1.0 General Policy

STH connections shall follow the requirements for the specific design elements listed in Trans 231. The Secretary or his/her designee may approve exceptions to these requirements under Trans 231.01(5). 09-10-20, 3.0, 7d This section provides guidance on many design elements, including those not listed in Trans 231, and has been developed from the sources listed below:

1. Access *Management Manual*, Transportation Research Board
2. *A Policy on Geometric Design of Highways and Streets*, American Association of State Highway Transportation Officials ("Green Book")
3. *Facilities Development Manual*, WisDOT ("FDM")
4. *Construction and Materials Manual*, WisDOT

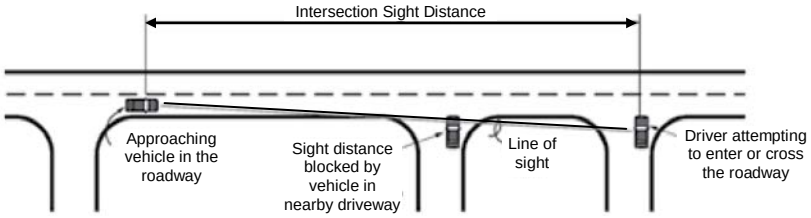
All of the necessary STH connection design information shall be documented on form DT1247 *STH Connection Design Checklist* and/or any additional plans or sketches as needed, and shall be included with the permit.

2.0 Design Elements for Local and Private Roads

STH connections involving local roads, or private roads and driveways serving multiple properties that act as local roads, shall follow the intersection design guidance listed in FDM 11-25-1. Private roads and driveways serving multiple properties shall, as a minimum, conform to Town road standards as listed in Wis. Stat. s. 82.50 In addition, review the design elements listed in sections 3.0 – 13.0 as appropriate for each STH connection permit application.

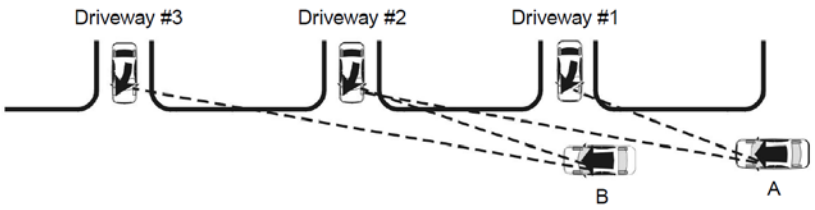
3.0 Intersection Sight Distance / Vision Corners

Follow the guidance in FDM 11-10-5.1 when evaluating driveways and road/street connections for intersection sight distance (ISD) and vision corner requirements. Spacing may be a concern if it could affect ISD as shown below.



4.0 Spacing

Follow the guidance in FDM 11-5-5.3 when evaluating STH connections for spacing requirements. Additional guidance from TRB's Access Management Manual may also be used if needed. For example, when evaluating spacing and attempting to provide ISD for driveways, spacing may be affected by overlapping right-turn maneuvers as shown below.



5.0 Configuration

Some driveways may need highway modifications in the form of separate left and/or right turn lanes, a left turn bypass lane, raised medians or median openings, islands, etc., to provide for the safe and efficient movement of traffic on the STH and the driveway. These modifications are based on many factors, but primarily driveway AADT and its use. If a traffic impact analysis is involved, these modifications are identified in the document. Use the following table as a guide to determine a proper driveway configuration:

DRIVEWAY CONFIGURATION GUIDELINES			
#	**Driveway AADT**	**Typical Uses**	**Recommendation Configuration**
1	>1000	▪ Large commercial or industrial	**Rural**: Type A intersection*; evaluate for left turn lane or left turn lane bypass **Urban**: Design as intersection
2	100 - 1000	▪ Medium commercial or industrial ▪ Multiple residential (>10 dwelling units)	**Rural**: Type B intersection*; evaluate for left turn lane or left turn lane bypass **Urban**: Design as intersection
3	50 - 99	▪ Small commercial ▪ Small industrial ▪ Multiple residential (5-10 dwelling units)	**Rural**: Type C or D intersection*, or 20'-35' wide with a 40' max radius
4	1 - 49	▪ Residential units ▪ Shared residential (1-4 dwelling units)	16'-24' wide with a 10' minimum radius
5	<10 trips (Intermittent)	▪ Agricultural ▪ Hunting land ▪ Field entrance ▪ Recreational use	16'-24' wide with a 10' minimum radius. Field entrances may be 35' wide with a 40' max radius
6	Non-automobile	▪ Bicycle trail ▪ ATV trail ▪ Snowmobile trail ▪ Pedestrian trail	Construction varies. May be limited to non-automobile and/or non-motorized traffic

* Exceeds Trans 231 requirements 09-10-20, 3.0.Intersection design is in FDM 11-25-1

6.0 Grades and Profiles

The change in grade between a highway cross-slope and a driveway apron slope is important for achieving a smooth transition. An abrupt change in grade will likely cause a vehicle bumper to drag on the highway and/or driveway surface. Drivers may then make a driveway turn at a wide angle instead of a sharp one, which may slow down highway traffic. Vertical curves are also used to provide a smoother transition between changes in grade on the driveway profile.

FDM 11-15-1, Attachment 1.14 provides guidance on profiles for rural driveways, including maximum grades. The low point for rural driveway profiles is generally over the roadside ditch.

FDM 11-20-10, Attachment 10.1 provides guidance on profiles for urban driveways, including maximum grades and maximum break-over angles. Where a sidewalk crosses a driveway, the sidewalk cross-slope shall be 2%. The low point of the profile for many urban residential driveways will be at the gutter line of the street. However, the low point for urban driveway profiles can vary, depending on the storm water management for the property.

7.0 Foreslopes

Driveway and side road intersection embankment slopes could be impacted at right angles by errant vehicles leaving the highway. Flatter slopes are desirable at these locations because steeper slopes can cause a vehicle's bumper to dig in, or cause a vehicle to vault.

In FDM 11-15-1, a foreslope of 6:1 or flatter shall be provided on driveways and side road intersections within the clear zone[1] of highways with AADT of 3,500 or more, and is recommended for all driveways and side road intersections regardless of AADT. For highways with an AADT of less than 3,500, the maximum connection foreslope that may be allowed in the clear zone is 4:1. Outside the clear zone, the steepest foreslope shall be 2½:1. Culvert end treatments, which have similar clear zone requirements, are detailed in 9.5

8.0 Throat Width, Driveway Return Radius, and Throat Length

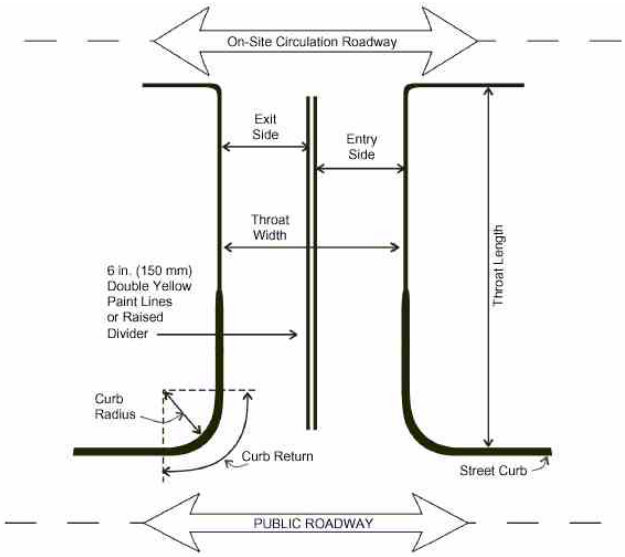
Throat width (Figure 8.1) is the edge-to-edge distance of a driveway measured at the right-of-way line.[2] The maximum width of any commercial driveway is limited to 35 feet under Trans 231. The width of residential driveways is limited to between 16 and 24 feet. The maximum width requirements may be exceeded in special cases, for example, to accommodate wide farm machinery. In many cases, a field entrance may have a 35-foot width.

A driveway return radius is a circular pavement transition at the entrance of a driveway that facilitates turning movements.[3] All driveways shall have sufficient radii to allow vehicles to safely make turns when entering and exiting a STH. The maximum radius allowed for a driveway is 40 feet.

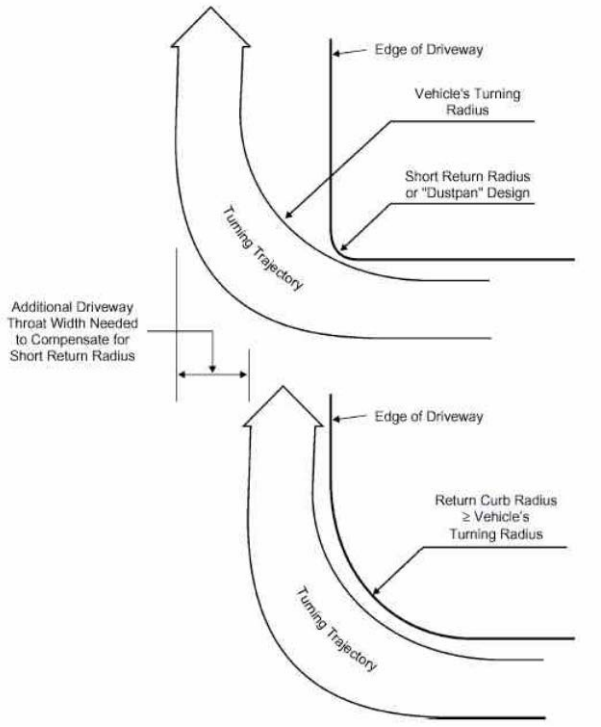
Throat width and driveway return radii are interdependent, for example, a longer radius permits the use of a narrower throat.[4] If a radius is less than the minimum inside turning radius of a vehicle, then drivers are displaced to the left in the driveway throat when completing the entry maneuver (Figure 8.2).

Throat length is the distance parallel to the centerline of a driveway to the first on-site location at which a driver can make a right or left turn. It is measured on highways with curb and gutter from the face of the curb, and on highways without curb and gutter from the edge of the shoulder.[5] The throat length for any driveway must be sufficient to prevent traffic from backing up onto a STH. Guidelines for throat lengths can be found in the *TRB Access Management Manual*, pages 181-186.

[6]Figure 8.1: Driveway Elements



[7]Figure 8.2: Effect of curb return radius on driveway entry maneuver



[1] See FDM 11-15-1.10 for a detailed explanation of clear zone.
[2] TRB Access Management Manual, Glossary, page 528
[3] TRB Access Management Manual, Glossary, page 524
[4] TRB Access Management Manual, pages 310-312
[5] TRB Access Management Manual, Glossary, page 528
[6] TRB Access Management Manual, Figure 13-23, page 308
[7] TRB Access Management Manual, Figure 13-25, page 310

9.0 Drainage

In the interest of maintaining highway safety and operability, a STH connection may not block or impair drainage of the ROW, which includes the highway ditches and roadside areas. Culvert pipes (culverts), where necessary, shall be adequate for surface water drainage along the ROW. Specific guidelines regarding culverts for STH connections are listed below. Consult the Bureau of Structures if a box culvert is required for a driveway.

9.1 Culvert Size

A hydraulic (drainage) study shall be done to properly size the culvert opening for all connections, unless WisDOT determines that the opening can be sized by matching the opening of an upstream culvert. This assumes no additional water is being placed in STH ditches and that upstream and downstream culverts are functioning properly. Hydraulic design of culverts is in FDM 13-15-10. A 25-year storm frequency shall be used as a minimum for a side pipe (connection) culvert design.

The minimum culvert size that should be allowed is 18" in diameter. This is slightly larger than the 15" diameter allowed in Trans 231.03(5) because the smaller pipe size tends to become clogged easier and frequently creates maintenance problems. A culvert is not required when the STH connection is at the high point of a roadside ditch profile. A culvert may not be required in cases where ditch grades are nearly flat and drainage is allowed to occur naturally through the soil.

9.2 Culvert Material

Culvert types that may be used under a connection include: Reinforced concrete (recommended for heavy truck traffic), corrugated steel, corrugated aluminum and corrugated polyethylene. Reinforced concrete box culverts may also be used if necessary. More information on culvert pipe selection is in FDM 13-1-15. All culverts shall be from a WisDOT-approved manufacturer.

9.3 Culvert Length

The length of a culvert will vary depending on the connection width, side slopes and ditch depth. WisDOT staff shall either check the applicant's calculation or perform one for the applicant to ensure that a proper length will be installed. Use the minimum length of pipe necessary to span a driveway plus allow for appropriate endwalls since a longer pipe may get clogged easier and frequently creates maintenance problems. In addition, the flattened area adjacent to the driveway invites the possibility for illegal use.

9.4 Culvert Placement

Culvert pipes shall be placed as far from the main roadway as possible while still following the flow line of the roadside ditch. Significant earthwork for the placement of driveway culvert pipes should be avoided. However, if earthwork is needed that modifies the cross section of the main roadway, then that earthwork shall conform to applicable WisDOT design and construction standards.

9.5 Culvert End Treatments

Culvert end treatments include apron endwalls and safety crossbars. All culverts shall have apron endwalls. Vertical endwalls are not allowed for safety reasons. Safety crossbars are required on all apron endwalls larger than 24" in diameter within the clear zone. Use the table to determine apron endwall slope.

Annual Average Daily Traffic	**Steepest Apron Endwall Slope**	
	Within Clear Zone	Outside Clear Zone
0 - 3500	6:1 *recommended* 4:1 acceptable	2½:1
3500 or more	6:1	2½:1

Endwalls shall conform to the applicable WisDOT Standard Detail Drawing from FDM Chapter 16:

- 8F1: Apron Endwalls for Culvert Pipe
- 8F2: Apron Endwalls for Pipe Arch and Elliptical Pipe
- 8F7: Steel Apron Endwalls for Culvert Pipe and Pipe Arch Slopped Side Drains

9.6 Handling Drainage Problems

Property owners, municipalities, and permitted organizations shall maintain their STH connections, which includes preventing the blockage or impairment of right-of-way drainage. Existing connections with culverts should be checked periodically to make sure they are cleaned-out and functioning at optimum capacity. Existing connections without culverts should also be checked to determine if they are creating ponding in the right-of-way ditches. In case of any problems with right-of-way drainage, WisDOT may require the owner to correct the problem at his/her own expense.

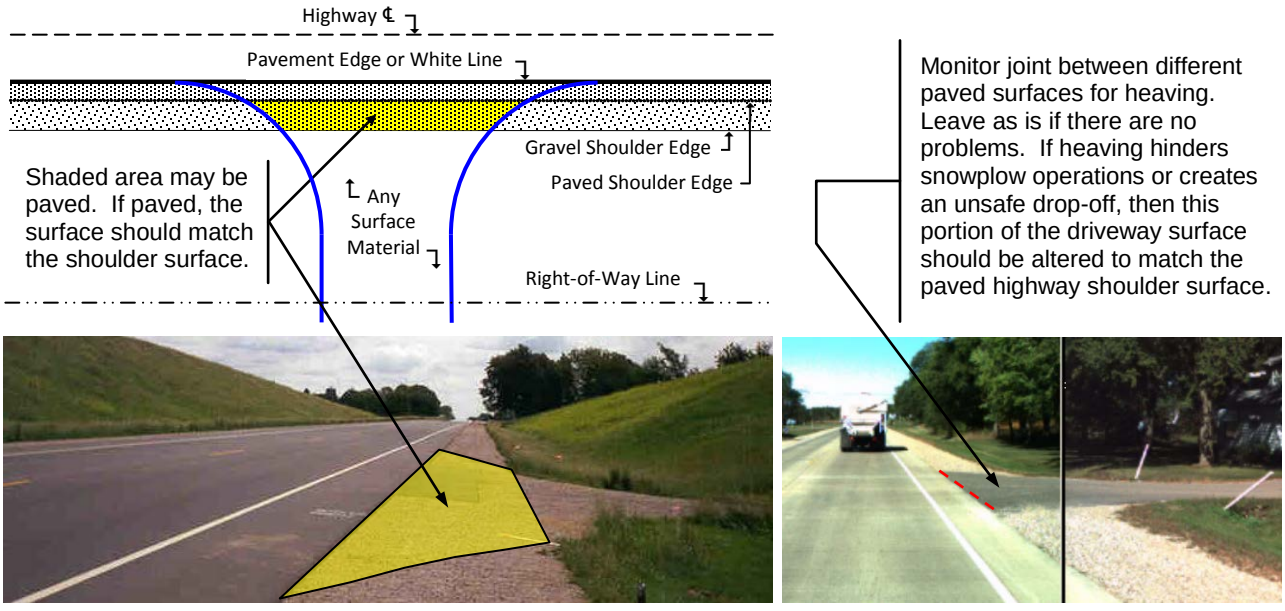
For those connections that do not have culverts in which problems with right-of-way drainage blockage or impairment is occurring, WisDOT shall require the property owner to install a culvert or remove the connection. If the connection is unpermitted, then issue a DT1504, *unless it has a nonconforming status and will remain that way, then issue a DT1812 for the work.* If the connection has an existing permit, then amend it, or reissue it and void and supersede the old one.

10.0 Surface Material

Most driveways are constructed with a surface material of asphalt, concrete, gravel, or earth. If paved, the driveway surface within the STH shoulder boundaries should be the same surface as the STH's paved shoulder (if present) or the pavement (if there are no paved shoulders). A property owner may use any surface material up to the gravel shoulder edge (figure 30-3).

WisDOT is obligated to replace the materials in kind when reconstructing the driveway within the ROW during an improvement project under FDM 11-15-1.15. When a property owner requests to construct a specialized or ornate driveway surface such as brick paving – one that typically costs more than what WisDOT would spend to restore a typical asphalt or concrete surface – a special provision should be placed in a permit that requires the owner to pay the cost differential between the typical and specialized surfaces each time WisDOT must reconstruct the driveway or a portion thereof for an improvement project.

Figure 30-3: RURAL CONNECTION SURFACE PAVEMENT DETAIL



11.0 Traffic Signals

In most cases, driveways will not be signalized. Those driveway applications requesting traffic signals must meet traffic warrants for them. The regional traffic engineer shall determine if the applicant's request for signals is merited. If signals are warranted, the regional traffic engineer shall also determine the necessary design, timing, and configuration of the signals. TGM 4-2-1

12.0 Traffic Control Devices

Traffic control devices such as stop and yield signs are not the responsibility of WisDOT. Property owners who desire to install such signs may do so on their own property and at their own expense. Under s. 346.18(4), drivers must yield before entering a highway when coming from an alley, driveway, or private road.

13.0 Design Restrictions

WisDOT may restrict the design of a driveway in order to protect and preserve the safety and operability of a STH. These restrictions are typically included with a STH connection permit in the form of conditions, supplemental provisions, etc. A list of these conditions is in 09-10-25, 2.0. In addition to these restrictions, WisDOT does not allow the following:

- Unique, non-standard, or homemade signs (photos below). Even though they are sometimes used on local roads at the discretion of the maintaining authority, they are not appropriate for STHs. In section 2C.14 of the Federal Manual of Uniform Traffic Control Devices, a "Hill Blocks View" sign may be used when there is limited stopping sight distance. TGM 2-3-14 provides additional guidance on when the sign may be used.

- Speed zone reductions, which are based solely on a particular STH connection or spot location. Speed limits are typically established with an engineering speed study using the 85th percentile speed. This is the speed below which 85% of all vehicles travel, and above which 15% travels. Speed advisory plaques, however, may be appropriate in certain situations.

- Any special device (for example, mirrors, television cameras, pavement sensors, etc.) that is intended to assist or substitute for the normal viewing of oncoming vehicles while entering or exiting from a STH connection.