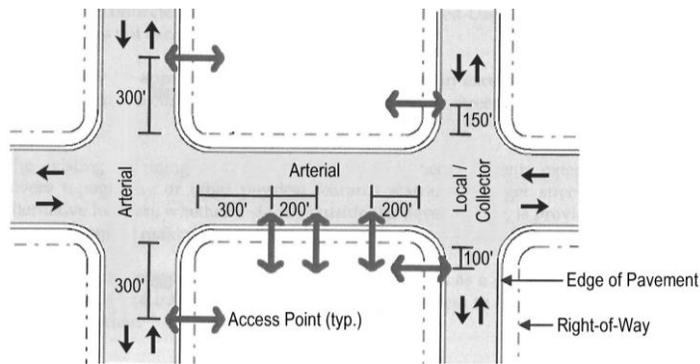
Parcel Frontage	Number of Access Points Allowed
<= 100 ft	1
> 100 ft	2

- 2. **Along Arterials and Collectors:** Developments should minimize or eliminate curb cuts along arterials and collectors. Single Family lots, attached or detached, shall not have access to a collector or arterial street, unless the collector is designed to the modified avenue section to include on-street parking on one-side and a landscaped median divide. In this instance rear loaded alley access is permitted on one side of the street section. Where possible, vehicular access drives should be shared with the adjacent properties and/or alleys should be utilized for access. All lots, parcels, or any other division of land adjacent to an arterial or collector may be allowed driveways or street connections in accordance with the following.

Parcel Frontage	Number of Access Points Allowed
< 500 ft	1
501 – 1200 ft	2
>1200 ft	3

B. Location of Driveway Access Points

- In General:** Except for shared drives, all driveways shall be a minimum of three-and-a-half (3½) feet from the property line.
- Along Arterials:** Location guidelines for driveway access points along arterials are shown in the illustration below in relation to the direction of traffic flow. If access to a lot, parcel, or other lawful division of land is physically unobtainable under the provisions illustrated below, driveway access points shall be located the greatest distance possible from one another and from other streets.



9.8 Median Cross-Over Spacing

In general, if the left turn lane storage requirements for adjacent intersections overlap, the minimum spacing specified below shall be increased to provide adequate left turn lane storage in both directions. Additionally, where the NC DOT Driveway Manual or Median Crossover Guide conflicts, the stricter of the two (2) standards should prevail.

Median Divided Street Type	Minimum Spacing Between Cross-Overs
Arterial	1,200 ft.
Collector / Local	660 ft.