To: SUPERSEDED BY EB 10-021 EFFECTIVE 1/6/11		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 07-023

Title: **Revised Median Width Warrants for Use of Median Barrier**

Distribution:		Approved:
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ADMINISTRATIVE INFORMATION:

- Effective Date: This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of January 10, 2008.
- Superseded Issuances: This EI supersedes Engineering Bulletin 06-052.
- Disposition of Issued Materials: This guidance will be incorporated into a subsequent revision of Highway Design Manual Chapter 10.
- Other superseded: This EI supersedes the width warrant guidance currently contained in the Highway Design Manual (HDM), Chapter 10, Roadside Design, Guide Rail, and Appurtenances, Section 10.2.4.

PURPOSE:

The purpose of this EI is to convey revised guidance for designers on the widths of traversable median that warrant the use of median barrier or guide rail.

TECHNICAL INFORMATION:

On divided, high-speed highways with traffic volumes over 20,000 AADT, barriers in medians are warranted when the median is traversable and its width is 50 ft or less. Barrier use on wider medians should be strongly considered, particularly where there is a history of median cross-over collisions.

The designer has wide latitude when selecting the type(s) of barrier and its location within the median. Guidance on selection and location is included in the Appendix to this Engineering Instruction. The designer should strive to select a median barrier or guide rail type and location which will reach an optimal balance in minimizing the number and severity of collisions, life cycle and installation costs, and environmental impacts. Barrier type and location should be considered together since one will affect the other. Designers should also note that type selection may need to be coordinated with Park or Parkway agencies and/or the Office of Parks, Recreation, and Historic Preservation in accordance with applicable portions of the National Historic Preservation Act - Section 106, the NYS Historic Preservation Act of 1980 (http://nysparks.state.ny.us/shpo/environ/preservation.htm) 14.09 Programmatic Agreements, or with Department guidelines (such as the Guidelines for the Adirondack Park).

IMPLEMENTATION: This guidance is effective for all new, reconstruction, 3R, and 2R projects with letting dates on or after January 10, 2008. Designers are encouraged to apply this to earlier projects where it is convenient to do so. While the cost impact may be noticeable on some projects, the overall statewide cost impact of this implementation will be relatively low, as there is only a small percentage of

the state's highway mileage that meets these criteria and is not already protected with median barrier or guide rail. Stand-alone median barrier projects are not required, but the guidance of this EI should be applied to projects being undertaken for other reasons.

No specifications are disapproved or issued by this EI.

TRANSMITTED MATERIALS: None

BACKGROUND: The 4/19/02 revision of the Highway Design Manual includes, in Section 10.2.4, a warrant for median barrier on freeways and expressways with high-speed, high-volume traffic and traversable medians less than 11 m (36 ft) wide. Based on this guidance, New York State has experienced a very low rate of median crossover fatalities on wide medians, typically only about one to three such crashes per year.

Elsewhere, other states have noticed large increases in the number of such fatalities on their highways. As a result, AASHTO revised its guidance width warrant for median barrier, moving the lower limit of the "barrier optional" range from 30 ft up to 50 ft, and recommending that barrier should be considered for traversable medians with widths up to 50 ft, unless a cost-benefit analysis indicates otherwise. The guidance changes issued by this EI are intended to ensure that NYSDOT's width warrant meets or exceeds the revised AASHTO recommendations. Because of the technical, legal, and long-term documentation complications that would be created by making the warrant conditional upon the results of a cost analysis, that option will be discouraged.

The Department recognizes that a small number of tragic cross-over accidents will continue to occur on wider medians in New York State. While the number of cross-median accidents is quite small compared to other types of fatal accidents, their occurrence is often sufficiently sensational, disquieting to the public, and disruptive to the Department to justify making more than ordinary efforts to prevent them. Therefore, similar to AASHTO's allowance for using barriers on traversable medians wider than 50 ft, NYSDOT encourages their use for widths over 50 ft and strongly encourages their use where there is a history of cross-median crashes with widths over 50 ft.

CONTACT: For further information or interpretation of this Engineering Instruction, contact Terry Hale thale@dot.state.ny.us in the Design Quality Assurance Bureau at (518) 485-7009.

EI 07-023, Appendix A
Median Barrier Selection and Placement Guidance

Barrier Selection Considerations: Barrier options include: generic cable median barrier, proprietary cable median barriers, W-beam median barriers, box beam median barrier, and concrete median barriers. The discussion that follows pertains specifically to the use of barriers on wide traversable medians. In general, it will not be appropriate to use roadside barriers on both sides of such a median, as it would deprive both directions of travel of the opportunity to stop in a median without striking any barrier. The use of roadside guide rail on both sides could result in a large increase in the number of vehicle-barrier collisions and require frequent repairs.

Generic cable median barrier is generally held to be effective on slopes as steep as 1:6.

Advantages of cable median barrier;

- Cable has the ability to snare large trucks and bring them to a stop, while beam-type barriers are often pushed down by large trucks which then pass right over them.
- Generic cable is the least expensive option when only the cost of the barrier is considered.
- Can be reliable on steeper slopes than other barrier types.

Disadvantages of cable median barrier;

- Cable is a "tender" system as it needs to be retensioned after every hit.
- Cable can have a relatively large deflection, requiring that it be located well away from both directions of traffic. A minimum offset of 12 ft is recommended.
- Current cable barriers have had problems with underride of vehicles with low front end geometries, especially when the vehicles have their suspension systems compressed when bottoming out in a median barrier. The proposed fixes involve placing the bottom cable so low that normal mowers will not be able to get under that cable, essentially standardizing the use of a vegetation control strip to prevent tree growth.

Proprietary cable median barrier is generally held to be effective on slopes no steeper than 1:9. Note, however, that some systems have received approval for use on steeper slopes, and competitors are pursuing similar approvals.

Advantages of proprietary cable median barrier;

- For systems that use it, pre-stretching of the cable reduces the potential for long term sag and the maintenance effort for retensioning.
- The pretensioning and the high tension that the cable is installed under increase the likelihood that the cable will remain effective after most typical impacts.

Disadvantages of proprietary cable median barrier;

- Closer post spacing then generic cable median barrier.
- Price varies and has not yet stabilized, but the system will generally be significantly more costly than the generic.
- Residencies would need to stockpile several additional types of extra parts and special tools would have to be purchased.

NOTE: Vehicles crossing a median invert typically experience a compression of their suspension system. This has sometimes resulted in vehicles with low front ends passing under the cables. For cable barriers with bottom cables higher than 15 inches, placement between four and ten feet from a median invert should be avoided whenever practical.

W-beam median barrier can be either weak post or heavy post blocked-out (HPBO) median barrier. In general, the HPBO is preferred. W-beam median barrier is generally held to be effective on slopes limited to 1:10 or flatter.

Advantages of W-beam median barrier;

- When HPBO is struck and the posts lean back a bit, the struck rail is actually raised slightly, as the blockout tilts up as the rail tilts back. This tends to keep the HPBO rail at an effective height for longer than it is with weak post.

Disadvantages of W-beam median barrier;

- W-beam is more likely to tear apart when struck than any of the other barriers.
- The risk of vehicles getting past a W-beam barrier is increased by the tendency of the W-beam to flatten out when struck. A flattened surface on a tilted-back rail can act as a ramp over the barrier.
- Weak post is much less likely to retain a heavy errant vehicle. The posts are easily bent, which may act to pull the rail downwards.
- Since W-beam is only considered reliable when placed on or above slopes of 1:10 or flatter, significant median earthwork may be required.
- Weak post W-beam is more expensive than cable. Heavy post W-beam is nearly as expensive as box beam.

Box beam median barrier is generally held to be effective on slopes limited to 1:10 or flatter.

Advantages of box beam median barrier;

- Box beam median barrier has a tough rail system that seldom snaps.
- Box beam median barrier is a weak post system which provides some give when struck by passenger vehicles.
- Box beam has more beam strength than W-beam, so it has more of a tendency to engage a vehicle, permitting the box to lock into the vehicle, even as the rail separates from the posts.

Disadvantages of box beam median barrier;

- When struck by heavy vehicles, there is a tendency for the posts to be bent over, pulling the rail down and permitting the heavy vehicle to pass over the system.
- Since box beam is only considered reliable when placed on or above slopes of 1:10 or flatter, significant median earthwork may be required.
- Generally the most expensive steel barrier option listed here.

Concrete barrier is generally held to be effective on slopes limited to 1:12.

Advantages of concrete barrier;

- Concrete barrier is the most effective at redirecting large vehicles and, the taller the barrier, the more effective it will be.
- When installed where hits are frequent, the infrequent need for repairs may soon pay for the barrier in terms of reduced maintenance costs.

Disadvantages of concrete barrier;

- Concrete barriers are distinctly the most expensive option when only installation cost is considered.
- The impact forces resulting from a collision with concrete barrier are severe, making it the least forgiving for occupants of typical passenger vehicles.

Considerations for the use of concrete barrier: An impact with a concrete barrier is a very destabilizing event, especially for a small vehicle, so it is important that no features be included that would be likely to increase the potential for destabilization, as a rollover accident could result and these are usually severe. Features to avoid in this regard are curbs and unpaved ground that could become rutted or soft. Another concern with concrete median barriers is the potential for high angle impacts which could be very severe. A significant percentage of out-of-control vehicles are curving away from the roadway, increasing their potential angle of impact as they get farther from the road. To avoid these problems, concrete barriers should be kept at the edge of the paved shoulder. On wider medians, this will minimize impact angles on the near side, while allowing deceleration on the far side.

Placement Considerations: Median barriers may be placed near the edge of a shoulder, on a side slope, or near the center of the median. Each location has advantages and disadvantages to take into account.

Shoulder placement allows a barrier to be placed without the need to do any grading work in the median. Any barrier used, however, must have a deflection distance that will not extend into opposing traffic. One drawback to placing a barrier inside of the shoulder break is that it increases the chance that a vehicle that has crossed the median will vault the barrier, particularly if it has retained a lot of speed. Under these circumstances, a vehicle speeding up the embankment will lose contact with the ground as it passes over the shoulder break. It will then strike high up on the back of a barrier that is at the shoulder and will have a significantly increased chance of passing over the barrier.

For concrete median barrier, a concern mentioned earlier was that the barrier be placed close to traffic to minimize the potential for high-angle impacts. Placing a concrete barrier at the edge of one shoulder means that the opposite side of the barrier is well removed from the opposite direction of traffic. In this instance, that situation is considered acceptable, because the wide median provides an opportunity for the vehicle to slow or redirect, whereas a vehicle that strikes the back of the barrier with a lot of energy would have struck opposing traffic if the barrier had not been present.

Slope placement will generally only be acceptable when the maximum slope is 1:6 in the case of generic cable, 1:9 for proprietary cable, and 1:10 for box beam or W-beam. The key issue to consider is the likely height of the bumper of a vehicle when it arrives at the barrier. Any abrupt change between the slope of the pavement and the embankment slope increases the chance that the bumper of a speeding vehicle will be high relative to the rail, increasing the chance of vaulting. In many instances, slope placement will mean that regrading must be done to level the median. This is likely to require retrofitting to inlet structures and introduces SPDES issues.

Invert placement will increase the likelihood of interference with drainage systems, either because posts may be driven near pipes, or because the posts may accumulate waterborne debris. Another issue is that of under-ride. A vehicle crossing the median is likely to have its suspension system compressed as it hits a broad, relatively level invert. If so, the bumper is likely to be low, increasing the likelihood that an aerodynamic vehicle with a low front end will slip under a cable or box beam rail. However, for wide medians, a vehicle has a fairly good width within which to brake and the contact with the posts should help to slow the vehicle. Additionally, if the grade change at the invert is significant, the vehicle is likely to bottom out, which should contribute to slowing it. If the "invert" of the median involves only very gradual slopes, then the placement should be referred to as

"central", the location may be moved slightly to avoid any buried drainage system, and the concerns of under-ride will be minimized.

Terminal placement may limit the types of terminals that can be used. If an end will be exposed as a leading end to oncoming traffic and within the clear zone for that direction of traffic, the end should have an NCHRP350-compliant design. If the end can be offset beyond the clear zone distance for approaching traffic, a compliant terminal is not required, though it is preferred.

Rather than placing long runs that could prevent cross median access for emergency response vehicles, breaks should be provided with lapped, but offset, terminal placement so that subsequent ends are mutually shielding, yet separated far enough to permit vehicles to maneuver through the gap.

Application of Engineering Judgment: Because of the many factors involved, no firm rules are being applied to barrier selection and location. Designers should use engineering judgment and consideration of the above factors to determine whether, what, and where to use median barrier on wide traversable medians. Similarly, judgment should be applied to the determination of whether or not a median is traversable. Traversable, as used herein, implies that a vehicle that enters the median on one side will have a significant chance of entering the opposing traffic.