

drainage design so that water does not flow across the roadway or carry soil or sand onto the roadway.

Where stopping sight distance cannot be obtained at any point along the frontage, and alternative access cannot be provided, consider purchasing the access rights or in some cases the entire property. Where this is not feasible, the risk involved in providing the access connection needs to be carefully evaluated. In general, the lower the driveway volume and roadway volume, the lower the risk of a collision. The risk can be addressed by including conditions or limitations on the use of the connection in the access permit, such as the volume of vehicles permitted to use the connection and restrictions on the type of movements allowed (i.e., right in/out only). Further information on permit conditions is provided in Chapter 12.

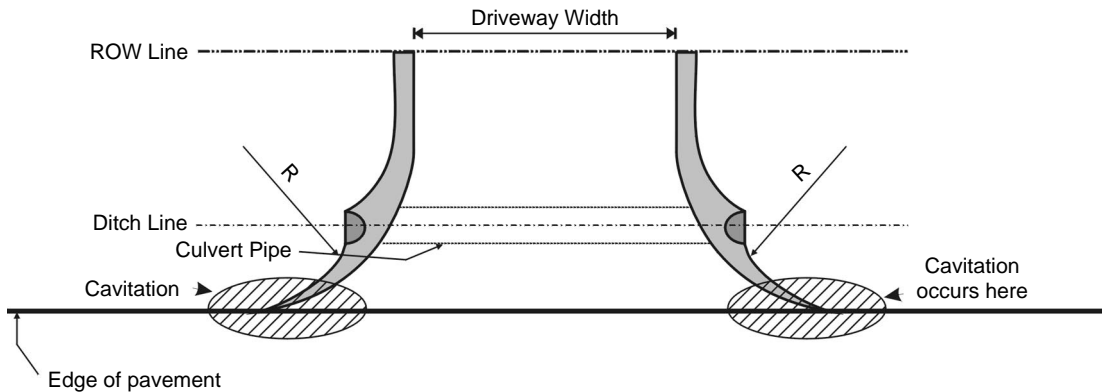
The common rural driveway design, which involves use of a simple radius, results in depressions at the edge of the pavement and the end of the radius as indicated in Figure 10-23 (1, 3). These maintenance and potential safety problems can be eliminated by use of a taper as indicated in Figure 10-24 (1, 3).

ALTERNATIVE ACCESS

Direct property access can be provided via a frontage road, or other service road, to reduce the number of connections to the primary roadway. The longer intersection spacing accomplished with service roads facilitates the use of auxiliary lanes for deceleration and acceleration, thereby improving roadway operations and safety. This also facilitates the design of access connections that can safely handle high driveway volumes as well as improved traffic progression through the signal system.

A frontage road is located near and parallel to the main lanes so that no development occurs between it and the major roadway. Figure 10-25 indicates the various frontage road configurations commonly found along at-grade arterials and freeways. A service road can be either perpendicular or parallel to the major roadway. Parallel service roads are separated so that development can take place between the service road and the major roadway. Figures 10-26, 10-27, and 10-28 present examples of site access provided by supporting roadways.

Figure 10-26 presents an example of a service road in Lee County, Florida, that pro-



Farmstead or Single Residence	
W (width)	24 ft (7.3 m)
R (radius)	20 ft (6.1 m)

All Other Connections		
	Autos and Light Trucks	Commercial, Heavy Truck
W, single-lane exit	30 ft (9.2 m)	35 ft (10.7 m)
W, 2-lane exit	42 ft (12.9 m)	47 ft (14.3 m)
R	30 ft (9.2 m)	40 ft (12 m)

FIGURE 10-23 Common rural driveway design. ROW = right-of-way.

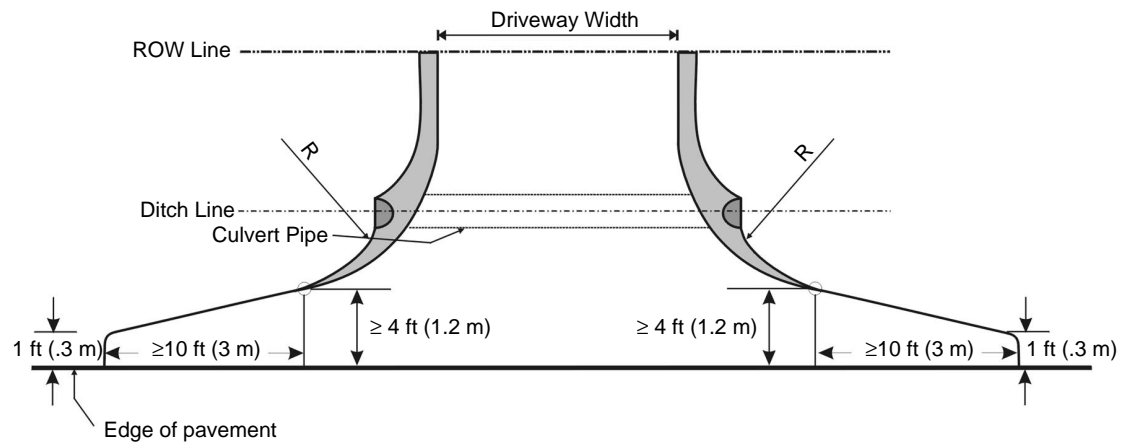
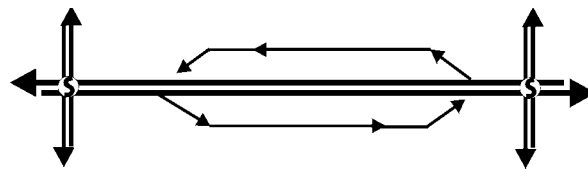
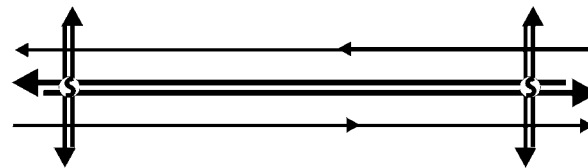


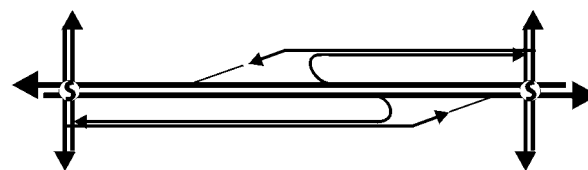
FIGURE 10-24 Example of a design for driveways on rural roads (1).
ROW = right-of-way.



One-Way Between Intersections



One-Way Continuous



Two-Way Between Intersections



Two-Way Continuous

Ⓢ Indicates traffic signal

FIGURE 10-25 Frontage road arrangements (5).



FIGURE 10-26 Access to businesses provided by a public road.



FIGURE 10-27 Access to businesses provided by an on-site circulation roadway.



FIGURE 10-28 Service road perpendicular to the major roadway.

vides access to a bank, an office building, and three restaurants, two of which serve primarily a tourist clientele. The service road is a public street. Signalized access to an arterial (lower right) is shared with a shopping center. Signal spacing on the major arterial (along the left side of the photo) is 1/2 mi. A connection between the major arterial and the service road is provided at the 1/4-mi point; connection to the major arterial is by right turns only.

Figure 10-27 presents an example of a service road that is part of the site development and is not a public street (Denver, Colorado). The outparcels between the service road and the major arterial, such as the fast-food restaurant in the center of the photograph, do not have access to the abutting public streets. Access is via the site circulation roadway that is shared with the adjacent shopping center.

Figure 10-28 presents an example of a service road that is perpendicular to the major public roadway. The development is located at an interchange with I-75 near Punta Gorda, Florida. Service stations, restaurants, and a motel obtain access via this service road. The large loop at the end of the service road is a turnaround for large vehicles.

Connecting a frontage road in close proximity to the intersection of the crossroad and main lanes results in a complex intersection, as indicated in Figures 10-29 and 10-30. Such arrangements can present serious safety and operational problems, even when traffic volumes are low. The complex pattern of movements cannot be efficiently signalized and capacity is very low.

One-way frontage roads offer safety and operational advantages over two-way frontage roads. This is because one-way operation reduces the number and complexity of vehicular and pedestrian conflict points at the intersection with crossroads, simplifies signal operation, and greatly increases capacity over two-way operation. Two-way frontage roads may be appropriate when the abutting development will be limited in both the length of frontage and the volume of traffic and when intersecting roads are widely spaced.

Guidelines for Frontage and Service Roads

NCHRP 348 (14) and *NCHRP 420 (5)* set forth the following guidelines for planning and designing frontage roads and service roads:

1. Frontage roads have been observed to function successfully when they serve low-density trip generation activities such as residential and small office areas.
2. Frontage roads for retrofit situations should operate one way and should enter and leave the main lanes as merging and diverging maneuvers (5).
3. Experience has shown that when a large separation is provided between the intersection of the major road and the crossroad, and the intersection of the crossroad and the frontage road, the minimum separation is suitable only where frontage road volumes will be very low (5). *NCHRP Report 348 (14)* and *NCHRP Report 420 (5)* indicate that, on a two-way frontage road,

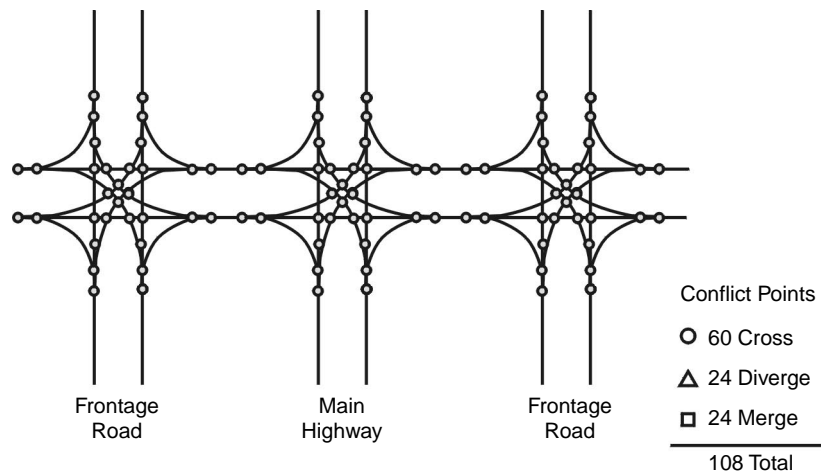


FIGURE 10-29 Complex pattern of conflict points that results when a frontage road is located close to the major roadway (5).



FIGURE 10-30 Confusing intersection where frontage road connects too close to a major side street.

a separation of at least 300 ft (preferably more) is necessary for efficient and safe operation and that the absolute minimum is 150 ft.

4. A landscaped buffer between the major roadway and the frontage road will help avoid driver confusion while improving roadway aesthetics. *NCHRP Report 420 (5)* suggests a minimum buffer width of 25 ft.

5. The reverse frontage design (Figures 10-31 and 10-32) results in a separation that allows the intersection of the frontage road and the crossroad to operate with little or no adverse effect on the intersection of the major road with the crossroad.

6. Pedestrian and bicycle traffic can be accommodated along the frontage road.

7. Parking on the frontage road may be permitted in residential areas (5).

Shared Access and Interparcel Circulation

Shared access and interparcel circulation (also called joint and cross access) can be readily implemented in the subdivision and site plan approval process if the local agency adopts the appropriate ordinances, policies, and procedures as discussed in Chapters 4 and 7. Reconstruction projects also offer opportunities for encouraging shared access.

Extension of the reciprocal easement to, or beyond, the first on-site intersection, as indicated in Figure 10-33, ensures that users of both properties will have full use of the shared connection. Extension of the easement at least 15 ft (4.6 m) on either side of the edge of the access connection, as indicated in Figure 10-34, allows for an on-site design that will accommodate a 90° right turn by a passenger car.

SUMMARY

The chapter sets forth key objectives to be addressed in the design of access connections. Considerations in ensuring adequate visibility of a connection to drivers, including the appropriate location, signing, and lighting, are also addressed. The benefit of auxiliary lanes in reducing speed differentials is discussed as well as the causal relationship between speed differentials and crash rates and the fact that typical driveway throat widths and return radii appear to do little to reduce speed differentials.

The first step in access design is to identify the intended operation of a specific connection: (a) Is it acceptable for a passenger car to wait in the traffic lane if an exiting vehicle is present in the driveway? (b) Is simultaneous exit and entry by passenger



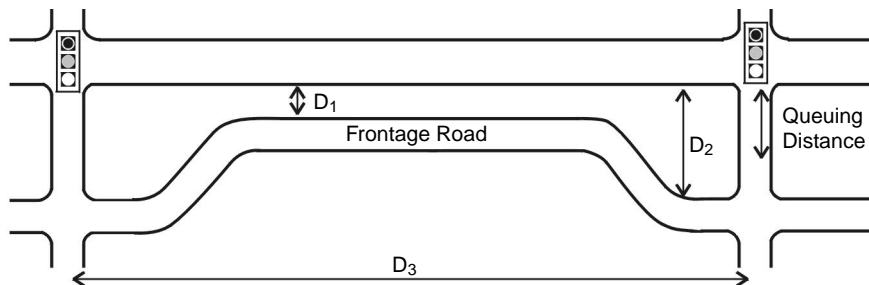
FIGURE 10-31 Frontage roads in residential or light office areas can work well where they are one way and begin and end between major crossroads.

cars desired? (c) Is simultaneous entry and exit by trucks, buses, or other large vehicles desired? Additionally, the interdependence of driveway throat width and return radii is discussed. Examples of throat width and return radius that provide similar operation are provided as well as sample throat lengths and widths for unsignalized and signalized access connections.

Another consideration in access design is the importance of providing a smooth transition between the roadway and the site. Examples are provided of the change in grade

between the pavement cross slope and driveway apron for an appropriate transition as well as driveway profiles for urban (curbed) and rural (open ditch) areas that illustrate the use of vertical curves to provide smooth transitions.

Alternatives to direct access to major roadways are presented. These include (a) frontage roads, (b) service roads where the separation from the major roadway permits development between the service road and the major roadway, and (c) a supporting circulation system where access is provided as part of the site development. Finally, examples of the geom-



- D₁ = Minimum midblock separation ≥ 25 ft
- D₂ = Minimum separation at intersection ≥ 150 ft minimum
 ≥ 300 ft preferred
- D₃ = Signalized intersection spacing

FIGURE 10-32 Minimum separation between a frontage road and the major roadway (5).

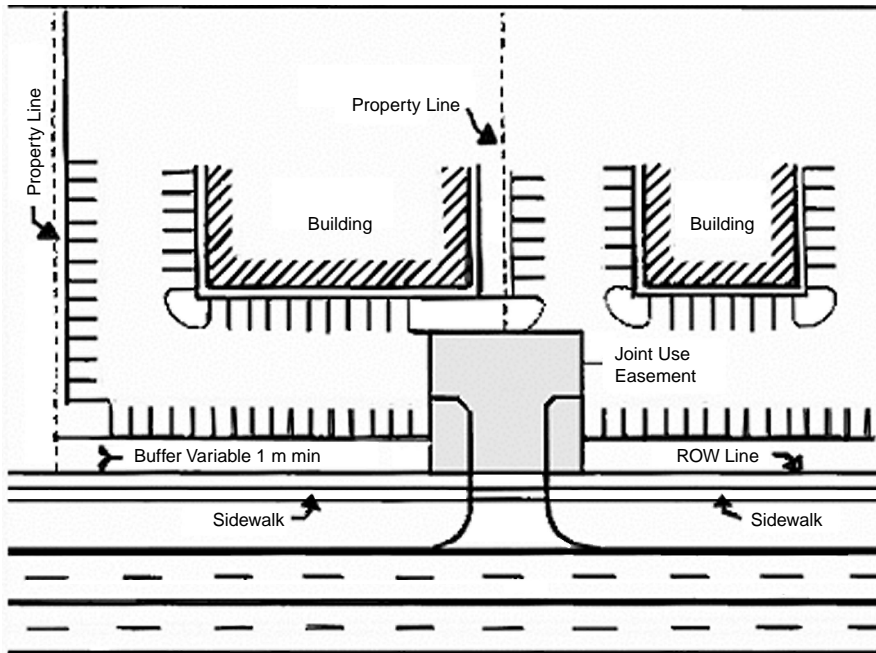


FIGURE 10-33 Schematic of shared access for a small commercial development (3). ROW = right-of-way.

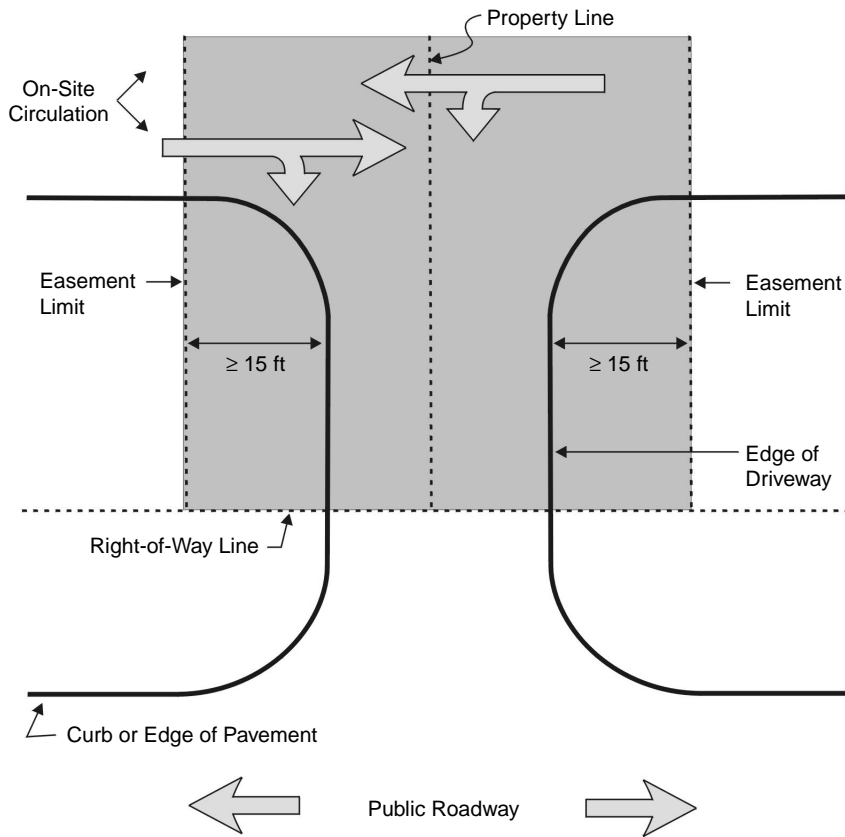


FIGURE 10-34 Typical easement width for shared access drives (1).