

DIVISION OF HIGHWAYS



**RESURFACING, RESTORATION
AND REHABILITATION (R-R-R)
OF HIGHWAYS AND STREETS**

**PROJECT SERVICES UNIT
ROADWAY DESIGN UNIT**

**VALUE MANAGEMENT SECTION
SPECIAL SERVICES GROUP**



R-R-R GUIDE

APRIL 2004

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
GUIDE FOR
RESURFACING, RESTORATION AND REHABILITATION (R-R-R)
OF HIGHWAYS AND STREETS (OTHER THAN FREEWAYS)

<u>CONTENTS</u>	<u>PAGE</u>
R-R-R Purpose	2
Definitions	2-3
References	3
Background	4-5
Examples and Objectives	5-6
Procedure	6
Exceptions	6
Design Guides and Criteria	(Revised) 6-12
Minimum Lane and Shoulder Widths	13
Guardrail	14
Bridges	14-16
Design Exception Request Forms	17-21
Detail Guide for Vehicle Recovery Area	22
Clear Zone Distances	23
Preferred Crossed Sections for Channels with Abrupt Slope Changes	24

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
GUIDE FOR
RESURFACING, RESTORATION AND REHABILITATION (R-R-R)
OF HIGHWAYS AND STREETS (OTHER THAN FREEWAYS)

PURPOSE

The primary purpose of R-R-R projects is to provide a better riding surface, enhance safety, improve operating conditions, and to preserve and extend the service life of existing non-freeway facilities. Highway safety is an essential element of R-R-R projects. Projects should be developed and designed in a manner, which identifies and incorporates safety improvements. Economic considerations are also a major factor in determining the priority and scope of R-R-R projects.

For purposes of this guide, the following definitions apply:

1. Criteria - The term "criteria" as it relates to R-R-R means either specific design criteria or procedures, or a process which establishes geometric design values for individual projects or groups of projects.
2. Maintenance - This work is directed towards maintaining the existing roadway and related appurtenances as necessary for safe and efficient operation. Design improvements are not the normal intent of maintenance operations. Pavement repairs such as seal coats, full width patching, crack sealing, and thin plant mix resurfacing for sealing of the pavement surface correcting minor surface irregularities, etc., are generally considered as maintenance activities. This work is not considered an R-R-R activity.
3. Resurfacing - This work consists of the application of a new or recycled layer or layers of pavement material to existing pavement to provide additional structural integrity or improved rideability.
4. Restoration - This work consists of restoring or generally bringing back the originally designed capability of the facility. This may include, in addition to the resurfacing described above, such activities as minor pavement widening or addition of paved shoulders, culvert extensions, other drainage improvements, correction of superelevation, upgrading safety appurtenances to current standards, and other safety improvements. Generally, restoration activities are confined within the existing right of way.
5. Rehabilitation - In addition to the work described under restoration and resurfacing, this activity may include reconstruction of limited portions of the project's length in order for the facility to better serve existing and short-term traffic requirements. Additional right of way may be required.
6. Reconstruction - A project will be considered "reconstruction" if the majority (50 percent or more) of the project length involves vertical and/or horizontal alignment revisions, added lanes or reconstruction of roadway pavement to provide long term service. Reconstruction projects are constructed in accordance with the appropriate new construction criteria and are not considered to be within the scope of this R-R-R guide.

R-R-R DESIGN REFERENCES

1. Designing Safer Roads - (Special Report 214), TRB 1987
2. Technical Advisory - Developing Geometric Design Criteria and Processes For Nonfreeway R-R-R projects (T5040.28), FHWA 1988.
3. Safety Improvements on Horizontal Curves For Two-Lane Rural Roads Informational Guide (FHWA-RD-90-074)
4. Safety Cost-Effectiveness of Incremental Changes in Cross-Section Design -- Informational Guide (FHWA-RD-87-094)

GENERAL REFERENCES

1. A policy on Geometric Design of Highways and Streets, AASHTO 2001.
2. Highway Design and Operational Practices related to Highway Safety, Second Edition, AASHTO 1974.
3. Roadside Design Guide, AASHTO 2002.
4. National Cooperative Highway Research Program (NCHRP) Research Results Digest 98, Safety at Narrow Bridge Sites.
5. Standard Specifications for Highway Bridges, AASHTO 1989 and Addenda.
6. Manual on Uniform Traffic Control Devices (MUTCD), National Advisory Committee on Uniform Traffic Control Devices 2000.
7. N. C. Supplement to the Manual on Uniform Traffic Control Devices.
8. A Guide For Erecting Mailboxes on Highways, AASHTO, 1994.
9. State Highway General Ordinance 19A:NCAC:02E.0404 Highway Obstructions.
10. Truck Characteristics For Use in Highway Design and Operation. (FHWA-RD-89-226)
11. N.C. Map of National Truck Network.

BACKGROUND

It is apparent for the foreseeable future that available funds will be insufficient to improve existing highways and streets to the geometric and pavement standards desirable for reconstruction and new construction. This situation was recognized in the Federal-Aid Highway Act of 1976, which broadened the term "construction" to include "resurfacing, restoration and rehabilitation". The intent of this legislation was to permit the use of Federal-Aid highway funds to rehabilitate highways to extend their useful life without necessarily improving existing geometrics.

Part 625 of Title 23, Code of Federal Regulations, "Highways" (23 CFR 625), was revised on June 4, 1982 (47 FR 25263, June 10, 1982), to allow greater flexibility and local discretion in the geometric design of non-freeway R-R-R, projects. Effective July 2, 1982, minimum geometric design criteria adopted for new construction and reconstruction no longer apply to Federal-Aid non-freeway R-R-R projects unless state specifically proposes adoption of those criteria for non-freeway R-R-R projects. Separate Geometric Design Criteria may be developed and adopted by each state for non-freeway R-R-R projects.

Part 625 was further revised on March 24, 1983 (48 FR 13410, March 31, 1983), to comply with new subsection 109(o), Title 23, United States Code, added by Section 110(a) of the Surface Transportation Assistance Act of 1982. The new subsection clarifies that federally funded non-freeway R-R-R projects shall be constructed to preserve and extend the service life of existing highways and enhance highway safety.'

Technical Advisory T 5040.21, Geometric Design Criteria for Non-Freeway R-R-R Projects, dated April 4, 1983, was issued to provide guidance relating to 11 factors to be addressed, as a minimum, in the geometric design criteria developed by a state for use on R-R-R projects.

Part 625 was again revised on April 9, 1985 (50 FR 14914, April 15, 1985), to adopt as policy for Geometric Design, a new publication by The American Association of State Highway and Transportation Officials entitled "A Policy on Geometric Design of Highways and Streets". In the FHWA's memorandum dated April 15, 1985, subject "Implementation of New Design criteria for Federal-Aid Projects", 13 controlling criteria were identified. Design elements, which deviate below these minimum criteria, require a formal design exception

"Special Report 214, Designing Safer Roads, Practices for Resurfacing, Restoration, and Rehabilitation", Transportation Research Board (TRB), 1987, was the result of a study on Safety Cost-Effectiveness of Highway Geometric Design Standards for R-R-R projects on existing Federal-Aid highways as mandated by the Surface Transportation Assistance Act of 1982. Part 625 was amended on April 25, 1988 (53 FR 15069, May 3, 1988) to add this report as a guide and reference to the list of publications for application on Federal-Aid projects.

Technical Advisory T5040.28, Developing Geometric Design Criteria and Processes for Non-Freeway R-R-R Projects, dated October 17, 1988, was issued to replace T5040.21 and provides recommendations on design criteria and procedures based on the findings of Special Report 214. To obtain the greatest traffic service and safety benefits T5D40.21 addresses each of the 13 geometric elements established as the controlling criteria for geometric design. The controlling criteria are design speed, lane and shoulder widths, bridge widths, structural capacity, horizontal and vertical alignment, stopping sight distance, grades, cross slopes, superelevation, and horizontal and vertical clearances. Design exceptions are required when deviating below the minimum values. Division Engineer or appropriate Branch Manager must approve ALL exceptions.

This guide establishes broad limits by presenting minimum values for design and allowing engineering judgement to be applied. Engineering judgement shall be used to achieve desirable levels of traffic service and safety appropriate to the social, economic, and environmental controls applicable to specific projects.

EXAMPLES AND OBJECTIVES

The following list of improvements may be applicable to R-R-R projects; however, it is not intended to be all-inclusive. Each project should be examined to determine the scope of improvements which are appropriate and socially, economically, and environmentally acceptable.

- Improve surface smoothness to obtain better rideability, reduce fuel consumption, and enhance safety.
- Extend pavement life.
- Widen narrow pavement.
- Widen narrow shoulders.
- Construct paved shoulders.
- Reduce pavement edge drop offs.
- Reconstruct short sections of roadway having poor foundations.
- Improve horizontal and vertical alignments.
- Improve superelevation.
- Improve the vehicle recovery area.
- Provide adequate signing and delineation for narrow bridges.
- Remove or otherwise mitigate roadside obstructions such as driveway pipe and headwalls, which are located within the vehicle recovery area.
- Provide surface drains at bridge ends.
- Replace expansion joint seals or bridge.
- Restore or replace bridge approach slab. Extend or replace box culverts.
- Increase vertical and horizontal clearances to obstructions.
- Flatten slopes where justified by crash experience.
- Improve safety at recorded and potentially hazardous locations.
- Restore or replace deteriorated bridge decks.
- Rehabilitate obsolete bridge rails and guardrails to bridge rail transition.
- Replace bridge structures (under special conditions).
- Upgrade traffic barriers and install new ones where needed.
- Replace or remove to outside clear area, mailbox posts not in compliance with current AASHTO and State standards.

- Provide or upgrade impact attenuators and breakaway devices.
- Provide drainage modifications.
- Install or upgrade signing, signals, and pavement markings.
- Improve traffic operations by adding lanes at intersections, climbing lanes, or continuous lanes for left turns or through movements.
- Improve sight distance at intersections.
- Provide channelization.
- Improve skid resistance.
- Provide for control of erosion.

PROCEDURE

The Transportation Improvement Program will identify R-R-R type projects. The initial scope and schedule should include safety and/or pavement improvements and any right of way requirements. A planning document will be prepared by the Project Development and Environmental Analysis unit, detailing the proposed improvements. The planning document will include appropriate consideration of the safety, social, economic, and environmental consequences of the project. The planning document will identify any permits, which may be required.

Field reviews must be held during the planning and design process. Appropriate design, traffic, and division staff should be included on all field reviews. Planning documents and plans should have the concurrence of the State Traffic Engineer or his/her representative. Federal Aid projects must be coordinated with the appropriate FHWA Staff.

EXCEPTIONS TO GUIDELINES

Any design exceptions to this R-R-R Guide should be identified in the planning document. On federal aid projects requiring step by step FHWA review, the critical design elements not meeting R-R-R criteria, will require an approved design exception from the Federal Highway Administration. AASHTO Standards will apply to those critical design elements not addressed in this R-R-R Guide. The critical design elements are: design speed, lane width, shoulder width, bridge width, structural capacity, horizontal and vertical clearance, horizontal and vertical alignment, stopping sight distance, cross slope, superelevation, and grades. The information needed in the design exception request is shown on Page 20. The Division Engineer or appropriate Branch Manager must approve all design exceptions.

DESIGN GUIDES

TOPOGRAPHY AND PHYSICAL FEATURES

Rugged terrain, such as encountered in our mountainous regions and areas with heavy roadside development will often limit typical section improvements. These conditions should be reflected in the selection of cross-section element values near or at the minimum widths shown in Table 2 on Page 13.

TRAFFIC DATA

Although the basic purpose of the R-R-R project is to recondition the facility so existing traffic demands can be satisfied, traffic volumes shall be projected ten (10) years to assure that:

1. The pavement design will meet structural requirements for future traffic.
2. R-R-R treatment is appropriate for the facility in question. A significant projected increase in traffic volume may indicate the need for reconstruction rather than R-R-R treatment.

Traffic data required for R-R-R projects are as follows:

1. Current and projected (10 year) ADT
2. Percent trucks (TTST & Duals), as a minimum is required.
3. Current and projected intersection turning movements
4. Crash analysis that reviews crash rates, pattern analysis and concentrations of crashes within the project limits.
5. Appropriate speed studies as necessary.

DESIGN VEHICLE

The design must accommodate the design vehicles using the facility (regardless of the functional classification). The passenger car should be used as the standard small design vehicle and for the standard large design vehicle the WB-50 should be used. Other vehicles to consider are school buses and delivery trucks.

For routes located on the National Truck Network, lane widths should be 12 feet. Where feasible this should also include the portion of routes that provide "reasonable access" to and from the National Truck Network routes. The design vehicles to be used on these routes are the twin-trailer (WB-60) and the 48/53-foot semi-trailer (WB-62) since both of these vehicles are restricted to these routes. The N.C. National Truck Network Routes is available at www.doh.dot.state.nc.us/preconstruct/highway/dsn_srvc/value/manuals/RDM_2001/part1/chapter_12/ncntr.jpg.

SAFETY ENHANCEMENT CONSIDERATIONS

Safety considerations are an integral part of every R-R-R project.

A skid resistant pavement is an essential part of all pavement surface improvements. Only those surface course mixes containing aggregates approved by Materials and Test Unit shall be utilized on R-R-R projects.

Crash data provided by the Traffic Engineering Branch will be required for each R-R-R project. The Traffic Engineering Branch will analyze this data and provide recommendations for improvements at each location where there has been significant crash experience and at locations where reasonable engineering judgement indicates a high potential for crashes. Consideration will be given to including measures, which will provide for safer traffic operations. These measures can range from corrections of hazardous

alignment to the placement of warning signs and markers. Crash locations associated with limited sight distance on horizontal curves can possibly be corrected by selective clearing or minor slope flattening.

A vehicle recovery area is desirable for roadside areas. Additional right of way may be needed to provide the necessary vehicle recovery areas. This is particularly critical in high frequency crash locations. Obstructions located within the vehicle recovery area should be removed, shielded, or made crashworthy. On some projects vehicle recovery areas may not be economical because of existing topographic features and right of way limitations.

Where traffic barriers or attenuators are required to shield roadside obstacles, their installation shall be in accordance with the Roadside Design Guide (AASHTO) and the Roadway Design Unit's standard drawings.

HIGHWAY SYSTEM CLASSIFICATION

For purposes of establishing roadway cross-section element values, R-R-R projects are categorized by the following three highway system classifications:

1. Arterial System - These highways, including expressways, accommodate moderate to high volumes of traffic for travel between major points. These highways are primarily for through traffic, usually on a continuous route, and are generally the top 10% of the total highway system based on relative importance for statewide travel.
2. Collector System - Provide primarily intracounty service with shorter travel distances and generally more moderate speeds. These routes provide service to county seats and towns not on the arterial system. Routes, which carry traffic from local roads to arterials, are collectors.
3. Local System - Provides access to farms, residences, businesses, or other abutting properties. The traffic volumes generated by the abutting land uses are largely short trips or a relatively small part of longer trips where the local road connects with major streets or highways of higher classifications.

The Non-Freeway North Carolina Highway System has been classified by these functional classifications. The project planning report will include the proper classification for the road being improved.

DESIGN ELEMENTS

DESIGN SPEED

The design speed selected should best coordinate the various geometric elements to produce a safe highway. There are two methods available in selecting the project design speed. One method is to select an overall design speed that meets or exceeds the posted or statutory speed limit. Another method is to use the 85th percentile speed as determined by the Traffic Engineering Branch. This method is especially suited for mountainous conditions. Whichever method is used, the selected design speed shall in all cases meet the posted speed limit, statutory speed limit, or the design speed recommended by the Traffic Engineering Branch.

VEHICLE RECOVERY AREA

Each R-R-R project should seek to improve and establish a consistent vehicle recovery area. Typical improvements could be tree removal, utility pole relocation, extension of cross pipes, removal of driveway endwalls and non-standard mailbox posts, regrading hazardous ditches, and flattening fill slopes.

It is desirable to obtain a vehicle recovery distance as shown on page 22. However, in some areas there will be right of way, terrain, or other cost restrictions that preclude establishing a desirable clear zone. In these cases, factors such as existing right of way width, crash history, projected traffic, roadway alignment, and cost should be considered in establishing a consistent vehicle recovery area. Of particular importance is the area on the outside of horizontal curves where the probabilities of crashes are greater. The distances listed below are a recommended minimum for vehicle recovery areas. Engineering judgement should be used and desirable widths of clear recovery areas, shown in the AASHTO Roadside Design Guide, should be obtained whenever possible.

<u>DESIGN SPEED</u>	<u>MINIMUM VEHICLE RECOVERY AREA</u>
55 mph	15'
45 mph	10'
35 mph	5'

Right of way costs should be considered in determining cost effectiveness of providing vehicle recovery areas. However, the purchase of right of way or easements should not necessarily prohibit the establishment of a vehicle recovery area.

HIGHWAY OBSTRUCTIONS

Refer to the current N.C.D.O.T. Highway Obstructions Policy.

Note: HIGHWAY OBSTRUCTIONS INCLUDE DRIVEWAY HEADWALLS, FENCES, RURAL MAILBOXES, NEWSPAPER DELIVERY BOXES, UTILITY POLES AND OTHER ROADSIDE OBSTRUCTIONS WHICH INTERFERE WITH TRAFFIC OR MAINTENANCE.

Engineering judgement should be used to assess the benefit of mitigating highway obstructions located within a desired vehicle recovery area. It would be impractical to remove specific obstructions from a designated vehicle recovery area containing large or numerous other obstructions deemed too costly to mitigate.

HORIZONTAL AND VERTICAL ALIGNMENT

R-R-R projects should include examinations of potential hazards at intersections, sharp horizontal curves, short crest vertical curves or narrow bridges hidden by a vertical curve, particularly when the highway stopping sight distance falls below new construction standards. The investigation into the cost effectiveness of mitigation measures should assess the value of potential crash reductions.

If curve reconstruction is not justified, or if the curve is reconstructed to less than new construction standards, then appropriate safety and other mitigation measures should be applied. These safety measures include, but are not limited to:

the addition of traffic control devices (chevron signs, curve signs, advisory speed signs, or delineators), shoulder widening, appropriate superelevation, slope flattening, pavement anti-skid treatment, driveway relocation, or obstacle removal or shielding. These measures may be applied either separately or in combination.

The first substandard curve in a series should receive special attention because this change in alignment prepares the driver for the remaining curves in a series.

TWO LANE ROADWAYS - HORIZONTAL CURVES

An existing horizontal curve may be retained as is without further evaluation if:

The existing curve design, assuming correct super-elevation is provided, corresponds to a speed that is within 10 miles of the posted speed and the crash rate is below statewide averages provided by Traffic Engineering Branch. Reconstruction to either new construction standards or to these R-R-R standards is to be considered and evaluated when the previously discussed speed and crash criteria are exceeded. A cost effectiveness evaluation should be performed following the procedure contained in the May 1990 informational guide entitled "Safety Improvements on Horizontal Curves for Two Lane Rural Roads." This analysis considers the safety benefit and cost of: widening the roadway or paved shoulder width, improving superelevation, reconstruction, and improving vehicle recovery areas.

TWO-LANE ROADWAYS - VERTICAL CURVES

An existing vertical curve may be retained if the curve's design speed is within 20 mph of the posted or statutory speed limit and the design volumes are less than 1,500 ADT.

An existing vertical curve may be retained if the curve's design speed is within 10 mph of the posted or statutory speed limit and the crash rate is below the statewide average.

A design exception is required for horizontal and vertical curves that do not meet the above R-R-R criteria.

FOUR-LANE ROADWAYS - VERTICAL CURVES AND HORIZONTAL CURVES

An existing vertical or horizontal curve may be retained if the curve's design speed meets the posted or statutory speed limit. A design exception is required if the horizontal or vertical curve design speed is less than the posted or statutory speed.

GRADES

The existing roadway grade may be retained if the crash rate is below the statewide average. Climbing lanes and truck escape ramps should be considered on long steep grades.

SUPERELEVATION

It is desirable to superelevate curves in accordance with the AASHTO Guidelines for new construction. On R-R-R projects, constraints of excessive costs often preclude the use of desirable

AASHTO superelevation rates. The curve is to be signed and marked for the appropriate speed in accordance with the provisions of the "Manual On Uniform Traffic Control Devices For Streets And Highways" (MUTCD) if minimum superelevation rates cannot be achieved.

In some cases, reconstruction of substandard horizontal curves to larger radii may be feasible in lieu of increasing the superelevation.

INTERSECTIONS

Intersection geometry and design deserve some attention since crashes tend to concentrate at these locations. A primary purpose of R-R-R improvements is to correct an existing or potential safety problem. Capacity improvements are desirable but secondary to the main purpose of R-R-R projects. The cost of any improvements must be weighed versus potential crash reductions. Intersection improvements could consist of but not limited to adding turn lanes, improving sight distance, adding traffic signals, improving turning radius, improving pavement markings, or adding warning signs.

DRAINAGE

Surface drainage and pavement drainage improvements and pipe end treatments on R-R-R projects will be in accordance with Hydraulics Unit, Pavement Management Unit recommendations and the Roadway Design Manual to assure safety of the motoring public. Traversable drainage structures should be considered and used where practical. Areas where these improvements are most beneficial are those that have a history of run-off-road and/or fixed object crashes, areas on the outside of curves where site reviews indicate that vehicles frequently encroach on the unpaved shoulder, and areas where there is a high potential for vehicles to run-off the road.

UTILITIES

The disposition of utilities on R-R-R projects will be as recommended by the Utility Section. All utility poles should be removed from the vehicle recovery area or treated with shield and/or breakaway devices.

SIGNS, SIGNALS AND MARKINGS

Signs, signals and markings on R-R-R projects will conform to the requirements of the current "Manual On Uniform Traffic Control Devices For Streets And Highways" and the N.C. Supplement to the MUTCD.

PAVEMENT CROSS-SLOPE

Although pavement cross slopes of 2% (Normal Crown) are preferred, actual slopes of 1% to 3% are acceptable. Existing pavement cross slopes on R-R-R projects should be revised to fall within this range.

LANE WIDTHS AND SHOULDER WIDTHS

The lane and shoulder widths shown on Table 2 (Page 13) are the minimum acceptable values for R-R-R projects.

Pavement widening for horizontal curves, where justified, shall be done in accordance with latest AASHTO guidelines.

PAVED SHOULDERS

Refer to Note 4 of Table 2 of this guide.

CURBS

Curbs and/or shoulder berm gutter and/or expressway gutter may be utilized in rugged terrain and highly developed areas to control drainage and/or to minimize right of way requirements.

6" curb does not reduce the requirements for Vehicle Recovery Area.

It is desirable in high-speed facilities (50 mph or greater) that curb not exceed 4" in height when used in conjunction with guardrail.

DITCHES

It is desirable to obtain a traversable ditch section on R-R-R projects. This requires ditch front slopes and back slopes as shown on, page 24. There will be entire projects, or parts of projects, where this treatment is not cost effective. Priority should be given to hazardous ditches on the outside of curves and in high crash areas. When a non-traversable roadway ditch is to remain in place, the front slope should not be steeper than 4:1 (3:1 in mountainous terrain) with a minimum ditch depth capable of meeting drainage requirements.

ROADSIDE VEGETATION

It is desirable that the existing slopes and ditches within the identified project limits which are not to be regraded, be stabilized by vegetation or other erosion control device such that the project not be in a significantly erodable state. This is particularly important where the project is within a natural drainage area of high quality waters such as trout streams or coastal sounds.

Note: Consideration should be given regarding shoulders to improve drainage when the vegetation height is greater than the pavement causing water to pond on the pavement.

Table 2

Minimum Width Revisions Based on

(NCHRP Report 486, Table 4)

Minimum Lane and Shoulder Widths for R-R-R Projects

Design Speed	Current ADT	Arterial		Collector		Local	
		Lane Width	Shoulder	Lane Width	Shoulder	Lane Width	Shoulder
Under 50 mph (Level and Rolling Terrain)	0 - 1000	11	4	10	3	10	3
	1000-2000	11	4	10	3	10	3
	over 2000	12	6	11	6	11	6
50 mph and over (Level and Rolling Terrain)	0 - 1000	11	4	11	3	10	3
	1000-2000	12	6	11	4	11	3
	over 2000	12	6	11	6	11	6
Under 50 mph (Mountainous Terrain)	0 - 1000	10	3	10	3	10	3
	1000-2000	11	3	10	3	10	3
	over 2000	12	6	11	6	11	4
50 mph and over (Mountainous Terrain)	0 - 1000	11	3	11	3	10	3
	1000-2000	11	3	11	3	10	3
	over 2000	12	6	11	6	11	4

- NOTES:**
- Shoulder dimensions indicate graded widths and include paved shoulder widths.
 - Where guardrail is to be installed, graded shoulder width must be increased by 3 feet.
 - Where truck traffic (TTST and Duals) volume exceeds 10% of current ADT, lane widths should be increased by 1' to a maximum of 12'. 12' lane width should be used on routes designated as part of the National Truck Network.
 - For current ADT less than 1000, paved shoulder should be considered. For current ADT between 1000 - 3000, 2' paved shoulders are recommended. For current ADT over 3000, 4' paved shoulders should be used.

GUARDRAIL

Use Chapter 3 of the Roadway Design Manual to determine guardrail needs and location. The NCDOT Roadway Standard Drawings (Std. No. 862.01, 862.02, and 862.03) also contain useful information.

BRIDGES

The project planning report will contain recommendations and requirements concerning the disposition of any bridge within the limits of or contiguous to a R-R-R project. If replacement is required, the new bridge should be constructed in accordance with the current North Carolina Department of Transportation's Bridge Policy.

Bridges requiring replacement or major rehabilitation will normally be done using Bridge Replacement funds. The project planning report will address this matter and make a recommendation on the source of funding.

On R-R-R projects, bridges requiring no work or only minor structural rehabilitation may remain in place if the following requirements are met:

1. The bridge clear width is equal to or greater than the minimum widths shown in Table 3 (Page 19) and crash experience indicates no crash problems exist.
2. Vertical clearance equal to or greater than the minimum clearance shown in Table 3 and there is no history of damages due to overheight vehicles.
3. Bridge railings and transitions are revised to provide for adequate strength and geometric standards in accordance with current AASHTO "Standard Specifications for Highway Bridges".
4. The bridge has been rated and posted, if necessary, in accordance with the "Manual for Maintenance Inspection, Rating and Posting of Bridges on the North Carolina Highway System" to a weight limit determined to meet the needs of the route served; however, the safe load capacity shall be sufficient to carry school buses and vital service vehicles when there is no reasonable or adequate alternate route.

If these requirements cannot be met, then a design exception will be necessary.

Bridges within or contiguous to R-R-R projects shall be signed and marked in accordance with the MUTCD and N.C. Supplement to the MUTCD and the criteria as specified in the AASHTO report, "Highway Design and Operational Practices Related to Highway Safety, Second Edition, 1974". Approach traffic barriers are to be in conformance with AASHTO Roadside Design Guide, 2002.

If a bridge is to remain in place, an evaluation must be made to determine what treatment, if any is required for operational and structural adequacy. National Cooperative Highway Research Program (NCHRP) Research Results Digest 98, "Safety at Narrow Bridge Sites", provides guidance for making operational safety evaluations. Where crash data indicates a problem on a bridge, an analysis will be made to determine the necessary corrective action such as providing improved transitions, rehabilitation or replacement.

Action taken, if any, in revising vertical clearances at existing overpass structures will be based on the traffic characteristics of the route, history of damages due to overheight vehicles, cost required to increase the vertical clearance, and the availability of an adequate alternative route.

On bridges requiring major structural rehabilitation or replacement, the following requirements must be met:

1. HS-20 design live load in accordance with the current AASHTO "Standard Specifications for Highway Bridges". Emphasis is placed on the fact that a lower design live load may be determined to be acceptable if it meets the needs of the route served.
2. Strength and geometric requirements for bridge railings based on the current AASHTO "Standard Specifications for Highway Bridges".
3. Bridge clear roadway width requirements of the current North Carolina Department of Transportation's policy for new and reconstructed bridges. When it is not practical to widen bridges to these geometric standards (due to such factors as physical constraints and/or operational characteristics), an analysis will be required for review and approval as a design exception.

TABLE 3

MINIMUM CLEAR ROADWAY WIDTH FOR BRIDGES TO REMAIN IN PLACE (IN FEET)						
Local Des. ADT	Local (a)	Design ADT	Collector (a)	Arterial	Freeway	Interstate
≤ 250	20	≤ 400	22	28 (b) (f)		
251 To 1500	22	401 To 1500	22	28 (b) (f)		
1501 To 2000	24	1501 To 2000	24	28 (b) (f)		
Over 2000	28	Over 2000	28	28	24' Plus Paved Shoulders (c)	24' Plus Pav. Shldr. (d)
MINIMUM VERTICAL CLEARANCES FOR BRIDGES TO REMAIN IN PLACE						
	14		14	14	14	16 (e)

- a) Bridges longer than 100' may be analyzed individually in accordance with AASHTO.
- b) For arterials with 11' lanes and design speeds of 40 mph or less, 26' may be used.
- c) As a minimum, a Crash History Evaluation should be completed to determine if additional width is required. Ultimate widening should be considered for all existing bridges with less than 3' offsets to parapets. Bridges longer than 200' may be analyzed individually.
- d) Bridges longer than 200' may be analyzed individually in accordance with AASHTO (4' minimum offset to parapet required).
- e) 14' on Urban Interstate when there is an Alternate Interstate Routing with 16' clearance.
- f) Width of travel way may remain at 22' on reconstructed highways where alignment and safety records are satisfactory.

DATE _____

PROJECT ENGINEER: _____

DESIGN EXCEPTION REQUEST FOR A FEDERAL-AID PROJECT

Fed Aid Project No.:

State Project No.:

TIP No.:

County:

Design Exception Requested for: (design speed, bridge width, lane or shoulder width, structural capacity, vertical clearance, stopping sight distance, horizontal or vertical alignment, grades, cross slopes, superelevation)

Location of Design Feature in Question:

PROJECT DATA

Current ADT (Year):

Design ADT (Year):

% Trucks: * Dual Tire _____%
TTST _____%

Design Speed:

Posted or Statutory Speed:

Functional Classification:

Minimum AASHTO R-R-R Dimensions:

Dimensions Proposed:

Total Estimated Cost of Project:

Additional Cost to Meet Minimum AASHTO R-R-R Requirements:

BASIS FOR EXCEPTION

1. Describe how the crash history relates to the proposed design exception. See current 3-year crash history, attached (number, type, rates, severity, cause, comparison to statewide average, etc.).

*The percent trucks will be supplied by the Statewide Planning Branch.

2. Describe any future plans for upgrading this roadway either at or in the vicinity of this project.

3. Describe the cross section, geometrics, access control, etc. of the existing roadway outside the project limits.

4. Explain why it is not reasonable or feasible to meet (engineering, environmental and/or ROW constraints) minimum AASHTO R-R-R requirements.

5. Describe any measures proposed to mitigate the design element that is below standards.

MEMO TO: Division Engineer/Appropriate Branch Manager

FROM: Unit/Section Head

DATE: _____

SUBJECT: Project _____ (_____) _____ County
F. A. Project _____

Request for Design Exception

This is a request for a design exception _____. See attachment or
_____ pertinent information.

If you have any questions, please contact me at _____.

Requesting Design Engineer

Asst. Unit/Section Head

Requesting Design Engineer's
Immediate Supervisor

Unit/Section Head

Attachment
cc: State Design Engineer

APPROVED: _____

DATE: _____

cc: Unit/Section Head

NCDOT DESIGN EXCEPTION REQUEST
(Project does not require FHWA design approval)

F.A. Project No.: State Project No.:

TIP No.: County:

Design Exception Requested for: (design speed, bridge width, lane or shoulder width, structural capacity, horizontal or vertical clearance, stopping sight distance, horizontal or vertical alignment, grades, cross slopes, superelevation)

Location of Design Feature in Question:

PROJECT DATA

Current ADT (Year): Design ADT (Year):

% Trucks: Design Speed: Posted Speed:

Functional Classification:

Minimum AASHTO Dimensions: Dimensions Proposed:

Total Estimated Cost of Project:

Additional Cost to Meet Minimum AASHTO Requirements:

BASIS FOR EXCEPTION

1. Describe how the crash history relates to the proposed design exception. See current 3-year crash history, attached (number, type, rates, severity, cause, comparison to statewide average, etc.).
2. Describe any future plans for upgrading this roadway either at or in the vicinity of this project.
3. Describe the cross section, geometrics, access control, etc. of the existing roadway outside the project limits.
4. Explain why it is not reasonable or feasible to meet (engineering, environmental and/or ROW constraints) minimum AASHTO requirements.
5. Describe any measures proposed to mitigate the design element that is below standards.

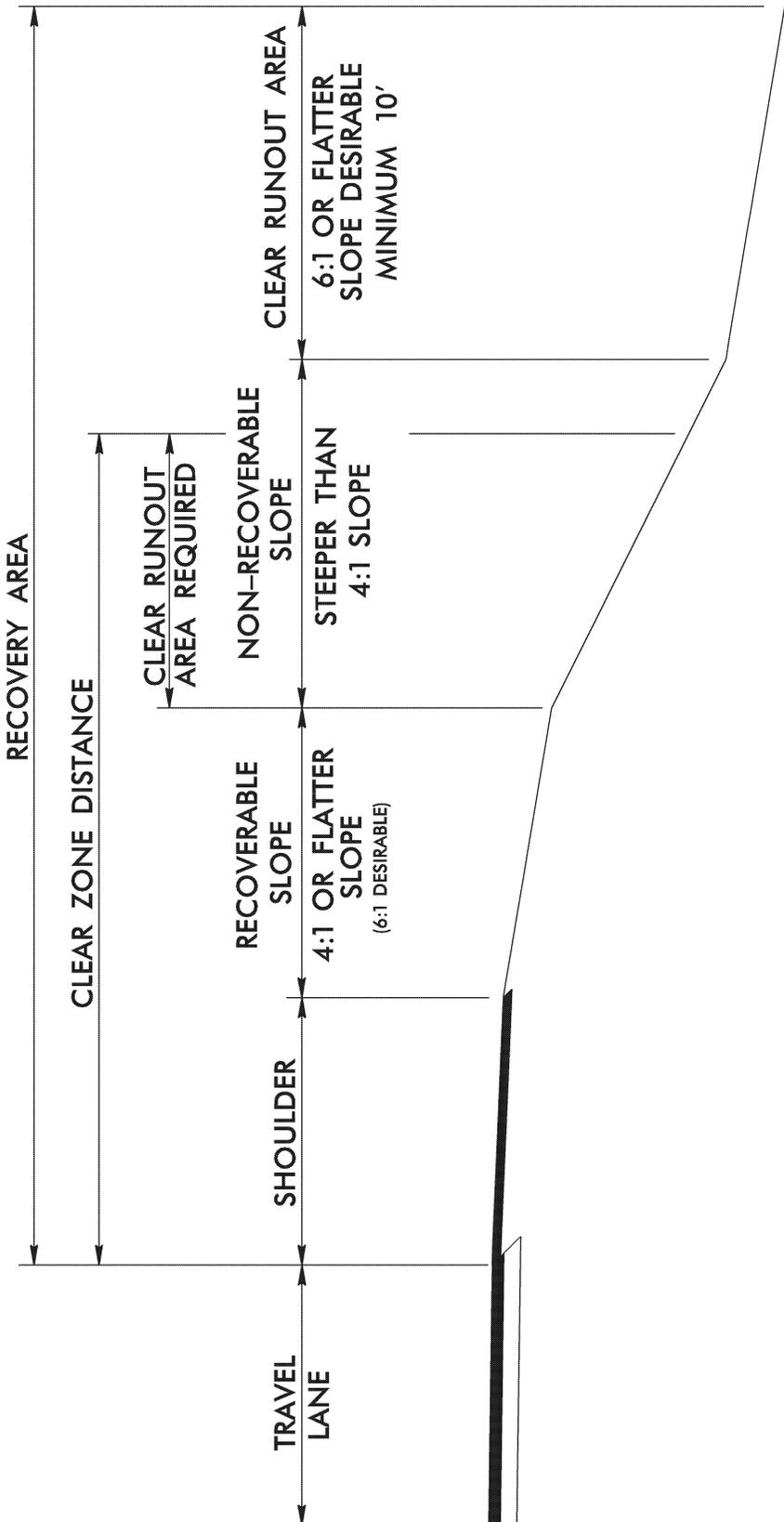
DESIGN EXCEPTION PROCESS CHECKLIST

Date: _____ Engineer: _____
 TIP No: _____ Functional Classification: _____
 Posted Speed _____ Terrain _____

<u>Items requiring formal approval</u>	<u>Prop Design</u>	<u>AASHTO Std⁽¹⁾</u>	<u>Exception Req'd</u>
Design Speed ⁽²⁾	_____	_____	_____
Lane Width	_____	_____	_____
Shoulder Width	_____	_____	_____
Bridge Width	_____	_____	_____
Structural Capacity ⁽³⁾	_____	_____	_____
Maximum Grade	_____	_____	_____
Min. Horizontal Curve Radius	_____	_____	_____
Sag Vertical Curve K	_____	_____	_____
Crest Vertical Curve K	_____	_____	_____
Horizontal SSD	_____	_____	_____
Vertical SSD	_____	_____	_____
Pavement Cross Slope	_____	_____	_____
Superelevation	_____	_____	_____
Vertical Clearance	_____	_____	_____
Horizontal Clearance	_____	_____	_____

Listed below are the known non-complying items not requiring an approved design exception.

- (1) The AASHTO STD. as it relates to the design speed should be equal to the higher of either the posted speed or the minimum "Greenbook" value for design speeds.
- (2) If design speed is less than the posted or statutory speed, a design exception is required.
- (3) Bridge Maintenance Design's responsibility - be sure they have checked for need of design exception.



DETAIL GUIDE FOR VEHICLE RECOVERY AREA

CLEAR ZONE DISTANCES

(IN FEET FROM EDGE OF TRAVEL LANE)

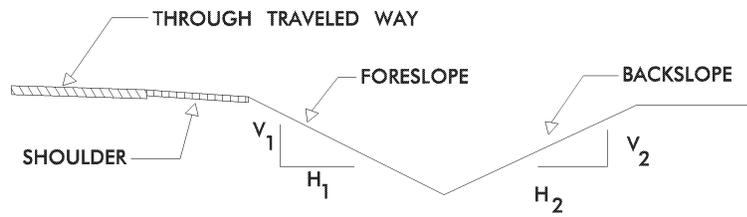
(U.S. Customary Units)

DESIGN SPEED	DESIGN ADT	FORESLOPES			BACKSLOPES		
		1V:6H or flatter	1V:5H To 1V:4H	1V:3H	1V:3H	1V:5H To 1V:4H	1V:6H or flatter
40 mph or less	UNDER 750	7-10	7-10	**	7-10	7-10	7-10
	750-1500	10-12	12-14	**	10-12	10-12	10-12
	1500-6000	12-14	14-16	**	12-14	12-14	12-14
	OVER 6000	14-16	16-18	**	14-16	14-16	14-16
45 - 50 mph	UNDER 750	10-12	12-14	**	8-10	8-10	10-12
	750-1500	12-14	16-20	**	10-12	12-14	14-16
	1500-6000	16-18	20-26	**	12-14	14-16	16-18
	OVER 6000	18-20	24-28	**	14-16	18-20	20-22
55 mph	UNDER 750	12-14	14-18	**	8-10	10-12	10-12
	750-1500	16-18	20-24	**	10-12	14-16	16-18
	1500-6000	20-22	24-30	**	14-16	16-18	20-22
	OVER 6000	22-24	26-32 *	**	16-18	20-22	22-24
60 mph	UNDER 750	16-18	20-24	**	10-12	12-14	14-16
	750-1500	20-24	26-32 *	**	12-14	16-18	20-22
	1500-6000	26-30	32-40 *	**	14-18	18-22	24-26
	OVER 6000	30-32 *	36-44 *	**	20-22	24-26	26-28
65-70 mph	UNDER 750	18-20	20-26	**	10-12	14-16	14-16
	750-1500	24-26	28-36 *	**	12-16	18-20	20-22
	1500-6000	28-32 *	34-42 *	**	16-20	22-24	26-28
	OVER 6000	30-34 *	38-46 *	**	22-24	26-30	28-30

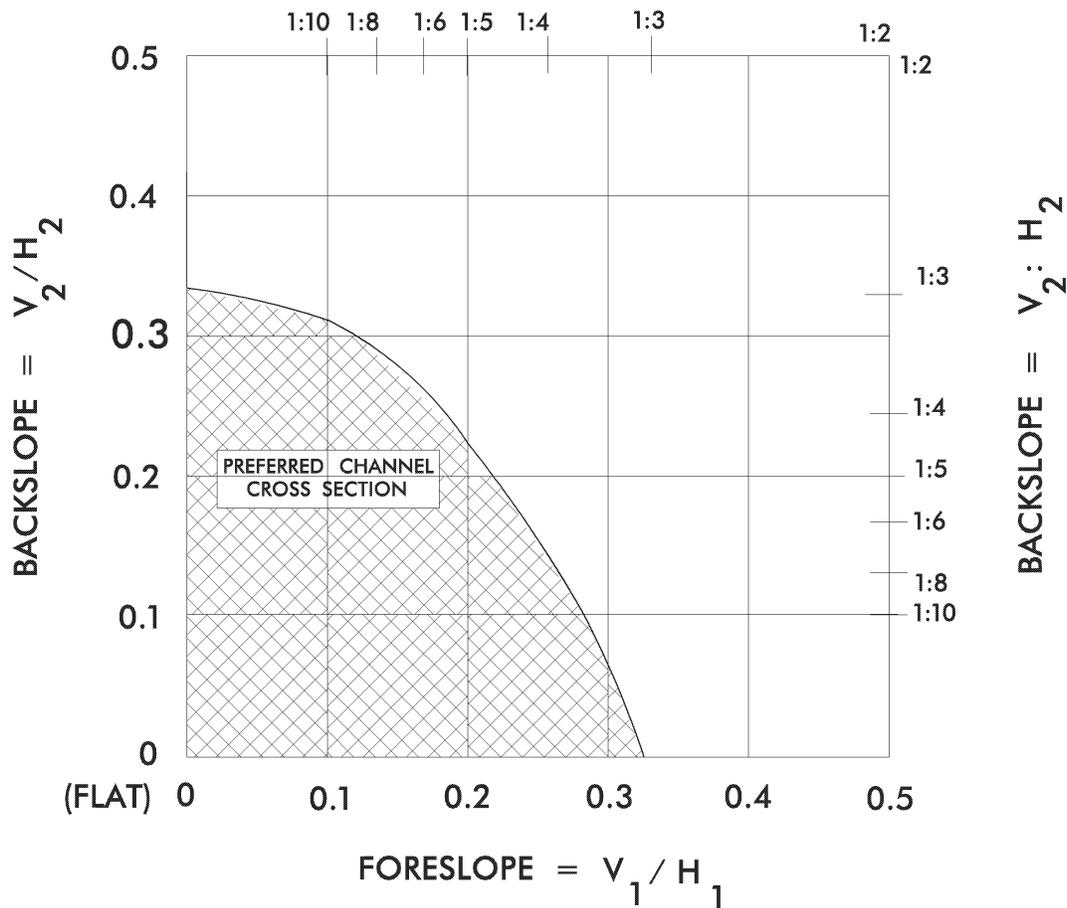
* Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear-zone distances greater than the clear-zone zone shown in Table 3.1. Clear zones may be limited to 30 ft for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

**Since recovery is less likely on the unshielded, traversable 1V:3H slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the through traveled lane and the beginning of the 1V:3H slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the foreslope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 3.2.

PREFERRED CROSS SECTIONS FOR CHANNELS WITH ABRUPT SLOPE CHANGES



$$\text{FORESLOPE} = V_1 : H_1$$



***This chart is applicable to all Vee ditches, rounded channels with a bottom width less than 2.4 m (8ft) and a trapezoidal channels with bottom widths less than 1.2 m (4ft).**