10.2.7 Developed Area and Large Volume Exceptions

Developed environments present more complicated safety design challenges than rural environments. The Regional Landscape Architect should be consulted for input on many of the design decisions. The most significant problem is the limited right of way. The cost of the developed real estate adjoining urban highways frequently makes expansion of the right of way economically prohibitive. The successive expansions of the highway system to meet increasing demand has resulted in many highways where the available right of way cannot accommodate the roadway and a clear zone. Because of the restrictions on reasonably available right of way, exceptions to the desired clear zone widths identified in Section 10.2.1 have been established for urban areas. While the clear zone widths selected in developed areas may have to be reduced for both practical and liability reasons, the designer should still strive to provide as much clear area as possible in those situations where vehicles may be expected to need that clear area. The effective clear area can be maximized by clustering the fixed objects (longitudinal placement) and by placing fixed objects as far from traffic as is practical.

Where vertical faced curbs are provided, the width of the clear zone should provide a minimum of 0.5 m from the face of curb to any utility pole, hydrant, or other obstacle. The primary purpose of this offset is to permit passenger doors to be opened when cars stop next to the curb. As such, the 0.5 m is primarily for convenience, rather than safety. The preferred minimum offset is 0.9 m. At curbed corners where long trucks are more likely to encroach, the minimum clear zone distance from the curb face to obstructions should be 0.9 m. For uncurbed streets, the minimum offset from edge of traveled way to obstructions should be 1.2 m. (Note that Chapter 2 of this manual requires a 0.5 m lateral clearance from the edge of traveled way to obstructions as a safety-related shy distance.)

While, in rural areas, attention may be focused primarily on protecting the motorist from the roadside, in populated areas, consideration must also be given to protecting pedestrians and bicyclists from errant vehicles. (Refer to Chapter 18 for guidance on bicycle and pedestrian safety accommodation.) Vertical faced curbs should generally be provided wherever pedestrians regularly travel along the roadside, provided it is not a high-speed highway. The designer should note that vertical faced curb has little rediverse capacity and is primarily provided to discourage the mingling of vehicular and pedestrian traffic. Barriers should be considered where areas of assembly, particularly playgrounds, schools and parks, are across "T" intersections, outside of sharp curves, and at locations with a history of run-off-road accidents. Special consideration should be given to urban school zones. Guide rail should be considered both to protect children from errant vehicles and to direct pedestrians to designated crossing zones.

Barriers should also be considered to shield features that, if impacted by an errant vehicle, could produce a catastrophe for the community, such as flammable or noxious gas storage facilities. Conversely, to guard against gas tanker or heavy-truck accidents, extra strength barriers should be considered on the approaches to overpasses that have heavy population concentrations below. Consideration may also be given to installing a barrier to shield structures which have been struck at sites having a history of run-off-road accidents.
On principal arterials, consideration should be given to providing pedestrian overpasses. These overpasses should be enclosed to inhibit or prevent objects from being thrown into traffic. Refer to Chapter 18 of this manual and Chapter IV of AASHTO's *A Policy on Geometric Design of Highways and Streets*, 1994, for a discussion of pedestrian overpasses and screening.

The roadways to be considered in this section will be broken into five categories for the convenience of discussion. Those categories are: Urban Freeways, Urban Arterials, Local Urban Streets, Suburban Roads, and Camp Areas.

10.2.7.1 Urban Freeways

Urban freeways differ from rural freeways primarily in the volume of traffic handled. In some instances, the urban freeways may also be faced with much tighter right of way constraints. Because the reduced right of way limits the amount of space available for clear zone development, the designer must resort to an increased use of roadside barriers. Where space permits, preference should still be given to providing the clear zone widths determined in accordance with Section 10.2.1.

Because of the large volume of traffic using the urban freeways, durability of the barrier system is a concern. Preference should be given to systems that will tend to remain in service after being struck. On large volume roads, repair crews are at risk and inadvertently create a hazardous condition for motorists. Because its impact durability is so poor, cable guide rail should not be installed on urban freeways with AADTs in excess of 5000 vehicles per lane per day. Box beam guide rails are more durable, but may also require frequent remounting. The offset from the traveled way and the anticipated frequency of impacts are factors that should be considered in the selection process. Where frequent impacts are anticipated, the recommended barriers for large volume urban freeways are the heavy-post blocked-out W-beam and concrete barriers. Furthermore, where truck and large vehicle traffic is permitted, consideration should be given to using extra height concrete barriers in narrow medians. (Refer to Section 10.2.4.9 C.) In general, with the exception of fiber optics facilities owned by transportation corporations, the longitudinal use of freeways and interstates by utilities will not be allowed.

10.2.7.2 Urban Arterials

Urban arterials, as indicated in Chapter 2 of this manual, often carry large traffic volumes within and through urban areas. Traffic speeds are generally lower than on freeways and access is only partially limited. Urban arterials tend to have too many signalized intersections and cross-median access points to warrant regular use of barriers. Guide rail should be provided for major drop-off hazards such as approach ramps to overpasses or bridges. Where the operating speeds are 80 km/h or greater, median barriers will frequently be warranted to prevent crossover accidents. (See Section 10.2.4.) At lower speeds, curbing may be provided instead of barriers. Because curbing may contribute to loss of control, it should generally be avoided where wide, obstacle-free medians or shoulders are possible. Wherever sidewalks are provided...
for pedestrian access, however, curbing should be provided.

While landscaped arterials are popular, walled planters and other structures that present hazards should not be permitted within clear zone distances. Flush planting areas should be used instead of raised beds. Trees will grow beyond a diameter of 100 mm and will become fixed objects. Therefore, they should usually be planted beyond the clear zone. Particularly near intersections and on horizontal curves, the landscaping should not interfere with the recommended sight distance.

On arterials, ditches should be eliminated in favor of a closed drainage system. (Note that, in some situations, there may be a conflict between potential safety benefits of a closed drainage system and the environmental benefits of water infiltration from open systems. The conflict is less relevant where soils have low permeability or ditch grades are steep. The Regional Environmental Contact and the Regional Landscape Architect should be consulted for water quality implications, including SPDES permit compliance.) Utility facilities should also be placed underground or above-ground facilities moved beyond the clear zone. The designer should consult the Regional Utilities Engineer (RUE), and Title 17 of NYCRR, Part 131 of the Highway Law, Accommodation of Utilities Within State Highway Right of way to determine the influence of current utility policy on this aspect of roadside safety.

10.2.7.3 Local Urban Streets

Local urban streets, especially in downtown areas, usually have frequent signalized intersections, typically at the end of each block. Frequently, buildings are close to the road. The roadside usually is curbed and has sidewalks from the curb to the buildings. Many downtown streets permit curbside parking. Where parking is permitted, errant vehicles will usually not reach the roadside. The speed limit is typically in the range of 50 km/h. Because of the generally low operating speeds, few roadside design concerns apply to downtown streets.

Large shade trees are popular and seldom present serious fixed hazard problems. On some streets, however, large tree trunks may impair sight distances. Due to the potential hazard of falling limbs, dead, diseased, and dangerous trees are to be considered for complete or partial removal.

The main needs for barrier design are for drop-offs and for median features, such as bridge piers, traffic control masts, and pedestrian islands. In addition to the impact attenuators discussed previously in Section 10.2.6, Hydrocell Clusters may be considered as a special application. The Hydrocell Cluster is appropriate for locations where there is inadequate space ahead of the hazard to permit placement of a larger attenuator system. Use of Hydrocell Clusters should be reviewed by DQAB.
10.2.7.4 Suburban Roads

Some of the most significant roadside safety challenges are presented by suburban roadsides. This category of exceptions recognizes an important type of roadside condition not well covered by AASHTO’s Functional Classification of Highways. The suburban environment represents a transition between urban and rural conditions. Often there is no clear demarcation between rural and suburban or between urban and suburban conditions. Safety treatments should consider, and be based on, the operating characteristics in the area, rather than routinely using urban guidelines. The designer should maintain standard lane and shoulder width and full clear zone widths (including traversability of ditches) as far into the suburban area as is reasonable. The suburban roadside environment is typically well established and less flexible than a rural environment, limiting the practically available space for clear zones and forcing the designer to consistently make safety concessions to the many preexisting constraints. These roads are bordered by numerous residences, other abutting property access points and intersections. In a typical situation, the residences are separated from the road by a ditch which is crossed by driveways. The ditch drainage is carried under the driveways by a pipe which may have a headwall constructed around it. Vehicles which leave the roadway are likely to be directed along the ditch to an abrupt stop at the pipe.

Many of the residences are landscaped with large trees close to the road. The landscaping may include large raised planters, decorative rock walls and rail fences. Mail boxes may have been encased in masonry to resist vandalism. Businesses are likely to have signs close to the road, sometimes in large planters. Utility poles are commonly present close to the roadway.

On many of the suburban roads, the operating speeds exceed 70 km/h. In addition to relatively high traffic volumes, pedestrians, bicyclists, and often delivery and mass transit vehicles, may have unrestricted access. As noted in Section 10.2.7 above, protection for pedestrians from possible errant vehicles may be prudent. As stated in Section 10.2.2.4, curbing has limited redirective capacity. Consequently, rather than providing only a 0.5 m clear area behind the curb, a broader clear area, more reflective of the off-peak operating speed, should be strived for. In higher speed suburban areas, serious consideration should be given to providing a shoulder, rather than just a curb offset. In general, curbs should only be introduced where warranted, such as for drainage or access control, delineation, or where there are sidewalks. Refer to Chapter 3, Section 3.2.9 of this manual.

A. Longitudinal Drainage Features and Transverse Embankments

Research has shown that vehicle control is much easier to maintain if the slopes on transverse embankments do not exceed 1:6. Several commercially available drain pipe end sections have been developed to match this slope. Various bar or pipe grate systems are available to allow vehicles to ride up over the end sections. On reconstruction projects where errant vehicles have a high probability of being directed into a limited number of end sections, consideration should be given to installation of grated 1:6 end sections.
Where possible, the ditch cross-section should be smoothed to permit vehicles to recover sufficiently to avoid end sections.

If space is available, the drain pipe may be set back from the ditch line beyond the path of vehicles trapped in the ditch and the portion of the embankment crossing the ditch line may be graded to 1:6 slopes.

Rather than providing two separate pipes for driveways in close proximity, a single pipe could be used to eliminate two end sections.

The safest treatment, however, is to eliminate all of the end sections and transverse embankments by installing a closed storm drainage system. The high cost of this measure may warrant a benefit-cost analysis. Note also the potential SPDES conflict discussed in Section 10.2.7.2.

B. Landscaping Features

Some roadside “landscaping” done by property owners may unintentionally produce potential hazards that may be difficult to deal with due to people’s personal association with them. Shade trees, walls, and decorative stones or boulders in front or side lawns may carry personal attachments that involved considerable forethought, time, money, and personal effort on the part of the property owner. Mail boxes, particularly those with special landscaping or atypical support and decoration, may become potential hazards. Mail box placement is subject to both Department and U.S. Postal Service regulations. (The latter may be obtained at most local Post Offices.) Refer to Section 10.5.1 for a discussion of mail boxes.

Potentially hazardous features on private property can only be moved or removed with the consent of the property owner or the purchase of the necessary piece of property with the feature on it. The latter action requires a significant effort, time, money, and, usually, an actual accident history. (Dead, dying, or otherwise impaired trees that have a potential for falling on the road can, of course, be removed without consent or purchase of property. Refer to Section 45 of the Highway Law.)

Potentially hazardous features within the Department's right of way are usually less difficult to move or remove. Notice must be given to the property owner that an encroachment exists and must be removed from the Department's property. A business sign or small hedge may be fairly easy to relocate; a large tree or a part of a structure is not. The more difficult it is to remove or relocate a feature, the more resistant a property owner may be. Refer to Section 10.5.6 for a discussion of public relations issues regarding hazardous feature removal on Department right of way.
C. Utility Poles

Because of the long lead times required for utility relocations, the need for relocations should be addressed during the scoping process.

The Department's official policy on utilities and their impact on roadside design is found in Title 17 of NYCRR, Part 131, *Accommodation of Utilities Within State Highway Right of way*. The following information is subordinate to Part 131 and Chapter 13 of this manual.

The Department's policy is that utility poles are not allowed to be located within the guide rail deflection distance or within a Department-designated clear zone. Relocation of utility poles from those locations will contribute to significantly improved roadside safety.

Utility pole accident histories, including, but not limited to, the periodically issued "Bad Actor" list (poles that have been involved in several crashes) should be reviewed and used in connection with the determination of the clear zone.

Relocating utility poles should not be required if numerous other similar hazards, such as trees, are to be left at similar or smaller offsets from the roadway. Utility poles located within the clear zone should be treated the same as other potential roadside hazards and evaluated according to the hierarchy of treatment options discussed in Section 10.2.1.2. and Chapter 13 of this manual.

If relocations are planned, the designer should consult with the Regional Utility Engineer (RUE) to determine the current rules for the accommodation of utilities within State highway right of way and should start liaison with the Utility. The RUE, or the designer with the RUE's oversight, should negotiate the details of a form HC 140-Utility Work Agreement along with any other required agreements. All Agreements should be submitted as early as possible to facilitate proper coordination with DOT's final design. Refer to Chapter 13 of this manual for additional details of the utility relocation procedures.

With regard to clear zone documentation, if, in their final location, utility poles are the closest hazards to the traveled way, they will generally set the clear zone width. In some situations, however, an isolated pole may be documented as an exception to an otherwise wider clear zone. Note that as much additional clear area as is practical should be provided behind a line of utility poles, provided there is no conflict with the Department's landscaping objectives. (While the defined clear zone may end at the poles, an errant vehicle may miss the poles and should be provided with as much additional deceleration distance as is practical.)
10.2.7.5 Camp (Seasonal Residence) Areas

While camp areas, such as those alongside many lakes, are a small part of the overall roadside environment, they have generated a significant enough number of queries to warrant special coverage. While this section will refer to camp areas, the guidance should also be considered as applying to other areas with similar conditions.

Camp-type areas present significant challenges for barrier design. Access breaks are required at short intervals for driveway openings and walkways. Right of way is usually very tight. Fixed objects are numerous and close to the traveled way. The adjoining terrain is often steep. Water hazards are often accessible. Alignments are often quite curved to follow terrain. Seasonal traffic volumes may be relatively high and operating speeds are often within the high-speed category. Typically, cable is not used because of its large deflection distance and the length needed to develop its lateral strength. Both cable and W-beam would be expensive due to the many anchor blocks that would be required for the frequent openings. W-beam also takes a significant length to be effective and is considered a poor aesthetic choice for camp areas. By default, box beam is generally the preferred barrier choice.

When it is decided to provide shielding by installing box beam guide rail, none of the three terminal options are without problems. The following information addresses the problems with each of the terminals in turn and then offers suggestions as to when it might be appropriate to select a given system.

**Type I Terminals:** With its abrupt 1 on 2 turned down end, the Type I end section should never be installed parallel to traffic. An essentially end-on impact would have four possible outcomes, which might occur in combination. One outcome would be unfavorable. The other three would, most likely, be quite unfavorable. Although unlikely, the vehicle might ride up on to the rail and then roll sideways off of it. The vehicle could be launched into the air, resulting in a subsequent impact with a fixed object or a rollover. The vehicle could fail the weld at the turndown, causing the box beam to spear into the passenger compartment. The vehicle might stop abruptly on impacting the terminal. Because of the above, Type I ends should only be installed where the end can be flared away from the road.

Type I terminals are designed to be installed so that all normal impacts will be side impacts. Vehicles that hit the end at a high angle will cause the terminal and adjoining rail to yield laterally as a cantilever, thereby minimizing the severity of the impact. If the errant vehicle bends the rail aside and passes beyond, any subsequent impact will be less severe due to the energy that was absorbed in bending the rail. Provided the ends are flared away, short runs of guide rail (less than the normally recommended minimum of 38 m) may be used if it is judged appropriate. In this instance, redirection is not assumed, only some amount of attenuation.

**Type II Terminals:** The Type II terminal was specifically designed for those situations where it was not reasonable to flare the end of a box beam away from the road. Its gradual ramping and weak vertical support ensure that there is little risk of impact (in the sense of
abrupt deceleration). The terminal is designed to shed vehicles over the terminal or up onto the rail. The disadvantages of this approach are that there is a longer area in which the rail system does not offer effective shielding of potential hazards beyond the line of the rail. This becomes particularly problematic in camp areas where frequent openings are required. Additionally, vehicles that ramp up onto the rail may roll off laterally or, at high enough impact speeds, may even be launched into the air. In either case, the resulting rollover accidents tend to be severe.

Type III Terminals: The Type III is designed to be an energy-absorbing terminal. It consists of a face plate on the leading end of a normal-height guide rail which includes a section of a larger-than-normal box beam that telescopes around the regular box beam. When the end is struck longitudinally, the telescoping action causes the crushing of a pair of sacrificial fiberglass pipes inside of the box beams. The crushing action produces the energy absorption. One of the limitations of the Type III is that it must have a completely straight alignment for the first 15 m to permit the telescoping to take place. If Type III terminals were applied on each end, their length alone, absent any other rail, would require minimum runs of 30 m. Also, the extensive grading required (often around 50 m³) does not lend itself to this terrain or type of development.

The Type III is a relatively expensive terminal with typical costs estimated at over $3000. The large face plate, larger tube, and breakaway hardware make it the most visually obtrusive of the three box beam terminals. The large face plate should be flared away from the roadway by at least 0.6 m to avoid the significant problems that would result if it were struck by a snow plow.

The standards for installation of Type III terminals are intended to maximize safety for roadside conditions that are normally associated with interstate highways. They presume that the prevailing clear zone is broad and readily traversable. They, therefore, require that any installation have a clear area behind the rail that runs for 23 m along the rail and 6 m back from the rail. These requirements are unrealistic in most camp areas and, if held to, would provide a spot treatment significantly safer than what would normally be found in adjoining unshielded areas. While designers should always strive to provide clear areas adjacent to highways, failure to provide that recommended clear area behind a Type III will not cause the Type III to malfunction. Any inability to provide the recommended clear area behind a Type III terminal should not be seen as preventing its use in camp-type situations. The objective should be to provide a terminal that is not a hazard in itself. While vehicles that strike the end of a Type III terminal (includes the rail back to the third post) are likely to pass on to the area behind the rail, this is essentially no better or worse than what would happen with either a Type I or Type II installation.

Type 0 Terminals: Although not officially designated as such, there is an end treatment for box beam that should be called the Type 0 terminal. It is shown in the middle of Standard Sheet M606-3 and consists simply of running the box beam back until it contacts a back slope. This should be the preferred end treatment when there is a relatively steep back slope in close proximity to the line of the rail. In camp situations, the Type 0 terminals would be appropriate on the high side of the road at locations where box beam was needed to
shield features such as incised watercourses cutting down the hillside.

A. When to Use Box Beam in Camp Areas

Before deciding what type of end sections to use, the question of whether or not to even use guide rail should be resolved. It should not be an automatic assumption that guide rail should be provided wherever possible, just because there are fixed objects near the road. The following questions should be considered.

1. Is there a history of ROR accidents that is significant enough to warrant the installation of barrier? Unless the number and severity indicate a need, the expense may not be justifiable.

2. Are there specific problem locations where there is either a history or the likelihood of ROR accidents? Suspect areas include the outside of blind or unexpected curves, areas with hidden driveways, curves at the bottom of ice-prone down grades, etc.

3. Are there areas where the consequences of leaving the road are unusually severe? There are many locations where a vehicle that skids off the road would impact a tree. Drivers who survive the initial impact without major trauma would likely survive the accident. On the other hand, if a vehicle rolls over on a steep slope and submerges in water, even a mildly injured rider would likely drown. It would, therefore, be appropriate to provide shielding where errant vehicles would be likely to reach bodies of water.

4. Are there areas where people adjoining the highway will need protection from the errant vehicles? While many camps will have trees between them and the road, some may not. Certainly, if the adjoining property owners wish to have shielding, that should be taken into consideration.

5. Will the installation of guide rail make the roadside significantly safer? If the driveways are relatively closely spaced, the percentage of the roadside length that will actually be effectively shielded will remain quite low. Most of the length will consist of driveway openings and end sections that are not capable of redirecting vehicles. Only a small part of the roadside will be shielded by the redirecting portion of rail between the terminals.

In light of the above considerations, the most likely places to warrant box beam guide rail in camp-type settings will be where lengths of over 40 m can be installed on the outside of curves, at common accident locations, and where an errant vehicle could be expected to reach a body of water. Additional use is left to the designer’s engineering judgement.
B. Terminal Selection for Box Beam Guide Rail in Camp Areas

If it is judged that a run of box beam guide rail should be installed, the following are recommended guidelines for selection of the terminal type.

Type I terminals should be used whenever the terminal can be satisfactorily flared enough so that near-longitudinal impacts on the ends are unlikely. The combination of the flare angle and the vehicle's divergence angle should result in a combined impact angle that is at least 45° greater than an in-line hit.

If the available ROW does not permit flaring the terminal enough to use a Type I, then either a Type III or a Type II should be considered. If the curvature of the road requires use of curved rail, a Type III can not be used and a Type II should be used.

If the available ROW does not permit flaring the terminal enough to use a Type I and there is not a relatively level (1 on 5) slope behind the terminal and there is not at least a 4 m wide clear area behind the terminal, then a Type II terminal should be used. In this case, the Type III would offer little advantage over a Type II due to the narrow clear area and the potential for either to contribute to rollovers on the slope. The significantly greater cost of the Type III terminal would not be warranted by any slight difference between the safety performance of the two terminals.

The Type III terminal should be used when there is not enough availableROW to flare back a Type I end, but there is at least 6 m of clear area behind the rail, the slope is 1 on 4 or flatter, and the rail and terminal can be installed along a straight line at least 30 m long.

The "Type 0" should be used when a back slope is in close proximity.

Designers should form their own evaluations of site-specific conditions and use their own engineering judgement to determine the shielding that they judge appropriate for each situation.

10.2.7.6 Hydrant Fenders

Hydrant fenders are similar to bollards and are placed beside hydrants with the intent of preventing vehicles from striking the hydrants. They should only be placed in an urban setting behind a parking lane, within or adjacent to parking areas, or in similar settings where they will not be directly accessible to errant high-speed vehicles.