Trees and Highway Safety

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The Caltrans Division of Research and Innovation (DRI) receives and evaluates numerous research problem statements for funding every year. DRI conducts Preliminary Investigations on these problem statements to better scope and prioritize the proposed research in light of existing credible work on the topics nationally and internationally. Online and print sources for Preliminary Investigations include the National Cooperative Highway Research Program (NCHRP) and other Transportation Research Board (TRB) programs, the American Association of State Highway and Transportation Officials (AASHTO), the research and practices of other transportation agencies, and related academic and industry research. The views and conclusions in cited works, while generally peer reviewed or published by authoritative sources, may not be accepted without qualification by all experts in the field.

Executive Summary

Background

To minimize the severity of run-off-road collisions of vehicles with trees, departments of transportation (DOTs) commonly establish clear zones for trees and other fixed objects. Caltrans' clear zone on freeways is 30 feet minimum (40 feet preferred) from the edge of travel way to a fixed object. Clear zone distances on conventional highways vary depending on conditions such as road geometry and design speeds.

California's current setback standards are based on studies that are decades old and on roadways with traffic volumes and speeds that are significantly lower than today's California freeways. While there is a considerable body of new transportation research focused on the safety of trees on urban main streets and rural highways, there appears to be a knowledge gap on the safety of trees on controlled access freeways and conventional highways.

Caltrans staff requested a Preliminary Investigation to identify state of practice in setting clear zones on freeways and conventional highways in the United States to provide guidance on the safety of using trees and other fixed objects and to find examples of mitigation measures being used to reduce the severity of roadside tree collisions.

Summary of Findings

We gathered information in four topic areas related to setting clear zones on freeways and conventional highways:

- National Guidance.
- Related Research.
- Online Resources.
- State Survey Responses—DOT Setback Standards for Roadways and Medians.

Following is a summary of findings by topic area.

National Guidance

In this section we detail the American Association of State Highway and Transportation Officials (AASHTO) and the National Cooperative Highway Research Program (NCHRP) guidance on clear zones and fixed-object collisions. Highlights include:

- AASHTO generally recommends a 30- to 32-foot clear zone for flat, level terrain adjacent to a straight section of a 60 mph highway with an average daily traffic of 6,000 vehicles. For steeper slopes on a 70 mph roadway, the clear zone range increases to 38 to 46 feet. These numbers are not considered to be controlling, and AASHTO encourages exercising judgment on a case-by-case basis that takes into account the crash history of a road.

- There has long been some confusion about differing clear zone standards in various AASHTO guides as well as the difference between "clear zone" and "horizontal clearance." AASHTO's Technical Committee on Roadside Safety has initiated a project to address this confusion and revise the Green Book and Roadside Design Guide. NCHRP also provided new guidance for urban clear zones (Report 612, 2008).
- NCHRP provides guidance in a number of documents about treatments for preventing run-off-road collisions with trees and utility poles.

Related Research

- Several studies recommend varying clear zone width by roadway curvature and slope severity.
- One study (*The Influence of Highway Clear Zone Width on Roadside Collision Characteristics*) shows that collision rates can be reduced by more than 60 percent by extending clear zones beyond 32 feet.
- Another study (*Parkways and Freeways: Safety Performance Linked to Corridor Landscape Type*) shows that contrary to conventional wisdom, parkways—with grassed shoulders and medians with trees and other landscape elements within 30 feet—had had significantly fewer fatal accidents per 100 million vehicle miles traveled than freeways. While the authors do not speculate on causes contributing to this difference, some urban and suburban studies have shown that trees can help define the roadway spatial edge, increase driver perceptions of safety and reduce driving speeds. (See *The Street Tree Effect and Driver Safety* and *Landscape Design in the Clear Zone: The Effect of Landscape Variables on Pedestrian Health and Driver Safety*.) Further, trees may be used with designs in ways that mitigate the effects of run-off-road accidents (*Trees and Roadside Safety in U.S. Urban Settings*).
- We have included various other urban and suburban studies for the potential relevance of some findings to highways and freeways.

Online Resources

- The Federal Highway Administration's (FHWA's) Safety web site includes links to clear zone resources.
- We identified two other web sites that compile case studies on clear zones and tree safety.

State Survey Responses—DOT Setback Standards for Roadways and Medians

- We contacted state DOTs concerning their current clear zone standards and received 27 responses. States typically use AASHTO guidelines to set clear zones on high-speed-limit freeways and highways at 30 feet or more, with more variation in urban areas.
- Maria Ruppe of Ohio DOT provided a spreadsheet of her own efforts to compile state practices for urban clear zones. (See "Details and Links" for the Ohio entry in **State Survey Responses—DOT Setback Standards for Roadways and Medians**, and **Appendix A** for the spreadsheet.) This spreadsheet provides detailed information for some states on clear zones in urban areas.

Gaps in Findings

Currently there is more research available on clear zones in urban and suburban arterials than in conventional highways and controlled access freeways, and forthcoming updates to AASHTO guidelines are concentrated on urban environments. We were also able to find only limited international guidance.

Our state survey showed that most states rely on AASHTO guidelines for setback standards, sometimes with modifications that have developed over time based on state experience but not supported by explicit research or available documentation.

Finally, as the Texas Transportation Institute notes (see *Criteria for High Design Speed Facilities*), current AASHTO guidelines for a 30-foot clear zone are "somewhat arbitrary" and based on crash studies with relatively flat roadsides. Further, "relationships between various vehicle, roadway, and roadside variables and lateral extent of encroachment have not been fully established. The use of crash data for determining the statistics on the extent of lateral movement of vehicles encroaching onto the roadside is limited because the lateral extent of encroachment in roadside crashes is controlled by the lateral offset of the object struck." The institute recommends computer simulations to develop the relationships between encroachment parameters required to develop more accurate clear zone guidance for high-speed highways.

Next Steps

Caltrans should consider:

- Following up with the AASHTO Geometric and Roadside Design committees considering the status and expected content of revisions to the Green Book and Roadside Design Guide.
- Contacting Maria Ruppe of Ohio DOT, who is involved in efforts to compile information about state practices concerning clear zones in urban areas.
- Following up with the Texas Transportation Institute (see *Criteria for High Design Speed Facilities*), which is the only organization we found that focused on using quantitative methods (including computer simulations) for establishing clear zones on highways and freeways.

National Guidance

We highlight below reports recently issued by FHWA and NCHRP with guidance related to clear zones and fixed-object collisions.

Clear Zone and Horizontal Clearance Frequently Asked Questions, March 2007.
http://www.fhwa.dot.gov/programadmin/clearzone.cfm
Clear zones are not governed by an AASHTO controlling criterion requiring a formal design exception when the adopted minimum value is not met on a project. When the list of these criteria was developed by AASHTO in 1985, "clear zone" was considered to be synonymous with "horizontal clearance." Following adoption of the Roadside Design Guide in 1990, it was decided that clear zone not be defined by a fixed, nationally applicable value. The various numbers in the guide associated with clear zones are not considered as exact but as ranges of values within which judgment should be exercised in making design decisions. The FHWA believes that a consistent design approach, guided by past crash history and a cost-effectiveness analysis, is the most responsible method to determine appropriate clear zone width.

AASHTO Design Guides

AASHTO guidance relevant to clear zones is contained within the following publications:

- **Roadside Design Guide**, AASHTO, Chapter 10, 2006.
  http://www.sddot.com/pe/roaddesign/docs/rdmanual/rdmch10.pdf
  This guide presents procedures to determine a recommended minimum clear zone on tangent sections of roadway with variable side slopes and adjustments for horizontal curvature. The recommended clear zone ranges are based on a width of 30 to 32 feet for flat, level terrain adjacent to a straight section of a 60 mph highway with an average daily traffic of 6,000 vehicles. For steeper slopes on a 70 mph roadway, the clear zone range increases to 38 to 46 feet, and on a low-speed, low-volume roadway the clear zone range drops to 7 to 10 feet. For horizontal curves, the clear zone can be increased by up to 50 percent from these figures.

- **Green Book—A Policy on Geometric Design of Highways and Streets**, AASHTO, 2004.
  https://bookstore.transportation.org/Item_details.aspx?id=110
  This edition enumerates a clear zone value for two functional classes of highway. For local roads and streets, a minimum clear zone of 7 to 10 feet is considered desirable on sections without curb. In the discussion on collectors without curbs, a 10-foot minimum clear zone is recommended. The general discussion on cross section elements also indicates a clear zone of 10 feet for low-speed rural collectors and rural local roads should be provided.

- **Guidelines for Geometric Design of Very Low-Volume Local Roads**, AASHTO, 2001.
  https://bookstore.transportation.org/Item_details.aspx?id=157
  This guide addresses design issues that highway designers and engineers face when choosing cost-effective geometric design policies for very low-volume local roads.

- **A Guide for Achieving Flexibility in Highway Design**, AASHTO, 2004.
  https://bookstore.transportation.org/Item_details.aspx?id=103
  This guide shows highway designers how to recognize the choices and options available to find the best solutions in highway projects.

- **A Policy on Design Standards—Interstate System**, AASHTO, 2005.
  https://bookstore.transportation.org/item_details.aspx?ID=1175
  This guide includes a discussion on horizontal clearances in the section "Horizontal Clearance to Obstructions" (page 4).

- **Guide for Selecting, Locating and Designing Traffic Barriers**, AASHTO, 1977.
  The guide presents the results of a large amount of research and was the first publication to outline the specific criteria used to select the appropriate safety treatments within the clear zone.

- **Yellow Book—Highway Safety Design and Operations Guide**, AASHTO, 1997, and
  A Guide for Accommodating Utilities within Highway Right-of-way, AASHTO. 1967.
  These guides recommend locating utilities as close to the right of way line as feasible. Critical locations should be considered for relocation of poles or other improvements, such as those dictated by crash experience or in potential crash locations, such as within horizontal curves. Where poles cannot be relocated from critical locations, mitigation such as breakaway or shielding should be considered. Poles should not be installed in a location that could act as a funnel directing an errant vehicle into an obstacle (for example a roadside drainage ditch that would also disrupt the hydraulics). Locating a pole as far as feasible from the traveled way improves sightlines and visibility, providing a safer roadside.

Realizing that there are still contradictory passages in these AASHTO documents, the Technical Committee on Roadside Safety has initiated a short-term project to identify all such inconsistencies and to recommend appropriate language corrections. The following presentation discusses the progress of this committee as of June 2007:

Clear Zone Conflicts in AASHTO Publications, Dick Albin, AASHTO Subcommittee on Design Meeting, June 2007.
http://www.transportation.org/sites/design/docs/Dick%20Albin_Clear%20Zone%20in%20AASHTO%20Documents%20-%20SCOD%202007.pdf
There are four basic consistency problems: the precise technical definition of clear zone, whether the presence of curbs by definition precludes clear zone requirements, the publication of specific dimensional guidance for clear zones and the relationship of the term "clear" to "horizontal clearance." The committee provides the following recommendations based on NCHRP Project 20-7, Task 171: Identification of Conflicts with AASHTO Publications Related to Clear Zone.

- Three terms are related to clear zones, with differing definitions in AASHTO guides: "clear zone," "clear recovery area" and "horizontal clearance." The committee recommends designating the Roadside Design Guide as the definitive publication for roadside issues; adopting a single definition for "clear zone"; and clarifying differences between "horizontal clearance," "operational offset" and "clear zone."
- In rural environments, where speeds are higher and there are fewer restraints, a clear zone appropriate for the traffic volumes, design speed and facility type should be provided in accordance with the Roadside Design Guide.
- In an urban environment, right of way is often extremely limited and in many cases it is not practical to establish a clear zone using the guidance in the Roadside Design Guide.

The AASHTO Technical Committees on Geometric Design and Roadside Safety are using this information as they prepare updates to the AASHTO Green Book and Roadside Design Guide, with new editions to be published in the summer or fall of 2010.

Two NCHRP projects will also provide clear zone guidance: 16-04, *Design Guidelines for Safe and Aesthetic Roadside Treatments in Urban Areas*, and 17-11, *Determination of Safe/Cost Effective Roadside Slopes and Associated Clear Distances.* (See the first and third citations, respectively, in the following section.)

NCHRP

Safe and Aesthetic Design of Urban Roadside Treatments, *NCHRP Report 612*, 2008.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_612.pdf
This report develops design guidelines for safe and aesthetic roadside treatments in urban areas, and a toolbox of effective roadside treatments that can balance the safety and mobility of pedestrians, bicyclists and motorists, and accommodate community values. The guidelines are based on an evaluation of the effects of roadside treatments

such as trees, landscaping and other features on vehicle speed and overall safety. The guidelines generally focus on arterial and collector-type facilities in urban areas with speed limits between 40 and 80 km/h (25 and 50 mph).

Roadside configurations most commonly associated with fixed-object crashes include:

- Obstacles in close lateral proximity to the curb face or lane edge.
- Roadside objects placed near lane merge points.
- Lateral offsets not appropriately adjusted for auxiliary lane treatments.
- Objects placed inappropriately in sidewalk buffer treatments.
- Driveways that interrupt positive guidance and have objects placed near them.
- Three kinds of fixed-object placement at intersections.
- Unique roadside configurations associated with high crash occurrence.
- Roadside configurations commonly known to be hazardous.

General recommendations (page 49) include:

- Avoiding locating rigid obstacles in close proximity to a curb face or lane edge (at curb locations where it is possible, increase the lateral offset to rigid objects to 1.8 m [6 ft] from the face of the curb and do not allow the distance of this offset to be less than 1.2 m [4 ft]).
- Restricting the placement of rigid objects at lane merge locations (avoid placing rigid objects within 3.0 m (10 ft) longitudinally of the taper point, which will provide a 6.1-m (20-ft), object-free length).
- Maintaining offsets at selected higher speed auxiliary lane locations, such as extended-length, right-turn lanes (maintain the lateral offset from the curb face at these locations).
- Maintaining careful object placement within the sidewalk buffer treatment (avoid rigid objects in buffers 0.9 m (3 ft) in width or less and strategically position objects in wider buffers).
- Avoiding placing rigid objects in the proximity of driveways (avoid placing rigid objects on the immediate far side of the driveway and do not place any objects within the required sight triangle for the driveway).

Vegetation Control for Safety: A Guide for Local Highway and Street Maintenance Personnel, Publication No. FHWA-SA-07-018, FHWA, August 2008.
http://safety.fhwa.dot.gov/local_rural/training/fhwasa07018/fhwasa07018.pdf
The purpose of this guide is to help local road agency maintenance workers identify locations where vegetation control is needed to improve traffic and pedestrian safety; provide guidance for maintenance crews; and make them aware of safe ways to mow, cut brush and otherwise control roadside vegetation. The guide includes advice on roadside trees (pages 8-10).

NCHRP 17-11: Determination of Safe/Cost Effective Roadside Slopes and Associated Clear Distances, Roger P. Bligh, Shaw-Pin Miaou, Texas A&M University, July 2004.
http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=426
From the abstract: The objective of this research is to develop relationships between recovery-area distance and roadway and roadside features, vehicle factors, encroachment parameters, and traffic conditions for the full range of highway functional classes and design speeds.

The AASHTO Technical Committee on Geometric Design is using this research to update the Roadside Design Guide, a new version of which will be published in the summer or fall of 2010.

A Guide for Addressing Collisions with Trees in Hazardous Locations, *NCHRP Report 500*, Vol. 3, 2003.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v3.pdf
http://safety.transportation.org/htmlguides/trees/
This report focuses on measures directed at reducing the harm in tree crashes after encroachment on the roadside has occurred, such as removing trees and shielding motorists from trees. The report was developed using the *Guide to Management of Roadside Trees* (see page 10 of this document), and survey information was obtained from 14 state DOTs regarding their methods for reducing tree crashes, including how environmental issues are considered.

The report includes a table of strategies by implementation timeframe and relative cost (page IV-1) as well as descriptions of strategies (pages V-1 to V-18), including:

- Preventing placement of trees in hazardous locations.
- Mowing and vegetation control.

- Delineating trees in hazardous locations.
- Removing trees from hazardous locations.
- Shielding motorists from striking trees.
- Modifying roadside clear zones in the vicinity of trees.

A Guide for Addressing Run-off-Road Collisions, *NCHRP Report 500*, Vol. 6, 2003.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v6.pdf
This report describes strategies for mitigating the consequences of run-off-road collisions (see page I-3 and section V for full descriptions of strategies), including for:

- Keeping vehicles from encroaching on the roadside by using:
    - Shoulder, edgeline and midlane rumble strips.
    - Enhanced shoulder or in-lane delineation and marking for sharp curves.
    - Improved highway geometry for horizontal curves, enhanced pavement markings, skid-resistant pavement surfaces and shoulder treatments.
- Minimizing the likelihood of crashing into an object or overturning if the vehicle travels on the shoulder by:
    - Designing safer slopes.
    - Removing or relocating hazardous objects.
    - Delineating trees or utility poles with retroreflective tape.
- Reducing the severity of crashes by improving the design of roadside hardware (such as light poles and signs) and barriers.

A Guide for Reducing Collisions Involving Utility Poles, *NCHRP Report 500*, Vol. 8, 2004.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v8.pdf
This report describes strategies for reducing the frequency of automobile collisions with utility poles, including removing or relocating poles from high-crash locations, shielding drivers, improving line-of-sight and placing utilities underground.

Related Research

The following reports, papers and articles document recent research on clear zones.

Highway and Freeway

Single-Vehicle Accidents Involving Trees in Malaysia – a Preliminary Study, Ahmad Abidin, Mohammad Rahim, Wong Voon, Radin Sohadi, Malaysian Institute of Road Safety Research, March 2009.
http://www.miros.gov.my/html/themes/MIROS/MIROS_pdf/research_reports/MRR_12_2009.pdf
The study was conducted to investigate factors in single-vehicle accidents involving trees in Malaysia, including day, time, road geometry, numbers of carriageway, pavement quality and road shoulder width. Results showed that the most fatal accidents occurred on two-lane roads with low pavement quality and a shoulder width below 2.5 meters.

The Geometric Design Standards and the Enhanced Clear Zone Concept as Utilized on the Trans Canada Highway Project, Blake Wellner, Annual Conference of the Transportation Association of Canada, 2008.
http://www.tac-atc.ca/english/resourcecentre/readingroom/conference/conf2008/docs/b2/Wellner.pdf
This paper addresses the application of an “enhanced clear zone” concept, which allows for low-cost safety improvements to be undertaken outside the traditional clear zone limits to add value to a project. The concept involves the use of variable clear zone widths, depending on roadway foreslope and curvature, and cost-effectively treating objects within the clear zone to extend it to a width of 20 meters. (See pages 8-9.) Treatments include flattening the foreslope and transitions at structures such as medians.

Setting the Clear Zone for 3R, Urban and Suburban Projects: Guidance and Standards Used by State DOTs, CTC & Associates LLC for the WisDOT Research & Library Unit, August 2007.
http://on.dot.wi.gov/wisdotresearch/database/tsrs/tsrclearzones3urbsub.pdf

This report details standards and guidance for six Midwest DOTs concerning clear zone design for resurfacing, restoration and rehabilitation projects as well as clear zone design for urban and transitional (suburban) areas:

- **Illinois:** Topics addressed in the Bureau of Design & Environment Manual include clear zone distance for reconstruction projects on nonfreeways, obstruction-free clearance for curbed urban and suburban sections, and guardrail modification for 3R projects on two-lane rural arterial highways and unmarked routes of the state highway system.
- **Indiana:** The Indiana Design Manual discusses clear zone applications for new construction/reconstruction (4R) projects on rural and urban arterials, 3R and partial 4R projects on freeways, rural and urban collectors, rural local roads and urban local streets, and urban roadways with barrier curbs. The use of three-beam guardrail on 3R, partial 3R and 4R projects is also addressed.
- **Iowa:** The Design Manual provides clear zone guidelines for reduced-speed urban roadways, and discusses guardrail design at bridge endposts for 3R projects.
- **Michigan:** The Road Design Manual includes guidance for guardrail and bridge rail upgrades on 3R projects.
- **Minnesota:** The Road Design Manual addresses the need to compromise clear zone criteria when, in some cases, they are impractical. The manual discusses the alternative use of the "horizontal clearance to obstruction" concept and provides guidelines for using it on various types of urban and rural 4R projects, and for preservation projects on urban sections.
- **Ohio:** The Location and Design Manual provides guidance for using the horizontal clearance measurement on low-speed urban streets. In addition, special considerations for 3R projects are presented and include the reduction of clear zone criteria by 50 percent to improve cost-effectiveness unless accident history, public comments or site inspection indicate a problem.

Criteria for High Design Speed Facilities, Kay Fitzpatrick, Karl Zimmerman, Roger Bligh, Susan Chrysler, Byron Blaschke, Texas Transportation Institute, March 2007.
http://tti.tamu.edu/documents/0-5544-1.pdf
This study expanded upon existing state and national roadway design guidance, which does not provide criteria for design speeds above 80 mph, to identify new criteria for design speeds of up to 100 mph. It includes a useful discussion on clear zones (Chapter 16, pages 183-191) and clear zone guidance for controlled access facilities with speeds above 80 mph. (See Figure 16-2, page 189.)

Safety and Cost-Effectiveness of Clear Zones in Iran, Ayah and M. Shahidan, February 2007.
Citation: http://www.atypon-link.com/telf/doi/abs/10.1680/tran.2007.160.1.19
This paper examines different clear zone improvement alternatives in rock cuts and compares the likely effect on safety and construction costs. Results show that the need for extra clear zone width in steep and bendy routes (especially with external curves of less than 195m radius) is more critical than for straight and level ones. The existence of external horizontal curves simultaneously with severe longitudinal slopes increases the probability of vehicles' encroachment by as much as eight times in comparison with straight and level routes. By providing wider lanes, the need for extra clear zone width is reduced dramatically.

The Influence of Highway Clear Zone Width on Roadside Collision Characteristics, Peter J. Lougheed, *Masters Abstracts International*, Vol. 47, No. 01, 2006.

> *Also available as:* **Relating Roadside Collisions to Highway Clear Zone Width**, Eric Hildebrand, Peter Loughheed, Trevor Hanson, University of New Brunswick Transportation Group, undated.
> http://www.unb.ca/transpo/documents/RelatingRoadsideCollisionstoHighwayClearZoneWidth.pdf

This study quantifies the relationship between clear zone width and collision reduction. Researchers evaluated 11 years of motor vehicle collision reports for 70 highway sections in New Brunswick to determine how single vehicle run-off-road (SVROR) collision rates varied when controlling for the existing clear zone. Results show that SVROR collision rates are reduced by as much as 50 percent when the clear zone provided is extended from a Category A (<6m or 19.7 feet) to Category B (6 to 10m or 19.7 to 32.8 feet). Similarly, collision rates are reduced by more than 60 percent when the clear zone provided is extended to Category C (10+m or 32.8+ feet). The three categories were found to have virtually the same accident severity proportions (injury, fatality or property damage only) as part of overall accident rates.

Landscape Improvement Impacts on Roadside Safety in Texas, Jeong-Hun Mok, Harlow C. Landphair, Jody R. Naderi, *Landscape and Urban Planning*, Vol. 78, 2006, pages 263-274.
www.naturewithin.info/Roadside/RdsdSftyTexas_L&UP.pdf
To test the effect of landscape improvements on driver performance, researchers performed a before-and-after comparison of crashes on 61 road sections in Texas that were landscape-designed as either urban arterials or state highways. Results show a significant decrease in crash rate after landscape improvements were implemented on 10 urban arterial or highway sites in Texas. However, these findings need further research to verify a relationship between a driver's visual perceptions according to travel-way corridor landscape treatments.

Urban Trees and Traffic Safety: Considering U.S. Roadside Policy and Crash Data, K. L. Wolf, N. Bratton, *Arboriculture & Urban Forestry*, Vol. 32, No. 4, July 2006, pages 170-179.
www.naturewithin.info/**Roadside**/TransSafety_ArbUF.pdf
This study analyzed national traffic collision data to address concerns about urban trees and traffic safety, including crash incidence and severity. Distinctions between urban and rural conditions were explored using descriptive, comparative and predictive analysis methods. The findings acknowledge the serious consequences of tree crashes but distinguish urban from rural situations. Circumstances of tree crashes in urban settings are not well understood. Conclusions address future applications of flexible transportation design. The clear zone philosophy has been widely applied in rural settings but may need modification to better incorporate community values in urban design. Future research needs include testing of trees as a mitigation technology in safe roadside design and risk assessment as a community expression of value.

Investigation of Median Trees and Collisions on Urban and Suburban Conventional Highways in California, Edward C. Sullivan, James C. Daly, California Polytechnic State University, *Transportation Research Record*, Vol. 1908, No. 14, 2005, pages 114-120.
http://trb.metapress.com/content/y660430083253 85r/
This study examines safety in the presence of large trees in curbed medians of conventional highways that are also principal streets in developed urban and suburban areas. The study produced statistical relationships linking the number and severity of reported collisions and the presence of median trees. In addition to median trees, the influence of numerous other design and environmental features were considered. Median trees on urban and suburban conventional state highways were shown to be associated with increased numbers of total collisions and fatal and injury collisions when collisions occurring on the right side of the roadway are excluded. However, some of these associations are statistically weak. For the situations examined, lower speeds and larger side clearances were not found to mitigate the increased collision impacts associated with median trees.

Safe Streets, Livable Streets: A Positive Approach to Urban Roadside Design, Eric Dumbaugh, *Journal of the American Planning Association,* Vol. 71, No. 3, 2005, pages 283-300.
http://www.naturewithin.info/Roadside/TransSafety_JAPA.pdf
This study examines the relationship between run-off-road crashes and turning movements, and finds that a smaller clear zone can actually increase safety on an urban roadway. Roadside crashes appear to be strongly associated with vehicle turning movements. Between 65 percent and 83 percent of all fixed objects involved in roadside crashes are located behind a driveway or intersection, not at random locations along the roadway. The roadside object most likely to be involved in a roadside crash is often not that which is closest to the traveled way, but that which is located behind a driveway or intersection. The result of using forgiving design values is that drivers will travel at a speed that limits their ability to respond to the vehicle and pedestrian hazards that naturally occur in these environments. Neither a roadway's fixed-object offset nor the provision of a paved shoulder was found to meaningfully enhance a roadway's safety performance.

Highway Clear Zones, CTC & Associates LLC for the WisDOT Research, Development and Technology Transfer Program, January 2005.
http://on.dot.wi.gov/wisdotresearch/database/tsrs/tsrclearzones.pdf
This report details the clear zone design and maintenance practices of five Midwestern states (pages 2-6)—Illinois, Iowa, Michigan, Minnesota and Ohio—and identifies formal studies that quantify a safe distance between the traveled way and trees or other fixed objects.

Parkways and Freeways: Safety Performance Linked to Corridor Landscape Type, J. Mok, H. C. Landphair, *Proceedings of the 82nd Transportation Research Board Annual Meeting*, 2003.
http://www.ltrc.lsu.edu/TRB_82/TRB2003-000499.pdf

This study compared the safety performance of parallel sections of freeways and parkways by measuring fatal accident rates and costs. Contrary to conventional wisdom, parkways—which have grassed shoulders and medians with trees and other landscape elements within 30 feet—had significantly fewer fatal accidents per 100 million vehicle miles traveled than freeways. Urban parkways were the safest segments, having the lowest proportions of fatal crashes resulting from the drowsiness or inattentiveness of drivers. The study does not allow conclusions about any specific landscape elements or settings that may be contributing to the decrease in collisions and accidents, and further research into these factors is recommended.

Guide to Management of Roadside Trees, A. J. Zeigler, Report No. FHWA-IP-86-17, FHWA, December 1986.
http://www.naturewithin.info/Roadside/Zeigler_FHWA.pdf
This guide addresses the management of roadside trees for safety on rural U.S., state and local roads. Characteristics of tree-vehicle collisions include the following:

- Vehicle/tree accidents typically occur along winding rural roads with the vehicle leaving the pavement on the outside of a curve (page 3).
- Typical accidents involve a larger tree within 30 feet of the road edge (85 percent of accidents), located in a drainage ditch or at the bottom of a downward grade.
- Fatal accidents are more likely with larger trees, with a median diameter of 20 inches at breast height.

Reducing collisions can be accomplished by:

- Removing trees; building barriers around them; spacing them less frequently; channeling fun-off-road traffic away from them; or using pavement markings and reflectors, rumble strips, object markers, chevrons, target arrows and lighting. The report includes a chapter describing each treatment (pages 15-31).
- Altering hazardous road designs, such as sharper curves, narrow lanes and soft shoulders.
- Increasing driver awareness.

The report includes chapters on evaluating higher risk roadside tree environments (pages 15-31) to prioritize the application of treatments.

Urban and Suburban

Clear Zone—A Synthesis of Practice and an Evaluation of the Benefits of Meeting the 10 ft Clear Zone Goal on Urban Streets, Iowa University Center for Transportation Research and Education, November 2008.
http://www.naturewithin.info/Roadside/UrbanClearZone.pdf
This study consisted of a synthesis of practice, including a literature review and a survey of practices in 20 other states, and an investigation of the benefits of a 10-foot clear zone, which included examining urban corridors in Iowa that meet or do not meet the 10-foot clear zone goal.

Survey results (pages 4-5) showed that:

- State standards ranged from a minimum clearance of 1 foot to 35 feet. These differing standards suggest that there is no universal standard that neither is nor should be applied to every urban community.
- As of 2008, 13 states (including California) have a minimum clear zone of 1.5 feet, 13 a minimum of 1.5 to 5 feet, five a minimum of 5 to 10 feet and one a minimum of 10 feet (pages 4-5).

Investigation results showed that:

- There is very little benefit of increasing the fixed-object setback to more than 5 feet from the face of the curb. In some cases, providing wider clear zones may even be counter to traffic calming treatments or context-sensitive design concepts.
    - A 5-foot clear zone is most effective when the goal is to minimize the number of fixed-object crashes.
    - A 3-foot clear zone is most effective when the goal is to minimize the cost of fixed-object crashes.
- A consistent fixed-object offset results in a reduction in the number of fixed-object crashes.
- A weak relationship was found between the number of fixed-object crashes and the posted speed limit on the roadway.
- There is no significant relationship between the density of fixed objects and the number of fixed-object crashes.

The Street Tree Effect and Driver Safety, J. R. Naderi, B.S. Kweon, P. Maghelal, *ITE Journal on the Web*, February 2008, pages 69-73.
http://www.naturewithin.info/Roadside/Tree&Driver_ITE.pdf
This pilot study examined the effects of clear zone trees on collector roads using a driving simulator. Results showed that the addition of curbside trees significantly increased driver perception of a roadway spatial edge, which in turn:

- Increased driver perception of safety.
- Reduced the driving speeds of both faster and slower drivers by an average of 3.02 mph in suburban landscapes.

Participants perceived suburban streets with trees as the safest streets with the most defined edges, and urban streets without trees as the least safe streets with the least defined edges.

Benefits and Risks of Urban Roadside Landscape: Finding a Livable, Balanced Response, Karen K. Dixon, Kathleen L. Wolf, Third Urban Street Symposium, Seattle, 2007.
http://www.urbanstreet.info/3rd_symp_proceedings/Benefits%20and%20Risks.pdf
This study weighs the risks and benefits of trees and other landscape features within the urban right of way, reviews existing research, offers recommendations on evaluating the safety impact of urban trees, and suggests solutions for tree and landscaping placement. Design solutions (see pages 9-12) include:

- **Urban control zones** with stricter utility placement standards—a concept introduced by the Florida Department of Transportation in its *Utility Accommodation Manual* (http://www2.dot.state.fl.us/proceduraldocuments/procedures/bin/710020001/710020001.pdf). Control zones are areas in which run-off-road accidents involving contact with fixed objects are more likely.
- **Functional offset and sight distance criteria** to make sure that drivers' views aren't obstructed—the Ohio Department of Transportation's *Roadside Safety Landscaping Guidelines* contains recommended offsets based on speed limits (http://www.dot.state.oh.us/policy/AestheticDesign/Documents/ref_landscaping_jan06.pdf).
- **Plant layering**, in which plants are grouped according to height with smaller, more forgiving plants positioned lateral to the road in front of larger plantings. (See the New Zealand *Guidelines for Highway Landscaping*, http://www.nzta.govt.nz/resources/guidelines-highway-landscaping/docs/highway-landscaping-contents.pdf.)
- **Perceptual placement strategies**, in which features such as architecturally unique buildings, key viewsheds, and other environmental stimuli serve as central reference points by which individuals orient themselves and cognitively map their travel progress. The New Zealand *Guidelines for Highway Landscaping* (http://www.nzta.govt.nz/resources/guidelines-highway-landscaping/docs/highway-landscaping-contents.pdf) encourages agencies to use highway planting to help drivers understand the road ahead.
- **Forest/vegetation strategies**, where it may be appropriate to develop placement exceptions for various tree selections based on species type, biomechanics of plants upon impact and tree flexibility. Some vegetation types naturally can function as energy absorption devices.

Evaluation of Roadside Collisions with Utility Poles and Trees at Intersection Locations, Todd Berry Mattox, Georgia Institute of Technology, November 2007.
http://smartech.gatech.edu/dspace/handle/1853/19829
This study examines roadside crashes on nine Atlanta urban arterial roadways according to accident type, severity, and location. Researchers found that roadside collisions with utility poles and trees were more prone to occur at intersection locations than midblock locations. Based on these findings initial recommendations are offered for improving clear zone requirements.

Street Trees and Intersection Safety, Elizabeth Macdonald, Alethea Harper, Jeff Williams, Jason A. Hayter, Institute of Urban and Regional Development, University of California at Berkeley, 2006.
http://www.escholarship.org/uc/item/9t6465vq
This study addresses whether street trees are the safety problem they are purported to be, and whether other physical, controllable qualities are more important for preserving sightlines at intersections. Researchers conclude (pages 81-83) that street trees—if properly selected, adequately spaced and pruned for high branching—do not create a strong visibility problem for drivers entering an intersection. Rather, on-street parked cars, particularly large ones such as SUVs, create substantially more of a visibility problem.

Trees and Roadside Safety in U.S. Urban Settings, N. Bratton, K. Wolf, University of Washington, 2004. This study analyzes national traffic accident data to address questions relating to roadside attributes that are associated with accident incidence and severity, urban and rural spatial differences in accidents, the association between trees and roadside accident severity, and the implications for roadside planning, design and management. The analysis involved the application of descriptive, comparative and predictive modeling statistical methods to answer the research questions.

Findings of the study (pages 11-12) include:

- While there is no significant difference in tree collision rates between urban and rural areas (1.1 percent vs. 0.7 percent, respectively), there is a significant difference between urban and rural areas for collisions with all fixed objects. Of all accidents in rural areas, 6.1 percent are collisions with fixed objects, whereas that type constitutes only 3.8 percent of urban accidents.
- Trees, as fixed objects, increase the likelihood of injury in accidents.
- The majority of tree collisions occurred on undivided, two-lane roads for which the average speed limit was 52 mph.

While outright removal (of trees) may lead to a reduction in injurious roadside accidents, it does so without taking into account the benefits trees provide or their value to communities. The current engineering solutions are constrained by a narrow understanding of trees' potential contributions to the safety of the roadside environment and their role in its design. Trees are another roadside technology. Research about the physical properties of various trees in collisions would enable roadside design that integrates plant life as a safety feature.

This concept has been applied in a limited way in Australian urban roadsides. The Traffic Authority of New South Wales addressed an increasing number of accidents along busy roads and in areas with accident-prone geometry by developing a tree planting policy. Minimum distances from the roadway were specified for certain types of trees, and the Authority differentiated between the physical characteristics of different tree species, namely how their physical properties related to accident outcomes. Emphasis was placed on improving driver visibility and selecting frangible (breakable) trees for stretches of road that were more prone to run-off-road accidents.

Landscape Design in the Clear Zone: The Effect of Landscape Variables on Pedestrian Health and Driver Safety, J. R. Naderi, *Transportation Research Record*, Vol. 1851, 2003, pages 119-130.
http://swutc.tamu.edu/publications/papers/167425TP2.pdf
This pilot study examines the effect of landscape design in the clear zone on safety (as well as pedestrian activity). Results show that a positive correlation exists between the landscape improvements along the roadside and a reduction in midblock accidents. These landscape improvements include raised concrete planters, shrubs, decorative lights, decorative paving, decorative noise barriers, sculptures and trees. While nearly all of the tree plantings and landscape improvements occurred within the clear zone, midblock accidents decreased from between 5 percent to 20 percent. The data generated from these case studies indicates that there may be a positive effect of having a well-defined edge, which may result in an overall decrease in run-off- road collisions with objects. The street tree may define the edge of the road space by providing a diverse visual edge that also is repetitively simple in color, texture and form.

Reducing Crashes with Fixed Objects on Suburban Arterials with Limited Clear Zones, *Tech Transfer Newsletter*, Winter 2000.
http://www.techtransfer.berkeley.edu/newsletter/00-1/crashespic.php
This article includes the following recommendations for mitigating fixed-object clear zone hazards:

- Provide for wider parkways and medians to allow for fixed objects to be placed farther from the travelway.
- Locate fixed objects at least 5 feet or more back of a raised curb, or 10 feet or more back of an edge line.
- Minimize fixed objects in areas that have a high probability of vehicles leaving the travel way (particularly on the outside of curves and at roadway transitions and intersections).
- Provide for positive guidance by improving pavement markings and delineation (durable marking materials, edge lines and delineators, and warning signs).
- Engineer and document the exact location of all necessary fixed objects. For existing roadways the following mitigations for necessary fixed objects should be considered:
  - Provide regular engineering review of high ran-off-road crash locations for resolution of problems.
  - Remove, relocate or protect fixed objects in areas that have a high probability of vehicles leaving the traveled way (particularly on the outside of curves and at roadway transitions and intersections).

- Provide positive guidance through improving pavement markings and delineation (durable marking materials, edge lines, delineators and warning signs).

Online Resources

- **Clear Zones**, FHWA Safety, 2010.
  http://safety.fhwa.dot.gov/roadway_dept/clear_zones/
  FHWA's Safety web site includes links to clear zone resources.

- **Cross-Section Elements: Clear zones**, Context Sensitive Solutions.org, 2005.
  http://www.contextsensitivesolutions.org/content/reading/cross-section-2/
  This site contains lists of publications, organizations and contacts, and projects and case studies concerning clear zones.

- **Human Dimensions of Urban Forestry and Urban Greening: Trees and Transportation,** University of Washington.
  http://www.naturewithin.info/transportation.html
  This web site contains numerous links to studies and other publications related to trees and traffic safety.

State Survey Responses—DOT Setback Standards for Roadways and Medians

We contacted state DOTs concerning their current clear zone standards and received 28 responses, detailed in the table on the following pages. Responses show that

- States are typically using AASHTO guidelines for clear zones rural roads and high-speed highways and freeways.
  - For **Roadways**, almost all states (27) either explicitly cite AASHTO as the basis for their setback standards or have standards similar to those prescribed by AASHTO.
    - 25 states explicitly cited AASHTO as the basis for their setback standards. Two states (Florida and Minnesota) noted that these standards are not strictly followed, and New Hampshire adds five feet to AASHTO specifications.
    - Three states (Arkansas, Missouri and Washington) did not cite the basis of their standards. Arkansas and Missouri have standards similar to those prescribed by AASHTO.
  - For **Medians**, 16 states (57 percent) explicitly cite AASHTO as the basis for their setback standards.
    - Ten states allow little or no planting in medians; two cite AASHTO for cases in which planting is allowed and eight cite no standards, presumably because planting is not allowed.
    - Iowa approaches median setbacks on a case-by-case basis. Minnesota and Ohio also use a flexible approach.
- There is far more variation concerning clear zones in urban areas. Maria Ruppe of Ohio DOT provided a spreadsheet of her own efforts to compile state practices for urban clear zones (see "Details and Links" for the Ohio entry in **State Survey Responses—DOT Setback Standards for Roadways and Medians**, and **Appendix A** for the spreadsheet). She notes that for urban areas, states either do not have well-defined policy, use the Roadside Design Guide or have very strict standards of their own. This spreadsheet provides detailed information for some states on clear zones in urban areas.
- Forthcoming revisions to the AASHTO Green Book and Roadside Design Guide are intended to create more consistency and clear up some of the confusion that has led to wide variations in state policies.

State DOT Setback Standards for Roadways and Medians

(Freeways, controlled access freeways and conventional highways)

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
Alaska	Lars Gregovich lars.gregovich@alaska.gov	30' (AASHTO)	No shrubs or trees planted in medians; what is planted in medians only done by local municipalities who also maintain what they plant.	Do very little planting, if any. See Alaska's Preconstruction Manual, pages 49-51: http://www.dot.state.ak.us/stwddes/dcsprecon/assets/pdf/preconhwy/ch11/chapter11.pdf Cites the AASHTO 200 Roadside Design Guide.
Arkansas	Tony Sullivan tony.sullivan@arkansashighways.com	30' clr zone, 10' transition zone		
Delaware	Chip Rosan eugene.rosan@state.de.us	30' (AASHTO)	AASHTO Medians can be planted if there is sufficient space to safely maintain the plantings, and if there is appropriate resources for the maintenance. Major trees (>4" cal. at maturity) are not planted in medians unless there is a barrier curb and sufficient driver recovery space.	Delaware's Clear Zone Safety Law, 17 DEL CODE, Section 525, 426 and 527. Effective June 27, 1998. Later modified to include roadways within city/town limits. See Delaware's Roadside Design Manual, which cites AASHTO's Roadside Design Guide: http://www.deldot.gov/information/pubs_forms/manuals/road_design/pdf/revisions042209/03_design_standards.pdf.
Florida	Jeff Caster jeff.caster@dot.state.fl.us	36' of recoverable area	Curbs are not a factor; › 45 mph – trees allowed; over 45 mph – need full horizontal recovery area.	Setbacks based on AASHTO guidelines but not strictly followed. FDOT Design Standard 700. http://www.dot.state.fl.us/rddesign/rd/rtds/10/700.pdf Volume I, Chapter 2, of the Plans Preparation Manual. See page 75. http://www.dot.state.fl.us/rddesign/PPMManual/2010/Volume1/Chap02.pdf

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
Georgia	William Wright william.wright@dot.state.ga.us	Rural – AASHTO Urban: ≤ 35 mph – 4’ from curb face in central business district, otherwise 8’ from curb face 40 mph – 10’ from curb face 45 mph – 14’ from curb face > 45 mph – Outside clear zone Interstates: 120% of the clear zone requirement	Rural : AASHTO Urban: ≤ 35 mph – 8’ from curb face 40 mph –16’ from curb face 45 mph – 22’ from curb face > 45 mph – Outside clear zone Interstates: 120% of the clear zone requirement	Small trees and shrubs that mature at ≤ 4” in diameter may be planted a minimum of 8 feet from the face of curb in medians adjacent to 40 to 45 mph speeds. Landscaping on DOT RW (6755-9) and referenced in the latest Driveway Manual – October 10, 2009: http://mygdot.dot.ga.gov/info/pap/Lists/Policies/DispForm.aspx?ID=345&Source=/info/pap/Pages/Office.aspx AASHTO 2002 Roadside Design Guide (page 4-26 in the Manual): http://www.dot.ga.gov/doingbusiness/PoliciesManuals/roads/Encroachment/DrivewayFull.pdf
Hawaii	Chris Dacus christopher.a.dacus@hawaii.gov	30' (AASHTO)	Median plantings of trees > 4" caliper must be greater than 8 feet in width, curbed, 35 mph posted speed.	Median plantings in Hawaii are difficult due to prior placement of utilities in the median and the addition of additional left turn lanes.
Idaho	Cathy Ford cathy.ford@itd.idaho.gov	30' setback for roadways (AASHTO guidelines)	30' setback for roadways (AASHTO guidelines)	The state does not plant. What planting that is done is w/road construction w/planting limited to flowers, shrubs and other low growing veg. What trees that are planted are limited to 5’ height in urban areas, 7’ in rural areas; 6” max caliper planted outside CRZ. See the Idaho Roadside Design Manual pages 19-22: http://itd.idaho.gov/manuals/online_manuals/Current_Manuals/Design%20Manual/500.pdf.

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
Iowa	Mark Masteller mark.masteller@dot.iowa.gov	30' (AASHTO)	Case by case basis.	In urban areas with lower speeds, we have recently completed some research that would indicate that more flexibility may be allowed in certain situations. The results of that research can be found at http://www.ctre.iastate.edu/research/detail.cfm?projectID=1914979082. It is titled; "Clear Zone – A Synthesis of Practice and an Evaluation of the Benefits of Meeting the 10 ft Clear Zone Goal on Urban Streets." As a result, we now look at these issues on a case-by-case basis and use this document as guidance as well as engineering judgment to reach a final decision. The bottom line is that the AASHTO 10' urban clear zone guidance does not necessarily need to apply as a blanket rule and that there may be some flexibility to consider lesser distances in appropriate situations.
Kansas	Scott Shields scottsh@ksdot.org	30" (AASHTO)	AASHTO. See comments.	Little median planting; in urban areas if 34-45 MPH, curb & gutter, median 15-20' wide, 1.5-2.0" trees; larger trees planted beyond clear zone.
Kentucky	David Cornett davidp.cornett@ky.gov	30' (AASHTO)	Do not plant w/I medians	Most of the medians are disappearing due to widening
Maryland	Dan Uebersax duebersax@sha.state.md.us	AASHTO, pushing 50'	Requirements are 8" barrier curb, 16' total width for 6' setback.	Use the Roadside design guide criteria. Our Landscape Operations Division has developed an Integrated Roadside Vegetation Manual that provides guidance on placement of shrubs and trees along our highways.

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
Michigan	Lynn Lynwood lynwoodl@michigan.gov	AASHTO guidelines but setbacks vary LA ROW no tree planting permitted on recoverable front slopes	20' min. offset behind barrier curb 10' min. at turn lane	Adhere to all clear vision and intersection sight distance requirements per interchange/intersection geometry Free access roadways: 2' back of barrier curb permitted in areas with on street parking and 25 mph speed. See Michigan's Roadside Design Manual pages 18-23, which cites AASHTO's Roadside Design Guide: http://mdotwas1.mdot.state.mi.us/public/design/files/englishroadmanual/erdm07.pdf
Minnesota	Tina Markeson tina.markeson@state.mn.us	Loosely based on AASHTO guidelines for rural roads over 40mph. Variable width based on ADT, design speed, in-slope and curvature of road. (See comments for URL of formula.) Urban roads are usually decided by previous factors and others such as curb presence, curb height, context sensitive design and municipal agreements.	Same as roadway. Planting of medians occurs more in urban settings than in rural settings.	For roads below 40mph, Mn/DOT is more flexible about placement of fixed objects. Mn/DOT looks at clear zone infractions as trees that will be greater than 4" in diameter when mature. We are very critical of clear zones when new plants are being placed. In contrast, we assess road aesthetics and history prior to determining if existing trees will be removed from the clear zone. The clear zone formula is found on pages 34-49 of http://www.dot.state.mn.us/design/rdm/english/4e.pdf These guidelines are based on AASHTO recommendations but recommend exceeding its minimums wherever practicable.
Missouri	Stacy Armstrong stacy.armstrong@modot.mo.gov	30' – 50' depending on speed, terrain and other roadside features.	Generally no planting in medians unless medians are extra wide or have a low speed limit. May allow community to do this.	
Montana	Paul Ferry pferry@mt.gov	Rural setbacks are based on the clear zone requirements in the AASHTO Roadside Design Guide (ADT, slope, design speed, horizontal curvature). Urban are evaluated on a case-by-case basis.	See Note #1 – 4" caliper width.	We typically do not plant trees in rural medians and have not planted any to date in the interstate median.

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
Nevada	Lucy Joyce ljoyce@dot.state.nv.us	AASHTO Roadside Design Guide	4" caliper w/width ‹ 20' @ 35-45 mph; no trees where speed limits are above 45 mph, presence of curbs immaterial. Context Sensitive Solutions applied on case-by-case basis.	Suggest reviewing "NCHRP Synthesis 21, Roadway Safety Tools for Local Agencies" by Eugene M. Wilson of Laramie, Wyoming. Member of TRB. This publication is a roadway safety tool: http://www.t2.unh.edu/nltapa/Pubs/nchrp_syn_321.pdf.
New Hampshire	Guy Giunta ggiunta@dot.state.nh.us	35" from EP (usually extra 5' of what AASHTO prescribes)	Same as roadway if have the width; if not, smaller ornamental trees; planting mainly for snow drift and headlight glare.	Still have many landscaping projects throughout the state. Native plants are becoming the norm.
New Jersey	David Earl david.earl@dot.state.nj.us	AASHTO Formula (see comments)	AASHTO Allowed w/ limiting factors.	Formula takes into consideration clr zone, site distances, ADT, curvature. See New Jersey's *Roadway Design Manual* section 8.02.3, which sites AASHTO's *Roadside Design Guide*: http://www.state.nj.us/transportation/eng/documents/RDME/sect8E2001.shtm#Clear Zone
New York	Terry Hale thale@dot.state.ny.us	AASHTO Freeways: 30' min Other highways: Clear zone commitment determined per project, based on consideration of speed, volume, accident history, project type and effort needed to create clear area.	AASHTO Freeways: 30' min Other highways: Clear zone commitment determined per project, based on consideration of speed, volume, accident history, project type and effort needed to create clear area.	Decision sometimes influenced by different advocacy groups, typically in aesthetically sensitive, developed areas. We do not have a discrete setback standard. Rather, our guidance is somewhat dispersed throughout Chapter 10 of our Highway Design Manual. Most of the coverage is in Section 10.2.1. The link to that chapter is: https://www.nysdot.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_10_0.pdf This standard is influenced by AASHTO, but customized according to an a history of practice that gets tempered by individual and then committee judgement, periodically annealed with project-specific compromises.

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
North Carolina	Bob Kopetsky bkopetsky@ncdot.gov	AASHTO 35 MPH or Less (C&G): Trees- 10' Lrg Shrub/Sm Tree- 5' Sm. Shrub- 1' (to foliage) 35 MPH or Less (SHLDR): Trees- 12' Lrg Shrub/Sm Tree- 8' Sm. Shrub- 6' (to foliage) >35 MPH – 45 MPH (C&G): Trees- 15' Lrg Shrub/Sm Tree- 8' Sm. Shrub- 6' (to foliage) >35 MPH – 45 MPH (SHLDR): Trees- 20' Lrg Shrub/Sm Tree- 10' Sm. Shrub- 8' (to foliage) >45 MPH (C&G): Trees- 25' Lrg Shrub/Sm Tree- 20' Sm. Shrub- 10' (to foliage) >45 MPH (SHLDR): Trees- 30' Lrg Shrub/Sm Tree- 20' Sm. Shrub- 15' (to foliage)	AASHTO Median setback standards, per roadway qualifying characteristic, are the same as the standard roadway setbacks. Both standards are further qualified by minimum setbacks outside ditch lines and shoulder breaks.	State guidelines were developed prior to 1980 between the NCDOT Roadside Environmental Unit (Landscape Unit) and traffic engineers closely following AASHTO standards. There is no documentation on when or how exactly they were defined, except that they were derived from standard AASHTO setbacks of the day with revisions over the years. Setbacks are generally based on roadway x-sect and posted speed limit. Landscape setback standards are defined for roadway sections, cloverleaf and diamond interchanges. Individual site characteristic as well as the preservation of safety sightlines are also taken into account when planned landscape enhancements are approved. Refer to NCDOT Guidelines for Planting within Highway Right-of-Way for further details: http://www.ncdot.org/doh/operations/dp_chief_eng/roadside/design/graphics/PlantingGuidelines.pdf
Ohio	Maria Ruppe maria.ruppe@dot.state.oh.us	(AASHTO) Rural: Primarily based on those from NC; 50' for interstates, 30' for others. Urban: See details.	(AASHTO) Rural: Do not plant medians; exceptions: expressways depending on speed limit, curbs. Urban: See details.	We are currently reviewing our setback standards for urban areas here in Ohio. Our intent is to follow the upcoming version of the AASHTO *Roadside Design Guide* due later this year. It will hopefully clarify some of the ambiguity that exists between definitions of clear zone, lateral setbacks and operational offsets, i.e., lateral offsets are often less than the clear zones in urban areas and are considered the distance from the curb as opposed to distance from traveled edge. We are currently considering 4'-6' setbacks to fixed

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
				object (like large trees) from curb in urban areas. Bike lane width and/or full-time parking lane width plus 1.5' operational offset from curb would also be acceptable. We are still debating acceptable setbacks to fixed objects in medians. Attached (see Appendix A) is the information for other states in urban areas ... please keep in mind it is not yet complete. The information is a compilation of emails, phone calls and Web searching. It makes it clear that some states don't really address the issue, others defer to the *Roadside Design Guide* (which in the past has been ambiguous), and some states have very strict standards of their own. Some states have some type of landscape architecture divisions that may allow items like trees or planters in areas that would otherwise be disallowed by their engineering standards division that would govern roadside safety.
South Carolina	F. Timothy Edwards EdwardsFT@dot.state.sc.us	AASHTO On Interstates, 45' min. for trees $\geq$ 4" cal. at maturity. 30' for trees < 4" cal. at maturity. On State Routes, based on clear zone, 1.5'-26' required (See comments)	AASHTO On Interstates, planting is discouraged, based on clear zone required; On State Routes, based on clear zone, 1.5'-26' required (See comments)	Access & Roadside Management manual, updated July 1, 2008, which is based on the AASHTO Roadside Design Guide. Local municipalities are required to maintain plantings; Setbacks listed in chart in Chapter 9 of the Access & Roadside Management manual; http://www.scdot.org/community/Landscapeguidelines.shtml
South Dakota	Mark Leiferman, mark.leiferman@state.sd.us	(AASHTO) 30' Clear Zone for rural, high speed highways 8' to 30' Clear Zone (calculated using AASHTO Roadside Design Guide) for suburban, intermediate speed highways	(AASHTO) We plant only shrubs and flowers in the median.	Very little tree planting, mostly involved with erosion and sediment control. The tree and shrub planting we do is typically outside the median and is used for snow blockage.

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
		5' desirable Lateral Offset measured from back of curb on urban, low speed highways		See: http://www.sddot.com/pe/roaddesign/docs/rdmanual/rdmch10.pdf
Texas	Barrie Cogburn bcogburn@dot.state.tx.us	30' (AASHTO)	Generally allowed beyond clear zone (30', AASHTO).	See Chapter 2, Section 6, Table 2-11: Horizontal Clearances: http://gsd-ultraseek/txdotmanuals/rdw/rdw.pdf No trees with mature caliper of 4" or greater within clear zone. Factors for determining a specific setback include location, functional classification, design speed and ADT based on a table TxDOT's Roadway Design Manual: http://gsd-ultraseek.dot.state.tx.us/manuals/
Utah	Terry Johnson terryjohnson@utah.gov	AASHTO Within the Design Clear Zone 4-inch diameter maximum. In urban areas where curb and gutter exists, larger trees are allowed outside 18" from face of curb.	AASHTO Within the design clear zone 4-inch diameter maximum. Rarely plant trees in medians in rural areas.	May 2007; latest update June 2009. Link to Roadway Design Manual: http://www.udot.utah.gov/index.php/m=c/tid=1498 Setbacks are based on the AASHTO standards for the most part. Utah does vary setbacks depending on the shoulder width; roadways with 12' design width shoulders do not require the AASHTO recommended offset of 2'.
Virginia	Al Bryan albert.bryan@vdot.virginia.gov	30' (AASHTO)	(AASHTO) 8' Min. for Canopy Tree Species, 1.5' with a design waiver.	Clear Zone for Barrier Curb, 2010 Edition of VDOT Road Design Manual: http://www.extranet.vdot.state.va.us/locdes/Electronic%20Pubs/2005%20RDM/RoadDesignCoverVol.1.pdf For mountable curb, clear zone for shoulder design would apply.

STATE	CONTACT	SETBACK REQUIREMENT		DETAILS AND LINKS
		Roadway	Median	
Washington	Sandy Salisbury salisbs@wsdot.wa.gov	Have formula developed by Design that takes into account ADT, terrain, cut or fill, and speed.	Same as for roadway.	Anything within the design clear zone needs to be 4 inches in diameter or less and it cannot obstruct sightlines. We have a brochure that shows urban median plantings at: http://www.wsdot.wa.gov/eesc/design/Urban/PDF/NewBrochure.pdf
Wyoming	John Samson john.samson@dot.state.wy.us	Trees or large shrubs > 4" DBH must comply with clear zone criteria AASHTO Rural Design sections. Any part of tree's canopy within 2-feet back-of-curb or rural taper pruned to maintain a minimum 19-foot airspace over travel lane(s). Conifers and cottonwoods (Populus sp.) are not allowed within the R/W. Shrubs and ornamental grasses minimum 2-foot setback back-of-curb and maximum 2.5 feet height within restricted sight distances (i.e., intersections and accesses).	AASHTO clear zone guidelines here usually disallow woody plantings. Arid climate so woody plantings not generally feasible especially with winter sanding salt spray and no irrigation.	WYDOT Operating Policy 20-1, revised April 01, 2009. Based strictly on AASHTO and no other research. Snow drifting concern in rural high wind areas. ADA access guidelines in urban corridors. Encourage native xeriscaping, non-irrigation where locally accepted.

APPENDIX A: STATE CLEAR ZONES IN URBAN AREAS, COMPILED BY OHIO DOT

Standard/ Study Name	Urban Standards							Different Rural Standards?	Other Notes/ Comments	Link	Contact Person	Title or Section	email address	Phone #
	Offset to Fixed Object from *Curb*			Offset to f.o. from uncurbed *Traveled Lane*			Offset from curbed Median							
	25-35mph	35-45mph	50-55 mph	25-35mph	35-45mph	50-55 mph								
Alabama	12'							no	Landscape reviewer's requirements: limits plantings or shrubs inside CZ to 18", nothing larger than 4" diameter within median. No fixed objects within 12' of pavement and 150' from intersection/drive/crossover. Curb is regarded as a "non-barrier" unless their Design Bureau over-rides this by treating it as a non-mountable curb barrier.		Howard Peavey	Argonomist, landscape reviewer		334-242-6282
Alaska	Low speeds...establish the minimum horizontal clearance as recommended by the AASHTO Green Book		Clear Zone	Clear Zone			Clear Zone	No	Appears to follow AASHTO's Clear Zones: Remove all trees greater than 4 inches in diameter, or those that are likely to be greater than 4 inches in diameter at full maturity, from the clear zone unless there are unusual circumstances	http://www.dot.state.ak.us/stwddes/dcsprecon/assets/pdf/preconhwy/ch11/chapter11.pdf	Lars Gregovich, P.E.	Preconstruction Standards Engineer	lars.gregovich@alaska.gov	907-465-6968
Arizona	1.5'						1.5'	no	As much clear zone as practical should be provided but in no case should an obstacle be closer than 1.5 ft from face of curb. Arizona Roadway Design Guidelines Section 303 along with the AASHTO Roadside Design Guide.	http://www.azdot.gov/highways/Roadway_Engineering/Roadway_Design/Guidelines/Manuals/PDF/RoadwayDesignGuidelines.pdf	Mary Viparina	Assistant State Engineer Roadway Engineering Group	MViparina@azdot.gov	602-712-4282
Arkansas	CZ is 1.5'			Clear Zone				CZ	no landscape policy, but std follows AASHTO - fixed objects allowed outside CZ typically a 3' green space + 5' sidewalk		Mike Fugett	Asst. Division Admin		(501) 569-2336
California	18" (foc)			30'			100' from end 5' (foc) <= 35 mph barrier req'd <= 45 mph		Sight distance required					
Colorado	18" (foc)			clear zone commensurate with the RDG				yes, CZ	See section 4.5 Horizontal Clearance to Obstructions	http://www.dot.state.co.us/DesignSupport/Design%20Guide%2005/DG05%20Ch%2004%20Cross%20Sec.pdf				
Connecticut	AASHTO CZ standards, with 1.5' operational offset to *utilites,* however, tree placement can also be considered on a case by case basis			AASHTO Clear Zone requirements				CZ	Along urban highways, the Department will require poles to be placed as close to the right-of-way line as practical. Where sufficient space is available, poles must be placed in back of the sidewalk. If insufficient space is available, the Department may allow poles to be placed between the curb and sidewalk or as far from the curb as practical when there are no sidewalk considerations (minimum 1.5 ft behind the face of curb).	http://www.ct.gov/dot/lib/dot/documents/dpublications/highway/chapter_13.pdf	Monique Burns DeLois Barnes	Roadside Design Landscape Architect	Monique.Burns@ct.gov	(860) 594-3292 (860) 594-3307
Delaware	2' Behind "8 in tall barrier curb" for low speeds		Clear Zone	Clear Zone			2' Behind "barrier curb" for low speeds	no	Large trees may be planted within CZ.....at barrier curbs (2 feet behind) or in areas behind existing guardrails (4 feet behind). Barrier curbing is any curb eight inches or higher. Trees may be planted behind barrier curbs if the road speed is sufficiently low as to prevent cars from mounting the curbing.	http://www.deldot.gov/information/pubs_forms/manuals/edh/index.shtml	Chip Rosan		Eugene.Rosan@state.de.us	

Standard/ Study Name	Urban Standards: Offset to Fixed Object from *Curb* 25-35mph	Offset to Fixed Object from *Curb* 35-45mph	Offset to Fixed Object from *Curb* 50-55 mph	Offset to f.o. from uncurbed *Traveled Lane* 25-35mph	Offset to f.o. from uncurbed *Traveled Lane* 35-45mph	Offset to f.o. from uncurbed *Traveled Lane* 50-55 mph	Offset from curbed Median	Different Rural Standards?	Other Notes/ Comments	Link	Contact Person	Title or Section	email address	Phone #
Florida	*Urban* may be 4' from curb face		Clear Zone	Clear Zone			6' from inside traveled lane		Plan Prep Manual 2.11 (offsets), Index 546, Stds Sections 546 Sight Distance at Intersections	http://www.dot.state.fl.us/rddesign/PPMManual/2009/Volume1/zChap02.pdf http://www.dot.state.fl.us/rddesign/rd/rtds/10/546.pdf	Andy Keel David C. O'Hagan	Standards Engineer	andy.keel@dot.state.fl.us David.OHagan@dot.state.fl.us	(850) 414-4334 850-414-4283
Georgia	1.5'	1.5'	Clear Zone	Clear Zone				yes	Horizontal clearance on urban roadways is not based entirely on the clear zone concept due to various pre-existing conditions...Horizontal clearance for urban roadways is based on the specific feature or element being considered. The horizontal offset of 1-ft., 6 in. from face of curb to fixed object stated in the AASHTO Green Book (2004) shall be an absolute minimum horizontal clearance for urban roadways. Horizontal offsets less than 1ft., 6 in. shall require a design exception.	page 5: http://www.dot.state.ga.us/doingbusiness/PoliciesManuals/roads/DesignPolicy/GDOT-DPM-Chap05.pdf Context Sensitive Solutions: http://www.dot.state.ga.us/doingbusiness/PoliciesManuals/roads/ContextSensitiveDesign/GDOT_CSD_Manual.pdf	Bill Wright	Landscaping Design		(404) -631-1397
Hawaii								no	no urban criteria					
Idaho														
Illinois	Clear Zone							no	Sight distance required					
Indiana	10'						10'							
Iowa	10' may be reduced on case by case basis								we now look at these issues on a case-by-case basis and use this document as guidance as well as engineering judgment to reach a final decision. The bottom line is that the AASHTO 10' urban clear zone guidance does not necessarily need to apply as a blanket rule and that there may be some flexibility to consider lesser distances in appropriate situations.	http://www.ctre.iastate.edu/research/detail.cfm?projectID=1914979082	Mark Masteller	Chief Landscape Architect	Mark.Masteller@dot.iowa.gov	515-239-1424
Kansas	6'						6'				Scott Shields		scottsh@ksdot.org	785-296-4149
Kentucky									follows AASHTO RDG					
Louisiana	1.5'	10'		40'	40'	40'	10' for large trees, & median >30' wide		For central business districts and local streets with barrier curbs, a minimum distance of 1.5 feet should be provided beyond the face of the curb to the anticipated outside diameter of the tree trunk when mature. On urban arterials and collectors with similar curbs and usually higher speeds, the offset distances should be increased.	http://www.dotd.la.gov/highways/maintenance/Policy_For_Roadside_Vegetation_Management.pdf				
Maine														
Maryland	AASHTO's RDG, may be reviewed by Landscaping Division for exceptions			AASHTO's CZ					Generally follow AASHTO's RDG. Lanscaping Division is involved in every project and will make exceptions on a case by case basis, particularly for curbed sections. Landscaping, including trees can be considered if tree lawn has sufficient width		Dan Uebersax	Landscape Architect	duebersax@sha.state.md.us	410-545-8603
Massachusetts	500mm or 19.7"			Clear Zone			500mm or 19.7"	yes, CZ	trees to remain outside Clear Zone, except Central business districs and local roads with curb: 500mm beyond face of curb to mature trunk	http://www.mhd.state.ma.us/downloads/manuals/design.pdf				
Michigan									follows AASHTO RDG					

Standard/ Study Name	Urban Standards							Different Rural Standards?	Other Notes/ Comments	Link	Contact Person	Title or Section	email address	Phone #
	Offset to Fixed Object from *Curb*			Offset to f.o. from uncurbed *Traveled Lane*			Offset from curbed Median							
	25-35mph	35-45mph	50-55 mph	25-35mph	35-45mph	50-55 mph								
Minnesota										http://www.dot.state.mn.us/design/rdm/index.html				651/366-4622
Missouri														
Mississippi														
Montana														
Nebraska														
Nevada														
New Hampshire	AASHTO's RDG, may be reviewed by Landscaping Division for exceptions								consider trees above the 6 inch diameter as a hazard and when landscaping will take that into consideration, whether it is an urban or rural situation. We always are concerned with a clear sight line and any obstruction is only allowed in very special instances.		Mike Hazlett	Senior Supervisor Final Design Section of Highway Design	MHazlett@dot.state.nh.us	(603) 271-1407
New Jersey	Case by Case	CZ	CZ	CZ	CZ	CZ	CZ	CZ			Brenda			609-530-5672
New Mexico														
New York	0.5 m for convenience, 0.9m preferred			1.2 m.					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.	https://www.nysdot.gov/divisions/engineering/design/dqab/hdm/hdm-repository/ch10developed.pdf	Nancy O. Alexander	Landscape Architecture Bureau	nalexander@dot.state.ny.us	518-457-8316
North Carolina														
North Dakota														
Oklahoma											Roadside Development: Dennis Schieber			(405) 521-4483
Oregon	4'													
Pennsylvania									Sight Distance Required					
Rhode Island														
South Carolina														
South Dakota	<=40mph, 5' preferred, 1' permitted from back fo curb		Clear Zone	<=40mph, 4' min offset 5' at intersections & curves		Clear Zone		Clear Zone	pages 10-4 through 10-8 for clear zone and lateral offset guidelines	http://www.sddot.com/pe/roaddesign/docs/rdmanual/rdmch10.pdf	Mark A. Leiferman		Mark.Leiferman@state.sd.us	
Tennessee		*	*		*	*			developing new landscaping standards…offsets are required to simply follow Clear Zone distances. *Absolutely no trees allowed within Clear Zone oh 45mp or higher	sight distance : http://www.tdot.state.tn.us/Chief_Engineer/engr_library/design/StdDrwgEng_PDFs/RD01SD2_000000.pdf			Ali.Hangul@tn.gov	(615) 741-2806
Texas									We follow the guidance in the AASHTO Roadside Design Guide for clearances and offsets		Mark Marek		MMAREK@dot.state.tx.us	
Utah														
Vermont	On curbed streets, a 1.5 foot horizontal offset to obstructions from face of curb should be provided. This dimension should be increased to 3 feet near turning radii at intersections with side roads and driveways.			Clear Zone				CZ		http://www.aot.state.vt.us/progdev/Standards/statabta.htm				

Standard/ Study Name	Urban Standards							Different Rural Standards?	Other Notes/ Comments	Link	Contact Person	Title or Section	email address	Phone #
	Offset to Fixed Object from *Curb*			Offset to f.o. from uncurbed *Traveled Lane*			Offset from curbed Median							
	25-35mph	35-45mph	50-55 mph	25-35mph	35-45mph	50-55 mph								
Virginia	typically 8', 1.5' min		10'		>= 45mph 10'				When curb is utilized on urban roadways with design speeds of < 45 mph, the greatest practical lateral offset is to be provided, and shall extend a minimum of 8' from the face of curb, or beyond the back of the sidewalk, whichever is greater. In situations where space is restricted, the lateral offset distance may be reduced to an absolute minimum of 1.5' beyond the face of the curb, with wider distances provided where practical. See Figure A-2-1, Case 4. (Source: AASHTO Roadside Design Guide, Chapter 3 and 2004 AASHTO "Green Book", Chapters 4 and 5) The justification for not providing a minimum 8' lateral offset beyond the face of curb (or to the back of sidewalk) is to be documented in the project file with an approved Design Waiver.	http://www.extranet.vdot.state.va.us/locdes/Electronic%20Pubs/2005%20RDM/appenda.pdf (pg 24&25)	Chuck Patterson	Standards and Special Design Section Manager	Chuck.Patterson@VDOT.Virginia.gov	(804) 786-1805
Washington	2'								2' Urban, Back of sidewalk Suburban Or by project agreement Sight Dist req'd					
West Virginia														
Wisconsin	2' from face of curb		6'	4'	4'	6'	2' from face of curb	yes	Has lateral clearance requirements for fixed objects which are different from the clear zone parking lane width+ 2' acceptable	http://roadwaystandards.dot.wi.gov/standards/fdm/11-20-001.pdf (Table 5, pg 12)				
Wyoming														