

HIGHWAY DESIGN MANUAL

Chapter 7 - Resurfacing, Restoration And Rehabilitation (3R)

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**CHAPTER 7
RESURFACING, RESTORATION AND REHABILITATION**

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CHAPTER 7 RESURFACING, RESTORATION AND REHABILITATION

7.1 INTRODUCTION

The purpose of this chapter is to provide specific requirements and guidance for freeway 3R (Resurfacing, Restoration and Rehabilitation) projects and to provide standards and guidance for non-freeway 3R projects. However, other chapters and Engineering Instructions continue to provide requirements and guidance for design elements not modified by this chapter, such as pavement design, traffic control devices, guide rail, accommodation of pedestrians and bicyclists, drainage, utilities, landscaping, driveways, etc.

There are two types of 3R projects: freeway 3R projects and non-freeway 3R projects. Section 7.2 contains the definition of freeway 3R along with specific requirements and guidance. Section 7.3 contains the definition of a non-freeway 3R project along with specific standards and guidance. Section 7.2 and 7.3 are distinct and independent of each other. There is no relationship between the requirements for freeway 3R projects and the standards for non-freeway 3R projects. Accordingly, projects that contain both freeway and non-freeway segments shall be designed in accordance with Sections 7.2 and 7.3 respectively.

7.2 REQUIREMENTS AND GUIDANCE FOR FREEWAY 3R PROJECTS

There are no separate standards for freeway 3R projects. The standards for 3R projects on interstates and other freeways are the same as those that apply to new and reconstruction projects, except as specifically noted in Section 7.2.7 of this chapter. Consequently, the requirements and guidance in this section apply to all interstate and other multilane freeway 3R projects regardless of funding. Unless specifically modified by this chapter, all other Department policies, procedures, standards, rules, regulations and guidance must be followed as appropriate. A freeway resurfacing project must follow these freeway 3R requirements if the minimum overall thickness of truing and leveling plus the single course overlay exceeds 40 mm, or the project proposes multiple overlays.

7.2.1 Definition of Freeway Resurfacing, Restoration & Rehabilitation (3R)

7.2.1.1 Definition of the Term Freeway 3R

For the purposes of this chapter, the term freeway 3R applies to interstates and other freeways, expressways and multi-lane divided parkways. The following definitions are based on Chapter 2, Section 2.4.1:

1. Interstate highways are highways on the Interstate Highway System. Generally, they are interregional, high speed, divided, high volume facilities with complete control of access. All interstates in New York State are freeways.
2. Freeways are local, intraregional and interregional high speed, divided, high volume facilities with complete control of access. Historically, most freeways have been classified as principal arterials.
3. Expressways are divided highways for through traffic with full or partial control of access and generally with grade separations at major crossroads.

7.2.1.2 Freeway 3R Project Scope of Work

Resurfacing is defined as the placement of an additional pavement layer or layers over the existing traveled way and paved shoulders to enable the existing pavement to achieve its design life and to provide additional strength or to improve serviceability. Restoration and rehabilitation are defined as the work required to return the existing traveled way and shoulders to a suitable condition for resurfacing while improving highway safety. This includes work necessary to return the roadway, including the shoulder, roadside, bridges and appurtenances to a condition of structural or functional adequacy.

Freeway 3R projects are designed to extend the operational and service life, and to enhance the safety of an existing freeway. Since the standards for 3R projects on interstates and other freeways are the same as those that apply to new and reconstruction projects, except as specifically noted in Section 7.2.7 of this chapter, there are almost no limitations on the type of work that can be accomplished. All work is allowable except the extensive replacement of existing pavement or the addition of new travel lanes. Projects with extensive full depth pavement replacement or the addition of new travel lanes can not be classified as 3R type projects and shall follow the criteria in Chapter 2, Section 2.7 for new or reconstruction projects.

The general philosophy to follow when developing a freeway 3R project is to treat interstates and other freeways as what they are, our most important highway system. Consequently, extra effort should be exercised to maintain, restore, or improve them with particular emphasis placed on improving safety and operations.

There is a federal legislative requirement [see 23 Code of Federal Regulations (CFR) Section 106(b)(3) and Section 109(a)] as well as Federal Highway Administration (FHWA) policy requiring safety improvements in every freeway 3R project. Emphasis should be placed on maintaining, re-establishing, or, in the cases of some older freeways, creating a forgiving roadside for the high speed traveler. Work to restore or upgrade existing safety provisions must be part of every freeway 3R project. Elements that affect safety, and which are not consistent with current standards or design guidelines, should be seriously considered for upgrading as part of any freeway 3R project. The greater the deviation, the greater the need to consider improvement.

One of the major decisions is to determine if a freeway 3R project is the appropriate type of project to address the needs and resulting objectives. A different type of project, such as a reconstruction project, or a freeway 3R project in combination with future reconstruction projects, may be necessary to address the identified needs and provide the most effective long term solution. Generally, the most effective long term solution will also be the most cost-effective solution.

Prematurely deciding on a freeway 3R project or deciding not to gather needed data defeats the scoping process. This can lead to a failure to identify important problems that need treatment, selecting the wrong type of project, or designing an incomplete solution. Accordingly, it is essential that functional group representation on the scoping team be emphasized to reduce the possibility of this occurring.

To ensure a freeway 3R project operates satisfactorily during its design life (which varies from about 8 years for a thin overlay to 15 years for crack and seat, rubblizing, or thick overlays), it is essential that the needs/deficiencies be identified during scoping and the resulting objectives identified and agreed to. How and to what extent the needs will be addressed must be discussed in the scoping documents and design reports. These documents must include the rationale for the decisions not to include work in the freeway 3R project that is needed to remediate identified deficiencies.

Freeway 3R projects should be designed to be compatible with future improvements. Transportation System Management (TSM) and Travel Demand Management (TDM), as well as other mobility enhancing strategies, need to be considered and discussed in the scoping document(s) and Design Report when there are current or expected congestion/mobility problems. There should be a deliberate consideration of opportunities to better manage demand or traffic flow on the system, such as the use of park-and-ride lots, intermodal connection facilities, signal system improvements at interchange crossroads, etc.

Opportunities for environmental improvements and mitigation should be considered. There may be many opportunities for landscaping, water pollution abatement, soil erosion control, pedestrian and bicyclist accommodations (at crossroads or along independent paths) and other appropriate work on freeway 3R projects. Contact the Regional Landscape Architect, the Regional Environmental Contact and refer to Chapter 18 for additional information on environmental enhancements.

The following sections provide specific requirements and guidance for freeway 3R projects. The intent is twofold: 1) to identify those features and scoping/design elements that must be examined and 2) to identify those features which may or may not need to be improved based upon engineering judgement following examination of particular project circumstances such as accident history, potential environmental impacts, the costs to correct and the benefits anticipated from the improvement.

7.2.2 Procedures

Project scoping activities for freeway 3R projects shall follow the procedures in the Scoping Procedure Manual, including the preparation of a scoping document. After project scope closure, freeway 3R projects shall follow the procedures in Design Procedure Manual (DPM) Part II as required by DPM Part I, Section I.C. This includes the preparation of a Design Report as described in Appendix B of the DPM. The format and content of the Design Report required by Appendix B was created to accommodate all projects, including freeway 3R type projects.

7.2.3 Pavement Condition and Treatment

For any 3R project, it is important to determine the primary types of deterioration, to perform a pavement evaluation, and to decide the appropriate corrective action. The NYSDOT Pavement Rehabilitation Manual (Volumes I & II); Chapter 3, Section 3.3 of this manual; and other current Department pavement policy and instructions must be followed.

The Department's two-volume Pavement Rehabilitation Manual is an important tool in scoping pavement work. Volume I, Pavement Evaluation, provides guidance on evaluating the condition of existing pavements and the preparation of Pavement Evaluation and Treatment Selection Reports. Additional guidance on Pavement Evaluation and Treatment Selection Reports is provided in

Volume II, Treatment Selection, which also describes accepted rehabilitation alternatives (ranging from preventive maintenance to reconstruction) and provides guidance on selection procedures. A related document, "Pavement Restoration Techniques", lists both the accepted rehabilitation techniques and the "Project Level Special" and "Experimental Feature" alternatives. (The current version of this document is contained in EI 92-26 and was partially revised by EI 93-28.) Engineering Instruction 92-15 "Project Level Pavement Selection Process" provides the guidance on which procedures should be used to select a pavement treatment.

Once a pavement treatment is selected, the following criteria determines whether or not the pavement treatment is consistent with a freeway 3R type project. A freeway 3R project, as defined in Section 7.2.1 of this chapter, applies to pavement treatments with:

1. single course overlays of 40 mm. (These projects may also be progressed as preventive maintenance paving projects if the project meets the requirements and selection criteria.)
2. a minimum overall thickness of truing and leveling plus the single course overlay over 40 mm;
3. multiple overlays;
4. no extensive replacement of existing pavement; and
5. no new additional travel lanes.

Freeway 3R projects that meet the criteria in EI 92-15 are required to follow the Project Level Pavement Selection Process described in the EI. Freeway 3R projects that do not meet the criteria for the Project Level Pavement Selection Process in EI 92-15 may use the conventional pavement treatments in Chapter 3, Section 3.3 of this manual. The conventional pavement treatments in Chapter 3, Section 3.3 do not require the preparation of a Pavement Evaluation and Treatment Selection Report. However, as with all freeway 3R projects, the existing conditions, needs and pavement treatment should be included in the Design Report as required by DPM Appendix B.

7.2.4 **Traffic Volumes and Level of Service**

7.2.4.1 Required Information

Traffic counts and traffic forecasts are required for the mainline, ramps and ramp terminal intersections. The following information should be included:

1. Mainline average annual daily traffic (AADT);
2. Crossroad (two-way) design hourly volume (DHV), as applicable;
3. Mainline and ramp (one-way) directional design hourly volume (DDHV);
4. Mainline (design hour) percent trucks in each direction for capacity analysis and the percentage of trucks during off peak periods (if greater than the peak hour percentage) for both safety and capacity storage issues;

5. Mainline traffic flow diagrams for commuter travel (e.g. A.M. and P.M. peak hours) which show, for each link, the current AADT, DHV, DDHV, and design hour percent trucks (for projects which may include, for example, a truck climbing lane), and
6. Interchange traffic flow diagrams with the current design hour turning movement volumes, design hour percent trucks, and current AADT's on all approaches, including ramp terminal intersections.

As an exception to taking detailed traffic counts, estimated traffic counts may be used for segments which meet all of the following:

1. based on observations during peak periods, the facility is operating at a level of service of A or B;
2. there are no back-ups from the ramps onto the mainline; and
3. there are adequate deceleration distances to the back of the stopped queues on the ramps.

There may be a need to provide traffic volumes for other peak periods for commercial generators or special events (e.g. weekend peak travel periods, concert or sporting events, etc.). Also, some highways have a noon peak period that should be shown and considered in the project's geometric design.

The level of service should be calculated for the mainline, ramps and intersections using the existing and future traffic volumes. Refer to Chapter 5, Section 5.2 and the "Highway Capacity Manual" (Special Report 209, Transportation Research Board, 1994) for information concerning highway capacity and level of service.

7.2.4.2 Design Year

For normal overlays (80 mm or less) the design year is the estimated time of completion (ETC) + 10 years. When the required capacity analysis indicates that any elements of the project (e.g. mainline, weaves, merges, diverges, ramps, ramp intersections, etc.) are at or approaching congestion levels (low level of service D or worse in the design year), evaluate the appropriateness of a freeway 3R project versus a project scoped to overcome the existing or emerging problems. If the analysis results in the need for reconstruction work (such as adding an auxiliary lane), that portion of the project requires a 20 year traffic projection for design (30 years for structures).

Transportation System Management (TSM), Travel Demand Management (TDM) and Intelligent Transportation System (ITS) measures should be considered as a way to alleviate congestion when elements of the project are at, or approaching, congestion levels. For additional information, refer to Chapter 5, Section 5.9.6 Increasing Capacity Without Adding Lanes.

Pavement treatments with longer design lives, such as crack and seat, rubblizing or thick overlays, need to be evaluated with traffic projections consistent with the expected design life of the pavement treatment as found in the Pavement Rehabilitation Manual Vol. II or in the latest Traffic Forecast Policy, which is located in Appendix D of the Scoping Procedure Manual. For example, a design year of ETC+15 is to be used for crack and seat, rubblizing, or overlays thicker than 80 mm.

7.2.4.3 Operational Problems

Of specific concern are operational problems that cause (or will cause during the design life of the project) back-ups on or onto the mainline, or that do not allow proper deceleration distance to the back of queues formed on ramps. (Peak hour observations, traffic projections and analysis, as necessary, are essential in identifying or confirming operational problems and their magnitude).

When work is proposed for the ramps, consideration must be given to the intersection of the ramp with the crossroad. Additionally, consideration should be given to the traffic characteristics of the adjacent crossroad sections. For example, adding a turning lane at the ramp terminal intersection may not resolve safety and operational problems if a nearby intersection will become congested in the design year and vehicles will queue up on the crossroad and block the ramp terminal. This just transfers the congestion from one intersection to another. How far to carry an analysis away from the ramp(s) intersection is a matter of judgement which depends on the magnitude and nature of the identified or potential problems. The intent is to consider mitigation of operational problems that affect the freeway mainline and to optimize the use of the freeway (e.g. interchange congestion preventing full utilization of the freeway mainline). When operational problems are identified, the project scope needs to be modified to include the work. When this is not practical, the work should be included in a future contract (in a timely manner), or, as a minimum, the operational problem(s) should be monitored.

The severity of the problem and the cost to mitigate are factors that should be considered when deciding whether to a) include the work, b) delay the work to a future contract, or c) just continue to monitor the situation. The Design Report must indicate how, when, or if the work will be accomplished. Interim treatments such as force off detectors on ramps or ramp metering should be considered, especially when there are identified accident problems or the potential for accident problems. Refer to Chapter 5, Section 5.9.6 Increasing Capacity Without Adding Lanes for additional information on innovative measures to alleviate congestion.

7.2.5 Accident Data and Analysis

7.2.5.1 Accident Data

Accident data is to be collected and analyzed to identify accident problems as part of the decision making process. Accident data must be included for the full length of the project, including the mainline, ramps, and ramp intersections with crossroads. (Note that accidents along ramps are currently coded to the mainline or to the intersection cross-street.) Accident data should also be requested for all sections within 0.5 km from the project limits.

Desirably, the most recent three year accident data should be used for the accident analysis. The date of the most recent data should be within two years of the design approval date, unless the Regional Traffic Engineer verifies that older data still represents the existing conditions. Regardless, the most recent Priority Investigation Location (PIL) list, Priority Investigation Intersection (PII) list, Safety Deficient Location (SDL) list and the Utility Pole "Bad Actors" list for the project location should be requested and reviewed before design approval. Note that older accident data should be reviewed, along with the newer data, when the pavement has deteriorated such that it is limiting vehicle speeds, since, after resurfacing, old accident problems related to speed may re-occur.

7.2.5.2 Accident Analysis

An accident analysis, as discussed in Chapter 5, Section 5.3, must be completed prior to design approval. Desirably, an accident analysis should also be performed after design approval and included in the project file. As a minimum, a PIL list, PII list, SDL list and the Utility Pole "Bad Actors" list for the project location should be requested and reviewed periodically after completion of the accident analysis and until the PS&E submission. This will ensure that an opportunity is provided to correct or mitigate any new accident locations or problems that may occur, prior to project letting.

7.2.5.3 Disposition of Accident Analysis Results

Every opportunity should be taken to incorporate safety improvements into freeway 3R projects at an early stage. Low cost safety enhancements, such as shoulder rumble strips, improved signing, improved superelevation, and utility pole relocations should be routinely incorporated in freeway 3R projects as a standard practice.

When safety deficiencies are noted, they should be corrected. Needed safety improvements that are not included in the project must be explained and documented in the Design Report. The decision to postpone work to future contracts should be considered carefully, especially where accident histories are significant. Interim measures should also be considered.

For more information on accident data and analysis, refer to Chapter 5, Section 5.3 and the Traffic Engineering & Safety Division's publication "Highway Safety Improvement Program: Procedures and Techniques."

7.2.6 Geometric Design Standards

There are no separate standards for freeway 3R projects. The standards for 3R projects on interstates and other freeways are the same as those that apply to new and reconstruction projects, except as specifically noted in Section 7.2.7 of this chapter. Federal law specifically prohibits separate interstate 3R standards. Consequently, there is no relationship between these freeway 3R projects and the Department's Non-Freeway 3R Standards which apply only to non-interstate and non-freeway resurfacing, restoration and rehabilitation projects. It is helpful to visualize interstate and other freeway 3R projects as reconstruction projects on existing alignment in respect to everything except the pavement treatment.

The standards that apply are from AASHTO's "A Policy on Geometric Design of Highways and Streets," 1990 and 1994 (Note: The 1994 AASHTO Policy has not been adopted by FHWA as of this date), and AASHTO's "A Policy on Design Standards - Interstate System," July, 1991. All standards used, including those reflected in the design criteria, must be consistent with the current design speed established in accordance with Section 7.2.7 of this chapter.

7.2.7 Design Criteria

This section provides the standard values for the critical design elements, which are to be listed as design criteria. A list of design criteria must be provided in accordance with Chapter 2 for the mainline, ramps and any crossroads that have proposed work at ramp terminal intersections. Any critical design elements that do not comply with this section and Chapter 2, Section 2.7 (as referenced in this section), or the appropriate standards that were in effect at the time of construction or the time of inclusion in the interstate system shall be discussed as non-standard features in accordance with Chapter 2, Section 2.8.

Except as noted below, this section and Chapter 2, Section 2.7 (as referenced in this section), shall be used to determine the design criteria which are derived from the standards referenced in Section 7.2.6. The important exceptions are:

Freeway 3R projects on interstates may use the selected design criteria listed below from the AASHTO Interstate Standards in effect at the time of original construction or inclusion in the interstate system (Reference: page 1 of AASHTO's "A Policy on Design Standards - Interstate System," July, 1991.). Similarly, freeway 3R projects on other freeways may use the selected design criteria listed below, for existing elements, from the interstate standards that were in effect at the time of the freeway's construction.

Selected Design Criteria: As shown in Tables 7-1 and 7-2, only the standards for stopping sight distance, minimum radii, maximum superelevation rate, grade, and the widths of medians, mainline travel lanes, and mainline shoulders from the AASHTO interstate standards in effect at the time of the freeway's construction or inclusion in the interstate system may be used in place of the current standards for existing elements. Other features shall be designed or evaluated against the current standards and guidelines. For example, mainline design speed, lateral clearance, vertical clearance, and ramp lane widths shall be based on current standards and guidelines and NOT the standards from the time of original construction or inclusion in the interstate system. Current standards must also be used for other controlling parameters such as speed change lane lengths, clear zone, etc.

When the standards from the time of original construction or inclusion in the interstate system are used, the design criteria must be consistent with the current design speed. In other words, the original design criteria based on a design speed of, say, 100 km/h (60 mph) cannot be used unless it will be consistent with the anticipated off-peak 85th percentile speed. The Design Report should reference the appropriate standards that were used. Refer to Section 7.4 of this Chapter for a list of the various editions of the AASHTO "A Policy on Design Standards - Interstate System."

Table 7-1 Mainline Critical Design Elements Based on "Standards of the Day"^{4,5}

Editions of AASHTO's "Green Book" & AASHTO's "Blue Book" ⁶	1990 & 1984	1984	1965	1954
Versions of AASHTO's & AASHTO's "A Policy on Design Standards - Interstate System"	1991	1967	1967 & 1965	1963 & 1956
Lane Width	3.6 m	3.6 m	3.6 m	3.6 m
Shoulder Width - Right	3.0 m	3.0 m	3.0 m	3.0 m
Right (Mountainous Terrain)	1.8 m	1.8 m	1.8 m	1.8 m
Left	1.2 m	1.2 m	1.2 m	1.2 m
Grade ¹ -	L R M	L R M	L R M	L M
	3.0 4.0 6.0	3.0 4.0 6.0	3.0 4.0 6.0	4.0 6.0
100 km/h (60 mph)	3.0 4.0 5.5	3.0 4.0 5.5	3.0 4.0 5.5	- -
110 km/h (65 mph)	3.0 4.0 5.0	3.0 4.0 5.0	3.0 4.0 5.0	3.0 5.0
115 km/h (70 mph)	- - -	- - -	3.0 4.0 -	- -
120 km/h (75 mph)				
Horiz. Curvature ^{2,3} -				
100 km/h (60 mph)	411 m	411 m	385 m	385 m
110 km/h (65 mph)	499 m	499 m	452 m	-
115 km/h (70 mph)	635 m	635 m	553 m	553 m
120 km/h (75 mph)	-	-	672 m	-
SSD ³ -				
100 km/h (60 mph)	160 m	160 m	145 m	145 m
110 km/h (65 mph)	168 m	168 m	168 m	-
115 km/h (70 mph)	191 m	191 m	183 m	183 m
120 km/h (75 mph)	-	-	205 m	-
Superelevation ²	6.0%	6.0%	6.0%	6.0%
Median Width - Rural Area	11.0 m	11.0 m	11.0 m	11.0 m
Mountainous Terrain	3.0 m	4.9 m	4.9 m	4.9 m
Urban Area	3.0 m	1.2 m	1.2 m	1.2 m

Notes

- 1 Level, rolling and mountainous terrain are abbreviated L, R and M, respectively.
- 2 For curves with radii larger than the minimum radius, use Tables 2-10, 2-11 and 7-4 to determine the superelevation rate.
- 3 To avoid technical discrepancies, radii and stopping sight distances are soft converted and rounded to the nearest meter.
- 4 "Standards of the day" refers to the standards in effect at the time of original construction or inclusion in the interstate system and only applies to existing features.
- 5 The design criteria must be consistent with the current design speed. Refer to Table 7-3 and Section 7.2.7.1.A of this chapter to determine the design speed. Mainline critical design elements not listed in this table shall be determined from Chapter 2, Section 2.7.1 and Section 7.2.7.1 of this chapter.
- 6 "Green Book" and Blue Book" refer to the AASHTO and AASHTO Policies noted in references 4 and 5 of Section 7.4 of this Chapter.

Table 7-2 Ramp Critical Design Elements Based on "Standards of the Day"^{3,5}

Editions of AASHTO's "Green Book" & AASHTO's "Blue Book" ⁶	1990 & 1984	1984	1965	1954
Versions of the AASHTO & AASHTO "A Policy on Design Standards - Interstate System"	1991	1967	1967 & 1965	1963 & 1956
Ramp Design Speed ⁴ -	Ramp Design Speed ⁷	Ramp Design Speed ⁷	Ramp Design Speed	Ramp Design Speed
Mainline Design Speed	40 km/h	40 km/h	40 km/h	40 km/h
80 km/h (50 mph)	50 km/h	50 km/h	50 km/h	50 km/h
100 km/h (60 mph)	50 km/h	50 km/h	50 km/h	-
110 km/h (65 mph)	60 km/h	60 km/h	50 km/h	50 km/h
115 km/h (70 mph)	-	-	60 km/h	-
120 km/h (75 mph)				
Grade -	8.0%	8.0%	8.0%	8.0%
40 km/h (25 mph)	7.0%	7.0%	7.0%	7.0%
50 km/h (30 mph)	6.0%	6.0%	6.0%	6.0%
60 km/h (35 mph)				
Horiz. Curvature at $e_{\max}^{1,2}$ -	<u>6.0%</u> <u>8.0%</u>	<u>6.0%</u> <u>8.0%</u>	<u>6.0%</u> <u>8.0%</u>	<u>6.0%</u> <u>8.0%</u>
40 km/h (25 mph)	46 m 46 m	46 m 46 m	46 m 46 m	46 m 46 m
50 km/h (30 mph)	70 m 70 m	70 m 70 m	70 m 70 m	70 m 70 m
60 km/h (35 mph)	104 m 94 m	104 m 94 m	104 m 94 m	- -
SSD ² -	46 m	46 m	49 m	49 m
40 km/h (25 mph)	61 m	61 m	61 m	61 m
50 km/h (30 mph)	69 m	69 m	73 m	-
60 km/h (35 mph)				
Maximum Superelevation ¹	6.0%	6.0%	6.0%	6.0%

Notes

1. For curves with radii larger than the minimum radius, use Tables 2-10, 2-11 and 7-4 to determine the superelevation rate. Note that an 8.0% maximum superelevation rate may be used as discussed in Sections 7.2.7.2 and 7.2.7.1.G of this chapter and also in Chapter 2, Appendix A, Table 2-8, note 1.
2. To avoid technical discrepancies, radii and stopping sight distances are soft converted and rounded to the nearest meter.
3. "Standards of the day" refers to the standards in effect at the time of original construction or inclusion in the interstate system and only applies to existing features.
4. Ramp design speed is based on mainline design speed. Therefore, the design criteria must be consistent with the current mainline design speed. Refer to Table 7-3 and Section 7.2.7.1.A of this chapter to determine the mainline design speed.
5. Ramp critical design elements not listed in this table shall be determined from Chapter 2, Section 2.7.5.2 and Section 7.2.7.2 of this chapter.
6. "Green Book" and Blue Book" refer to the AASHTO and AASHTO Policies noted in references 4 and 5 of Section 7.4 of this Chapter.
7. For loop ramps, a 40 km/h design speed may be used based on Chapter 2 of this manual and the 1984, 1990 and 1994 AASHTO Policies.

7.2.7.1 Guidance on Mainline Critical Design Elements

The following discussion of the critical design elements from Chapter 2 of this manual provides additional clarification on the standard values to be used. The following critical elements are lettered as shown in Chapter 2, Section 2.7.1.1:

A. Design Speed

Design speed is to be established in accordance with the methods in Chapter 2, Section 2.7.1.1.A. However, a speed study is not required when a 115 km/h or 120 km/h design speed is used. Refer to Table 7-3, Design Speeds for Freeway 3R Projects, to determine the design speed based on various combinations of previous design speeds, anticipated operating speeds and/or no speed studies. When realignment is warranted to eliminate a non-standard feature, consideration should be given to using a 120 km/h design speed. On freeway 3R projects, design speed shall equal or exceed the posted speed in every case.

A 115 km/h design speed is the minimum allowable for freeway 3R projects when a speed study is not performed. Although 10 km/h increments have been used for all other design speeds, a 115 km/h design speed offers the following advantages over both the 110 km/h and 120 km/h design speeds:

1. A 115 km/h design speed more closely represents the off-peak, 85th percentile speeds, which are increasing overall.
2. A design speed of 110 km/h (68.4 mph) is less than the 112.7 km/h (70 mph) used for most of the interstate system and would represent a lowering of the design standard at a time when operating speeds are increasing.
3. A 115 km/h design speed also helps accommodate the affects of an aging population, increased posted speeds, and changes in the vehicle type and mix.

Note that critical design elements, which meet the English unit standards for 112.7 km/h (70 mph) and do not meet the standards for 115 km/h, may be justified as technical discrepancies in accordance with Section 7.2.8.1.

B. Lane Width

Travel lane widths shall be a minimum of 3.6 m as shown in Table 7-1 and Chapter 2, Section 2.7.1.1 B. Hard metric conversions, rounded to the nearest 0.3 m increment, should be used for the lane width design criteria in the Design Report (e.g. original lane widths of 3.66 m (12 ft) should be converted to 3.6 m lanes). When the existing pavement width is greater than the proposed pavement width, the entire existing pavement width can be resurfaced, as appropriate, by increasing the shoulder widths.

Table 7-3 Design Speeds For Freeway 3R Projects^{1,2}

Original Design Speed Used (km/h (mph))	Anticipated Off Peak 85th % Speed (km/h (mph))	Design Speed to be Used ³ (km/h (mph))
80 (50)	no speed study	115 (70)
80 (50)	#80 (50)	80 (50)
80 (50)	>80 (50)	85th % ³
90 (55)	no speed study	115 (70)
90 (55)	#90 (55)	90 (55)
90 (55)	>90 (55)	85th % ³
100 (60)	no speed study	115 (70)
100 (60)	#100 (60)	100 (60)
100 (60)	>100 (60)	85th % ³
110 (65)	no speed study	115 (70)
110 (65)	#110 (65)	110 (65)
110 (65)	>110 (65)	85th % ³
115 (70)	no speed study	115 (70)
115 (70)	#115 (70)	115 (70)
115 (70)	>115 (70)	85th % ³
Unknown	no speed study	115 (70)
Unknown	perform speed study	85th % ³

Notes:

1. Speeds are in metric units (km/h) with English units (mph) in parentheses.
2. In all cases, the "Standards of the day" can be used. "Standards of the day" refers to the standards in effect at the time of original construction or inclusion in the interstate system and applies only to the elements listed in Tables 7-1 and 7-2. All other critical design elements shall be based on current standards. Design criteria from the "standards of the day" shall be based on the current design speed as shown in the right column.
3. Anticipated 85th percentile speeds rounded to 100 km/h, 110 km/h, 115 km/h or 120 km/h. As stated in Chapter 2, Section 2.7.1.1.A, where terrain is mountainous, a design speed of 80 km/h or 100 km/h may be used, provided that the design speed is consistent with driver expectancy, as reflected by the anticipated 85th percentile speed. In urban areas, the design speed shall be at least 80 km/h, even if the anticipated 85th percentile speed is below 80 km/h. Design speed shall equal or exceed the posted speed in every case.

C. Shoulder Width

Hard metric conversions should be used for the shoulder width design criteria in the Design Report (e.g. original shoulder widths of 1.22 m (4 ft) should be converted to 1.2 m lanes).

The shoulder width from Chapter 2 and Table 7-1 refers to the paved or stabilized shoulder which is flush with the edge of the traveled way. Generally, the full design shoulder width should be paved unless the facility is a historic parkway with aesthetic concerns, in which case at least 1.2 m of the shoulder should be paved. Additional shoulder paving may be necessary based on the historic parkway's accident history. In any case, the entire shoulder width shall be usable. If no shoulder is provided or the shoulder width is below standards, it shall be listed as a non-standard feature and justified accordingly.

Areas behind curbing (turfed, stabilized or paved) shall not be considered part of a freeway's shoulder since the edge of the useable shoulder must be flush with the traveled way. Therefore, curbs located closer to the edge of the traveled way than the required shoulder width require the shoulder to be justified as a non-standard feature and the curb to be listed as a non-conforming feature. The area behind curbing (turfed, stabilized or paved) is useful for disabled vehicles (when mountable curbing is provided) and also serves as part of the clear zone. See Section 7.2.11 for guidance and requirements for curbing.

D. Bridge Roadway Width

Determine from NYSDOT "Geometric Design Policy for Bridges."

E. Grade

When "Standards of the Day" are used, refer to Table 7-1. Otherwise, determine the maximum grade from Table 2-1 of Chapter 2.

F. Horizontal Curvature

When "Standards of the Day" are used, refer to Table 7-1 for the minimum radius. Otherwise, refer to Chapter 2, Section 2.7.1 except for the 115 km/h design speed. For a 115 km/h design speed with a maximum superelevation rate (e_{max}) of 6.0%, the minimum radius is 650 m. Similarly, at $e_{max} = 8.0\%$, the minimum radius is 580 m.

For a curve with a 115 km/h design speed, normal crown may be retained on curves with radii equal to or greater than 4630 m (i.e. Adverse crown should be eliminated on horizontal curves with radii less than 4630 m). Superelevation is required for curve radii less than 3180 m. The superelevation rates for curve radii less than 3180 m should be determined from Table 7-4.

Table 7-4 Values for Design Elements Related to a 115 km/h Design Speed and Horizontal Curvature¹

Radius R (m)	Design Speed (V_d) = 115 km/h					
	$e_{max} = 6.0\%$			$e_{max} = 8.0\%$		
	e (%)	Minimum Run Off L (m)		e (%)	Minimum Run Off L (m)	
		2 lanes	4 lanes		2 lanes	4 lanes
7000	NC	0	0	NC	0	0
5000	NC	0	0	NC	0	0
3000	2.2	64	96	2.3	64	96
2500	2.5	64	96	2.7	64	96
2000	3.1	64	96	3.3	64	96
1500	3.9	64	96	4.3	64	96
1400	4.1	64	96	4.5	64	96
1300	4.4	64	96	4.8	64	96
1200	4.6	64	96	5.2	64	96
1000	5.2	64	96	6.0	64	96
900	5.5	64	96	6.6	64	96
800	5.7	64	96	7.1	64	96
700	6.0	64	96	7.6	67	100
600	-	-	-	8.0	70	105
Minimum Radius (R_{min}) = 650 m			Minimum Radius (R_{min}) = 580 m			

Notes:

1. Table 7-4 was created using the method 5 distribution described in Chapter III of AASHTO's "A Policy on Geometric Design of Highways and Streets," 1994.
2. NC = Normal Crown.

G. Superelevation Rate

The maximum superelevation rate for the mainline is 6%. However, an 8% maximum superelevation rate may be used in the design criteria if it currently exists on the mainline and it is not contributing to the accident history.

Increases in the mainline superelevation rate from 6% to 8% for sharp horizontal curves require approval as a non-standard feature on a case by case basis. However, a rigorous non-standard feature justification is not necessary since AASHTO's "A Policy on Geometric Design of Highways and Streets," 1990 and 1994; FHWA's November, 1992 "Safety Effectiveness of Highway Design Features, Volume II: Alignment" (Publication No. FHWA-RD-91-045); the limited right-of-way; and the social, economic and environmental impacts of increasing the curve radius can be used to justify the increased superelevation rate.

The justification for superelevation rates greater than 6% should also discuss the proposed shoulder treatment required to comply with the 8% maximum rollover rate between the traveled-way and the high-side shoulder. When shoulders slope towards the travel lanes, measures should be provided to prevent water from beyond the shoulders from draining across the travel lanes. Water from a recent rainfall or melting snow can continually wet the travel lanes, which then ice-up as the temperature drops. This situation is usually present in cut sections or where guide rail allows snow to accumulate at the pavement edge. A typical section of the superelevated section will suffice for the discussion of the shoulder treatment. Refer to Chapter 3, Section 3.2.5.1 for additional information on shoulder cross slopes and superelevation.

H. Stopping Sight Distance

Refer to Table 7-1 when "Standards of the Day" are used. Otherwise, refer to Chapter 2, Section 2.7.1 except for the 115 km/h design speed. For 115 km/h, the stopping sight distance should desirably be 265 m and a minimum of 190 m. These values are based on the following AASHTO formula using the assumed average running speeds of 94.5 km/h and 115 km/h for minimum and desirable values, respectively:

$$d = (0.278)(t)(V) + \frac{V^2}{254(f)}$$

Note that the assumed average running speed from AASHTO is below the design speed. Therefore the desirable values for stopping sight distance should be used for design whenever practicable. Refer to Chapter 2, Section 2.7 for cautions on the use of minimum design values for design.

The effect of concrete barriers and other visual obstructions must be considered when determining sight distance. A concrete barrier placed on the inside of a horizontal curve will restrict sight distance around that curve. This is a common problem on curvilinear freeways with concrete median barrier. Refer to Chapter 5, Section 5.8.2 for additional information on sight distance.

I. Lateral Clearance

The minimum lateral clearance equals the shoulder width, but never less than 1.2 m, except on bridges where the NYSDOT "Geometric Design Policy for Bridges" allows less than 1.2 m.

J. Vertical Clearance

Determine from the NYSDOT "Geometric Design Policy for Bridges."

K. Pavement Cross Slope

Travel lane = 1.5% minimum to 2.0% maximum.

L. Rollover

Between travel lanes = 4.0% maximum. At edge of travel lanes = 8.0% maximum.

M. Structural Capacity

Determine from the NYSDOT "Geometric Design Policy for Bridges."

N. Level of Service

For freeways on the interstate system, determine from Section 2.7.1.1.N of Chapter 2. Otherwise, level of service is not a critical design element and should be listed as a controlling design parameter as stated in Section 7.2.7.3.B, below.

O. Control of Access

Control of access is a critical design element for freeways. Existing legal and physical controls of access should be assessed and considered for improvement where inconsistent with Chapter 2, Section 2.7.1.1.O and Chapter 6. Specifically, access control for connections to crossroads shall extend 30 m beyond the ramp terminals in urban areas and 90 m in rural areas. Additional access control should be considered in areas with the potential for development that might create traffic operational problems.

P. Pedestrian Accommodation

To assure access for persons with disabilities, pedestrian facilities shall be located and constructed in accordance with Chapter 18 and the Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities.

Q. Median Width

Refer to Table 7-1 when "Standards of the Day" are used. Otherwise, medians in rural areas in level or rolling terrain shall be at least 11.0 m wide. Medians in mountainous terrain or in urban areas shall be at least 3.0 m wide.

7.2.7.2 Guidance on Ramp Critical Design Elements

When "Standards of the Day" are used for existing features, refer to Table 7-2 for the minimum values for the ramp design speed, maximum grade, horizontal curvature and stopping sight distance. Otherwise, ramps shall conform to Chapter 2, Section 2.7.5.2, including lane width adequate to accommodate the design vehicle. This applies for rest areas and safety parking area ramps as well as interchange ramps. Note that the "Standards of the Day" do not apply to ramp lane widths.

An 8% maximum superelevation rate may be retained if currently used. Additionally, an 8% maximum superelevation rate may be created on a case by case basis as described in Section 7.2.7.1.G. Superelevation rates of up to 8.0% should be considered as part of the mitigation for ramps with non-standard radii.

7.2.7.3 Guidance on Other Controlling Design Parameters

Other controlling design parameters determine the characteristics of important (critical and non-critical) design elements such as lane width, turning radii, etc. The following is a partial list of the other controlling design parameters which are addressed in detail in Chapters 2 and 5 of this manual, but warrant additional mention in this chapter for clarification:

A. Design Vehicle

Although the design vehicle is not a critical design element, the design vehicle parameters affect critical design elements, such as the minimum vertical clearance and the minimum ramp and turning roadway pavement widths. Therefore, it is important to select the proper design vehicle for the freeway and affected crossroads.

The design vehicle shall be the WB 20 except on parkways where trucks are prohibited, in which case an SU design vehicle should be used in order to accommodate maintenance vehicles, tow trucks, plows, etc. Refer to Chapter 2, Section 2.5.3.2 and Chapter 5, Section 5.8.1 for design requirements for routes designated as Qualifying Highways on the national network of Designated Truck Access Highways (1982 STAA highways). The Regional Traffic Engineering and Safety Group should be contacted to determine if a route has been designated as a Qualifying Highway.

For projects on the STRAHNET, refer to the most recent NYSDOT "Geometric Design Policy for Bridges" and EI 91-22 "Vertical Clearance Over the New York State Thruway, I-190 and I-90 and Revised 16' Clearance Network" for special geometric requirements.

Freeways and interchanges should be designed to safely accommodate the design vehicle. Ramp and turning roadway widths that are inadequate for the design vehicle shall be listed in the Design Report and justified as non-standard features in accordance with Section 7.2.8.1. Intersection radii that cannot accommodate the design vehicle without a lane infringement are to be listed in the Design Report and explained as non-conforming features in accordance with Section 7.2.8.2. Non-standard feature justifications and the non-conforming feature explanations should include the extent of any lane infringement and the largest design vehicle that can be accommodated by the limiting feature.

B. Level of Service

For freeway 3R projects on non-interstate freeways, level of service should be included as a controlling design parameter. For freeway 3R projects on interstates, level of service is a critical design element as stated in Chapter 2, Section 2.6.14 and shall be listed with the other critical design elements in the design criteria.

7.2.8 Non-Standard and Non-Conforming Features

7.2.8.1 Non-Standard Features

A non-standard feature is created when the established design criteria for a critical design element is not met. All non-standard features to be retained must be listed, addressed separately, correlated to accident history, justified and approved in accordance with Chapter 2, Section 2.8. (This includes horizontal stopping sight distance, which is often overlooked.) Since many of the values for the critical design elements are dependent on the design speed, the selection and justification of a non-standard design speed is not appropriate. Instead, the design speed should be determined in accordance with section 7.2.7.1.A and the non-standard critical design elements must be individually justified. (Additionally, most of the critical design elements can usually be designed to the required design speed, leaving only one or two non-standard features.)

Although they have not been formally adopted, the "Parkway Standards" dated January, 1989 and amended on March 20, 1989, may be referenced and used to help justify the retention of non-standard and non-conforming features on parkways. However, this only supplements the normal justification required based on the accident history, environmental impacts, cost to correct, etc., in accordance with Chapter 2, Section 2.8.

There is a technical discrepancy between the metric and English values for horizontal radii and stopping sight distance in Section 2.7.1 and Appendix A of Chapter 2, and also in AASHTO's "A Policy on Geometric Design of Highways and Streets," 1990 and 1994. As shown in Table 7-5, the discrepancy exists for facilities designed to 30 mph, 35 mph and 60 mph, which are now non-standard based on the comparable metric design speeds of 50 km/h, 60 km/h and 100 km/h. For

example, with a 6.0% superelevation rate, an existing minimum 1348' radius curve for 60 mph does not meet the required minimum 435 m (1427') radius curve for 100 km/h (62 mph).

If other factors result in a decision to reconstruct, features should be upgraded to meet the required metric design criteria, even though the features would be standard if the project were to be designed under the English (foot-pound) system. However, since metric conversion was not intended to create non-standard features, a formal non-standard feature justification in accordance with Chapter 2, Section 2.8 is not necessary if the feature is to be retained and it meets the criteria listed below.

1. The feature meets the English (foot-pound) system design criteria;
2. The feature will be resurfaced or reconstructed and the alignment can not be easily (economically) adjusted to meet the required metric design criteria; and
3. The feature has a satisfactory accident history and is expected to continue as such in the future; or the accident counter-measures do not require geometric modification, which could then be designed to metric values.

Table 7- 5 English Unit to Metric Unit Technical Discrepancies ^{1,2}

DESIGN SPEED	STOPPING SIGHT DISTANCE		MINIMUM CURVE RADIUS	
	Minimum	Desirable	$e_{max}= 4\%$	$e_{max}= 6\%$
50 km/h (31 mph)	60 m (196.9')	70 m (229.7')	100 m (328')	90 m (295')
48.3 km/h (30 mph)	61 m (200')	61 m (200')	92 m (302')	83 m (273')
60 km/h (37.3 mph)	80 m (262.5')	90 m (295.3')	150 m (492')	135 m (443')
56.3 km/h (35 mph)	68.6 m (225')	76.2 m (250')	131 m (430')	118.6 m (389')
100 km/h (62.1 mph)	160 m (524.9')	210 m (689')	490 m (1608')	435 m (1427')
96.6 km/h (60 mph)	160.0 m (525')	198.1 m (650')	465.7 m (1528')	410.9 m (1348')

Notes:

- 1 Grey areas represent criteria that have become more stringent under the metric system of units. This can result in features, which were standard according to the English unit design criteria, becoming non-standard features according to the metric unit design criteria. Therefore, these values can be justified as technical discrepancies due to the English to metric unit conversion if they meet the criteria in Section 7.2.8.1.
- 2 This table is for illustration and is not intended to be comprehensive.

When the above criteria are met, a brief paragraph should be added to Section III.C.2.a - Geometrics of the Design Report for each feature or group of similar features to be retained. The paragraph should indicate the feature to be retained and should include the three criteria listed above.

7.2.8.2 Non-Conforming Features

In addition to the critical design elements, there are other design elements with established values or parameters that must be considered when scoping or designing a project. These other elements are important because they can have a considerable effect on the cost, scope, schedule and quality of a project.

The following is a list of some of these other elements that are described in detail in other chapters of this manual. This list is not in priority order or intended to be all inclusive but is being provided to give a representative sample of items to be considered when scoping or designing an interstate or freeway 3R project.

1. Level of service (This is a critical design element for interstate projects)
2. Clear zone
3. Intersection corner radii with respect to the design vehicle
4. Superelevation run-off and run-outs
5. Minimum length of vertical curves
6. Lane drops
7. Broken back curves
8. Compound curve ratios
9. Acceleration and deceleration lane lengths and type
10. Transit and high occupancy vehicle facilities and accommodations
11. Weaving lengths
12. Design storm for drainage facilities
13. Traffic control devices

Variances from recommended values or accepted practices for these elements shall be documented in the scoping document (when identified) and the design approval documents as non-conforming design elements and, when identified after design approval, in the project files with a copy to the Regional Design Engineer. The more significant the deviation or the more important an element is to good (safe) design, the more rigorous the explanation should be. For example, an explanation similar to the requirements for non-standard features is appropriate if the project proposes to retain an acceleration lane that is 75% of the values in AASHTO's "A Policy on Geometric Design of Highways and Streets", 1990, or retain a horizontal curve that violates the compound curve ratio by a substantial margin. However, not achieving the minimum length of a vertical curve by a few meters or exceeding the ramp compound curve ratio by 15% would only warrant brief mentioning in the Design Report.

Unlike non-standard features, non-conforming features do not require a specific approval for their retention. Instead, non-conforming features are approved with the recommended alternative at design approval or, if the non-conforming feature is identified after design approval, when the Regional Director (or designee) signs the PS&E transmittal memo.

7.2.9 Interchanges

7.2.9.1 Speed Change (Acceleration/Deceleration) Lanes

Acceleration and deceleration lanes must be addressed with respect to length, width, configuration, and consistency with Chapter 2, Section 2.7.5.3, Table 7-6 of this chapter and the AASHTO design recommendations (including grades), regardless of whether or not work is proposed for ramps. Additional length should be considered for the acceleration and deceleration lanes in congested areas since additional merging time or storage may be needed. Refer to Section 7.2.4.3 of this chapter for operational considerations.

Parallel type acceleration/deceleration lanes should be provided rather than the taper type. Therefore, existing taper type ramps on freeway 3R projects need to be considered for conversion to parallel type if warranted based on existing and future operational and safety needs or concerns. The following is a partial list of concerns that warrant consideration when determining whether or not to convert the taper type acceleration/deceleration lanes to parallel type acceleration/deceleration lanes:

1. Ramps with inadequate tapers or inadequate acceleration/deceleration lane lengths according to AASHTO design recommendations.
2. Ramps or interchanges with an accident history attributable to the taper design. High accident rates may occur at interchanges containing exit ramps with an inadequate taper into a sharp radius horizontal curve.
3. Highways predominantly with parallel type acceleration/deceleration lanes and only one or two rapid taper type acceleration/deceleration lanes.
4. Exit ramps with inadequate storage lengths that cause back-ups onto the mainline.
5. Entrance ramps where the ramp and freeway carry or will carry volumes approximately equal to the design capacity of the merging area. A parallel acceleration lane of at least 360 m, plus the taper, is desirable in this situation.

Acceleration and deceleration lanes require explanations as non-conforming features when significant geometric deviations in length from AASHTO will be retained. Substantial deviations from normal practices should be justified with a level of detail similar to the level of detail required in Chapter 2, Section 2.8, since these features can have significant effects on the operational and safety aspects of the mainline. However, an acceleration or deceleration lane with an acceptable accident rate and a proposed length that is in the order of 5% less than the AASHTO recommended values requires only a brief mention.

Table 7-6 Speed Change Lane Lengths for the 115 km/h Design Speed ^{1,2}

Acceleration Lane Length, L (m)									
Highway Design Speed, V (km/h)	Speed Reached, V_a (km/h) at End of Accel Length, L	Entrance Curve Design Speed, V' (km/h)					Initial Speed V_a' (km/h) at the Beginning of the Accel Length, L		
		Stop Condition	20	30	40	50	60	70	80
115	0	20	28	35	42	51	63	70	
	480	465	450	425	395	350	275	190	

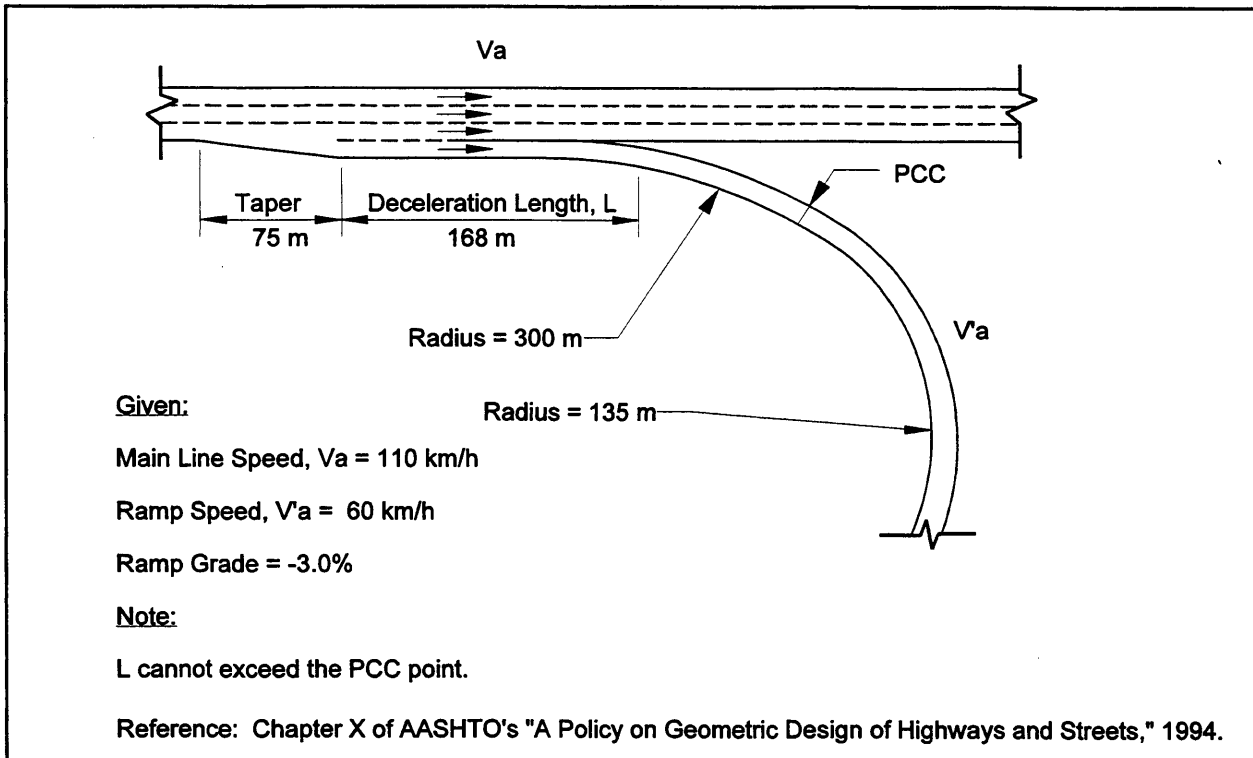
Deceleration Lane Length, L (m)									
Highway Design Speed, V (km/h)	Speed Reached, V_a (km/h) Before Entering Decel Length, L	Design Speed of Exit Curve V' (km/h)					Average Running Speed on Exit Curve, V_a' (km/h)		
		Stop Condition	20	30	40	50	60	70	80
115	0	20	28	35	42	51	63	70	
	195	190	180	170	160	150	130	115	

Notes:

1. Refer to Chapter X of AASHTO's "A Policy on Geometric Design of Highways and Streets," 1994 for:
 - a) the speed change lane adjustment factors as a function of grade;
 - b) the speed change lane lengths for speeds other than 115 km/h; and
 - c) the locations of V, V_a , V_a' and L on acceleration and deceleration speed change lanes.
2. Speed change lane lengths that do not meet the minimum lengths for the design speed of the mainline and ramps, as shown in this table or in the tables in Chapter X of AASHTO's "A Policy on Geometric Design of Highways and Streets," 1994, shall be treated as non-conforming features. The level of explanation for non-conforming speed change lane lengths should be commensurate with the difference between the standard and non-conforming lengths.

Additionally, the Design Report should contain an explanation for the retention of a taper type acceleration/deceleration lane over a parallel type when any of the above five conditions apply. However, only a brief statement is needed if the accident history reports do not indicate a higher than normal accident rate at the interchange and there are no existing or anticipated operational problems associated with the taper type acceleration/deceleration lanes.

Figure 7-1 Transitional Curve



7.2.9.2 Transitional Curves

A transitional curve between the deceleration lane and the ramp proper with a radius of 300 m or greater is exempt from the 2:1 maximum compound curve ratio for ramps since a transitional curve is a desirable feature prior to the ramp proper. Additionally, the 300 m or greater radius curve may act as part of the required deceleration length provided the curve connects with a relatively straight ramp. Similarly, at entrance terminals, the 300 m or greater radius curve may be considered as part of the required acceleration length provided the motorist on the ramp has an unobstructed view of the mainline.

Figure 7-1 shows a 300 m radius transitional curve prior to a 135 m radius curve on the ramp proper. The resulting compound curve ratio is 2.2:1 for this desirable feature.

7.2.9.3 Exit Gores

Special attention should be given to gore areas at exit ramps. The area behind the nose should be graded as level as practicable and should be free of fixed objects as stated in Chapter 6, Section 6.06.03. Curbing in the gore area is to be removed entirely where located in front of guide rail or impact attenuators as required by Chapter 10, Section 10.2.2.4. Additionally, impact attenuators should be considered for gore areas as appropriate. Refer to Chapter 10, Section 10.2.6 for information on impact attenuators.

7.2.10 **Medians**

7.2.10.1 Geometry

Median width is a critical design element for freeways. The design of medians should satisfy the clear zone or barrier requirements of Chapter 10. Refer to Chapter 10, Section 10.2.4 for additional guidance on medians.

7.2.10.2 Emergency Crossovers

Chapter 5, Section 5.8.13 and AASHTO's "A Policy on Geometric Design of Highways and Streets," 1994 should be used to evaluate existing or proposed emergency crossovers. Parallel type deceleration lanes and improved turning radii and width to accommodate maintenance vehicles should be considered at median emergency crossovers. Wider median shoulders immediately downstream of a crossover can serve as an acceleration lane for emergency vehicles. Where sight distance or median width is inadequate, consideration should be given to relocating or closing the cross-overs.

Emergency cross-over embankment slopes, transverse to the mainline direction of travel, should be 1 on 10 or flatter if they are likely to be encountered by errant vehicles. Embankment slope culverts with a diameter greater than 300 mm at a location accessible to errant vehicles or mowing equipment should have safety grates to allow vehicles and mowing equipment to traverse the culvert opening.

7.2.11 Curbs

In general, curbs are not to be retained on freeways and should be removed except as specifically noted. So-called safety walks (that are not an integral part of the structural integrity of the bridge) should be removed from all bridges. All retained curb (except standard bridge approach configurations) on Department freeway 3R projects should be included as a non-conforming feature as stated in Chapters 3 and 10 and the freeway should have an acceptable accident history with respect to curb involvement. Refer to Section 7.2.11.4 of this chapter for curb restrictions and non-conforming feature justification requirements.

The following sections describe the three general types of curbing generally found on freeways. For a complete description, refer to Chapter 3, Section 3.2.9.

7.2.11.1 Non-Mountable Curbing (Barrier Curb)

Non-mountable curbing generally has a 150 mm high steep face which is designed to discourage vehicles from leaving the pavement. Non-mountable curbing shall not be retained on freeway 3R projects (except standard bridge approach configurations where the curbing on the bridge cannot be removed because it is part of the structural integrity of the bridge).

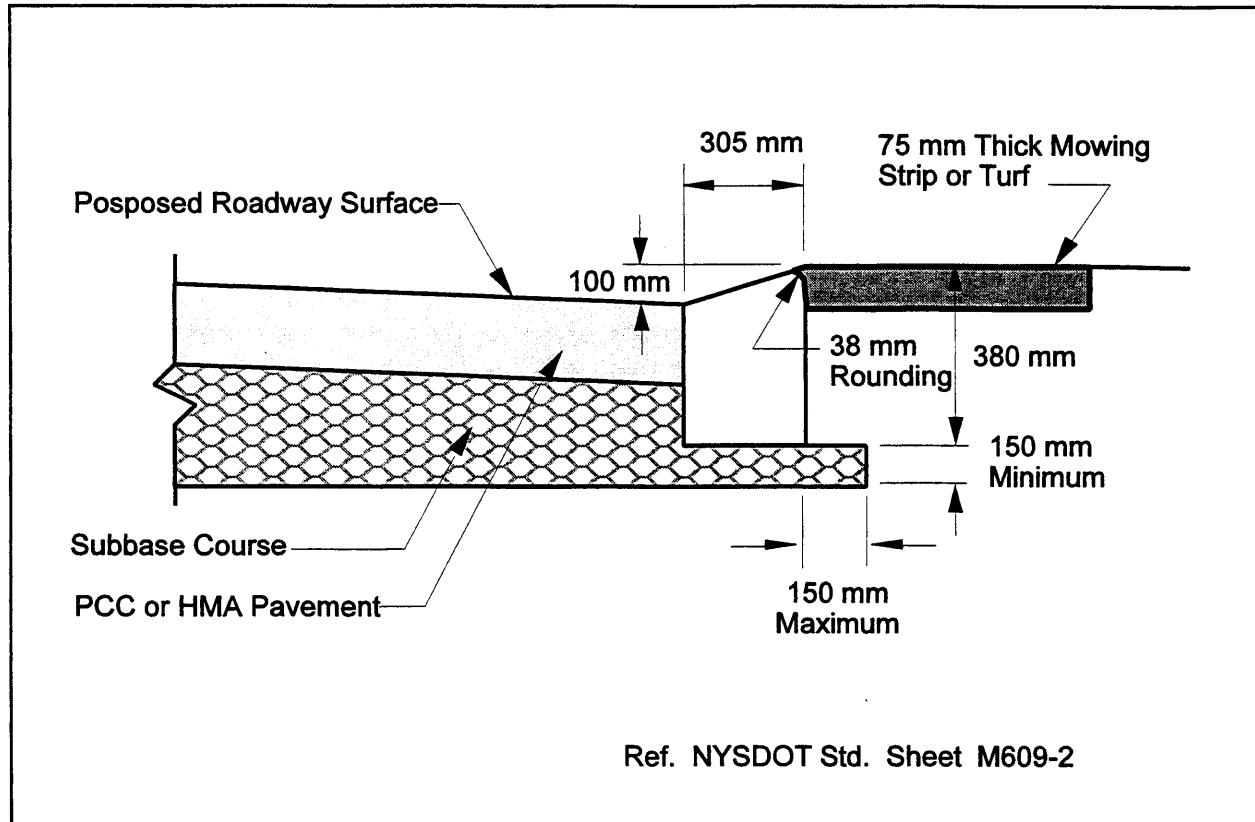
7.2.11.2 Mountable Curbing

Mountable curbing has a 100 mm or 150 mm sloped face so that vehicles can leave the pavement at a crawl speed. Mountable curb with a height of 100 mm (or less) may be retained as a non-conforming feature on historic parkways or where it must be used for drainage or erosion control. Mountable curb greater than 100 mm in height shall be removed or reduced to 100 mm or less by milling or resurfacing when it will be retained as a non-conforming feature. Traversable curb (as described in the following section) shall be used instead of mountable curb where long sections (such as in the order of 300 m) of curb will be removed and replaced as part of a historic parkway or where it must be used for drainage or erosion control.

7.2.11.3 Traversable Curb

Traversable curb is 305 mm wide with a 1:3 sloped face and no vertical reveal, which helps prevent vehicles in a lateral skid from tripping on the curb reveal (i.e. destabilizing or rolling after impact with the face of curb). Traversable curb is designed to permit delineation and drainage control while minimizing the potential destabilizing effect to errant vehicles. A detail of the 1 on 3 traversable curb is shown in Figure 7-2. Traversable curb shall be used instead of mountable curb where long sections (such as in the order of 300 m) of curb will be removed and replaced as part of a historic parkway or where it must be used for drainage or erosion control.

Figure 7-2 Traversable Curb



7.2.11.4 Curb Restrictions and Non-Conforming Feature Justification

Barrier curb shall not be retained on freeway 3R projects (except standard bridge approach configurations where the curbing on the bridge cannot be removed because it is part of the structural integrity of the bridge). As stated in Chapter 10, Section 10.2.2.4, curbs of any type shall not be retained in conjunction with concrete barriers, guide rail systems with deflections of greater than 1.2 m (including cable guide rail), or impact attenuation systems. Where it is necessary to use mountable curb and guide rail together, the face of the curb should be flush with the face of the guide rail or behind it. Where the traversable curb is used, the guide rail post should be as close to the back face of curb as possible. The roadside accident history should be reviewed to ensure that the retained curb will not adversely affect safety.

The level of justification for the retention of curb will depend on the severity of the deviation from Chapter 10, Section 10.2.2.4. For example, a traversable or 100 mm mountable curb needed for drainage control, located at the outside edge of a full width shoulder with adequate clear zone, will require only a brief mention if there is no related accident problem.

As previously stated in Section 7.2.7.1.C, areas behind curbing shall not be considered part of a freeway's usable shoulder since the shoulder must be a smooth continuous surface which is flush with the traveled way. Therefore, curbs located closer to the edge of traveled way than the required shoulder width require the shoulder to be justified as a non-standard feature and the curb to be justified as a non-conforming feature. In this situation, the retained curb should be mountable with a height of 100 mm or less and, when long sections of mountable curb are replaced, the curb should be the 1 on 3 traversable curb shown in Figure 7-2. Additionally, the justification for the retention of the non-standard shoulder should include an evaluation of incremental shoulder widths.

7.2.12 **Clear Zone**

The minimum clear zone widths (or clear runout widths below non-recoverable slopes) for both sides of the highway in each direction must be established in accordance with Chapter 10. The goal is to provide a minimum 9 m clear zone. The clear zone for freeway 3R projects should be treated in the same way as reconstruction projects.

Objects located within the minimum clear zone(s) need to be removed, relocated, modified, shielded or delineated as stated in Chapter 10, Section 10.2.1.2. Accident history is a very important factor in this overall evaluation. Wider clear zones may be cost effective at specific locations to help mitigate accident problems. If the original design provided for a clear zone of 9 m or greater, it must be restored as part of the freeway 3R project or justification for not doing so provided. (e.g. On sections where a previously wide clear zone is now reduced by tree growth, clearing and grubbing should be included in the project. This is a common problem in wide medians.)

A site inspection should be performed to identify hazardous roadside features and other safety concerns as described in Chapter 10, Section 10.3.1.2. Of particular interest are items that may reasonably be expected to be reached by an errant vehicle and may be hazardous if encountered at any speed, even if beyond the clear zone. Such features include cliffs and bodies of water or water courses (e.g. detention basins, recharge basins, drainage ditches, etc.) with a normal base flow that is more than 0.6 m in depth.

7.2.13 **Guide Rail, Median Barrier and Impact Attenuators**

Consideration should be given to eliminating the need for guide rail by slope flattening or regrading, removal of fixed objects, extending culverts etc. All guide rail, bridge rail and median barrier runs that will be retained are to be brought up to current standards if not meeting current point of need criteria, or the system will not function properly when struck.

New guide rail or median barrier shall be installed where needed to meet current warrants. Additionally, every effort should be made to eliminate the need for exposed end terminals by anchoring the guide rail into cut-slopes. Exposed end terminals are expensive, difficult to maintain, and are not as good an end treatment from a safety perspective.

Trees and other fixed objects must be removed from the deflection area of the existing or new guide rail. Where object removal is not practical, as a last resort, the guide rail deflection should be reduced to less than the distance to the object. This can be accomplished by reducing the post spacing or using a stronger barrier system.

Chapter 10 contains detailed information on guide rail, median barrier and impact attenuator systems. An explanation shall be provided in the Design Report for locations where deficient sections are not corrected.

7.2.14 **Traffic Control Devices**

Pavement marking, signs, signals, and delineation must be included to bring all traffic control devices into conformance with the New York State Manual of Uniform Traffic Control Devices (NYS MUTCD).

7.2.15 **Drainage**

The adequacy of pavement surface drainage provisions (gutters, ditches and closed drainage systems) and cross drainage facilities (culverts) shall be considered as part of all 3R projects. A site inspection as described in Chapter 8, Section 8.6.5 should be conducted to determine the adequacy of the existing drainage system. Recalculating the flow rate and capacities of a drainage system that is functioning adequately is not required unless significant changes will be made to the highway or drainage system.

7.2.15.1 Roadside Surface Drainage Systems

Drainage systems should be inspected and cleaned or repaired as necessary to ensure that the drainage system will function as originally designed. If changes are made to the original drainage system or highway, such as paving the median, increasing the width of shoulders, or re-grading drainage ditches, the flow rates and capacities of the drainage system may require recalculation.

Due to the potential for hydroplaning on high speed facilities, the design storm should not flood the travel lanes as noted in Chapter 8, Section 8.7.4.4.C. As a minimum criteria for high speed facilities with narrow shoulders, surface water runoff should not cover more than half of the travel lane for the design storm in Chapter 8, Section 8.3.2.4. Flooding is herein defined to occur when surface water runoff covers more than half of any travel lane (i.e. the maximum width of spread is

exceeded). If flooding has occurred, the storm that caused the flooding should be compared with the design storm specified in Chapter 8, Section 8.3.2.4. The drainage system should be improved if the analysis indicates that flooding will occur for the design storm. This is particularly important for depressed portions of freeways.

If freeway 3R projects will allow flooding for storms less than the specified design storm, the designer shall document the drainage system as a non-conforming feature. The Design Report should include a statement concerning the maximum storm that the facility can accommodate without flooding and the specified design storm from Chapter 8, Section 8.3.2.4.

7.2.15.2 Cross Drainage Structures

Inadequate cross drainage structures can cause serious problems due to upstream ponding and the potential roadway flooding or roadway embankment failures that might result. Therefore, the hydraulic adequacy, safety, and structural adequacy of each cross drainage structure shall be evaluated based on field inspection(s) and previous performance history. Inadequate drainage structures should be evaluated based on the design storm specified in Chapter 8, Section 8.3.2.4.

When freeway 3R projects retain an inadequate cross drainage structure, it shall be documented in the Design Report as a non-conforming feature. The Design Report should include a statement concerning the maximum storm that the facility can accommodate and the design storm specified in Chapter 8, Section 8.3.2.4.

Cross drainage structures have a design life and an anticipated service life dependent on the material (steel, concrete, aluminum, etc.). Structures approaching their anticipated service life should be considered for replacement or rehabilitation, as discussed in Section 8.6.5.2.

7.2.15.3 Hazardous Drainage Features

Hazardous drainage features should be removed, modified or shielded to increase safety as stated in Chapter 10, Section 10.3. For example, bodies of water or water courses with a normal flow depth over 0.6 m may be hazardous if encountered by an errant vehicle at any speed. Even if outside the design clear zone, serious consideration should be given to shielding these potential hazards if an errant vehicle could reasonably encounter them. Refer to Chapter 3 of AASHTO's "Roadside Design Guide," 1996, for additional guidance on identifying and treating hazardous drainage features.

Safety improvements include: elimination or removal of potentially hazardous fixed objects to outside the clear zone; regrading non-traversable drainage ditches; headwall and end section upgrading; culvert extensions for slope flattening; and guide rail protection. Gratings may be placed across a drain pipe greater than 300 mm in diameter to permit vehicles (including mowing machines) to traverse the openings without dropping in. For cross drainage structures, the

Department has had satisfactory experience with the use of plain No. 8 reinforcing bars spot welded together on 0.3 m centers. These grates may be used in sizes up to 1.8 m by 2.6 m. The grates should be held down with bent No. 6 bars driven at least 0.7 m into the ground. The grates should be sufficient to extend a minimum of 0.15 m beyond the supporting edge of the opening. The hydraulic effect of safety improvements should be considered. Significant safety improvements may require recalculation of the flow rates and capacities of a drainage system.

7.2.16 **Soils**

Pavement widening may result in steeper slopes or affect roadside drainage. Refer to Chapter 9 and consult the Regional Geotechnical Engineer where proposed work impacts embankment side slopes or cut slopes.

7.2.17 **Utilities**

Any utilities that do not conform to the current "Accommodation of Utilities within State Highway Right-of-Way" policy and which could constitute a fixed object to traffic or violate new or original clear zone(s) shall be considered for relocation or removal. The Utility Pole "Bad Actors" list for the project location should be reviewed when considering the retention of fixed objects within the clear zone. The decision to retain fixed objects should be documented and explained as stated in Chapter 10, Section 10.3.3.

7.2.18 **Lighting**

Roadway lighting should be evaluated on every project in accordance with Chapter 12 and the Department's "Policy on Highway Lighting" issued by Traffic Engineering and Highway Safety. Non-functional lighting systems should be rehabilitated, upgraded, or where no longer warranted or maintainable, removed. Light standards shall, in order of preference, be a) located outside of the clear zone or located outside the deflection distance of a barrier needed for other reasons, b) breakaway, or c) explicitly shielded by a barrier and located outside the barrier's deflection distance.

7.2.19 **Traffic Control (Maintenance and Protection of Traffic)**

Cross section elements should be assessed for the ability to adequately maintain traffic for reasonably foreseeable maintenance or construction activities. There are a number of instances where shoulder or auxiliary lane improvements or partial retention of temporary cross-overs would greatly facilitate traffic movement and/or construction safety on planned future projects or maintenance activities. Refer to the Design Procedure Manual, Appendix B as well as the

applicable Engineering Instructions for additional guidance on traffic control plans (TCP) and related issues such as A+B bidding, incentives/disincentives, lane rental and nighttime construction.

7.3 STANDARDS AND GUIDANCE FOR NON-FREEWAY 3R PROJECTS

The guidance and standards for this section applies to all non-freeway 3R projects as defined in EI 92-28 and the "Standards for Non-Freeway Resurfacing, Restoration and Rehabilitation Projects (3R Standards)," July 1, 1992. Additionally, refer to EI 94-11 for the Metric Supplement to the 3R Standards.

7.4 REFERENCES

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2. Design Procedure Manual, 1999, Design Quality Assurance Bureau, New York State Department of Transportation, State Campus, Albany, NY 12232.
3. Design Traffic Forecast Policy, April, 1993, Appendix "D" of the Scoping Procedure Manual, Mobility Management Section, New York State Department of Transportation, State Campus, Albany, NY 12232.
4. A Policy on Geometric Design of Highways and Streets, 1984, 1990 and 1994, American Association of State Highway and Transportation Officials, Suite 225, 444 North Capitol Street, N.W., Washington, D.C. 20001.
5. A Policy on Geometric Design of Rural Highways, 1954 and 1965, American Association of State Highway Officials, Suite 225, 444 North Capitol Street, N.W., Washington, D.C. 20001.
6. A Policy on Design Standards, Interstate System, July 12, 1956; April 12, 1963; October 24, 1963; May 15, 1965; June 20, 1967; and July 1991, American Association of State Highway and Transportation Officials, Suite 225, 444 North Capitol Street, N.W., Washington, D.C. 20001.
7. Official Description of Designated Qualifying and Access Highways in New York State, Oct. 1995, Traffic Engineering and Highway Safety, New York State Department of Transportation, State Campus, Albany, NY 12232.
8. Highway Capacity Manual, Special Report 209, 1994, Transportation Research Board, National Research Council, 2101 Constitution Avenue, N.W., Washington D.C., 20418.
9. Americans With Disabilities Act Accessibility Guidelines for Buildings and Facilities, Dec. 1993, Landscape Architecture Bureau, New York State Department of Transportation, State Campus, Albany, NY 12232.
10. (NYS) Manual of Uniform Traffic Control Devices, July, 1983, Traffic Engineering and Highway Safety, New York State Department of Transportation, State Campus, Albany, NY 12232.
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15. Safety Effectiveness of Highway Design Features, Volume II: Alignment (Publication No. FHWA-RD-91-045), November, 1992, Federal Highway Administration, Design Concepts Research Division, HSR-20, Turner Fairbank Research Center, 6300 Georgetown Pike, McLean, VA 22101-2296.
16. Highway Safety Improvement Program: Procedures and Techniques, 1989, Traffic Engineering and Safety Division, New York State Department of Transportation, State Campus, Albany, N.Y. 12232.
17. Pavement Rehabilitation Manual, Volume I - Pavement Evaluation, June, 1990, Materials Bureau, New York State Department of Transportation, State Campus, Albany, N.Y. 12232.
18. Pavement Rehabilitation Manual, Volume II - Treatment Selection, May, 1993, Materials Bureau, New York State Department of Transportation, State Campus, Albany, N.Y. 12232.
19. Recommendations of the Parkway Standard Task Force, January, 1989 (Amended March 20, 1989), Design Quality Assurance Bureau, New York State Department of Transportation, State Campus, Albany, N.Y. 12232.
20. Roadside Design Guide, January 1996, American Association of State Highway and Transportation Officials, Suite 249, 444 North Capitol Street, N.W., Washington, D.C. 20001.

Referenced Engineering Instructions

EI 91-22 Vertical Clearance Over the New York State Thruway, I-190 and I-90 and Revised 16' Clearance Network .

EI 92-015 Project Level Pavement Selection Process.

EI 92-026 Pavement Restoration Techniques, 1992.

EI 92-028 Standards for Non-Freeway Resurfacing, Restoration and Rehabilitation Projects (3R Standard).

EI 93-028 Repair of Spalled Areas, Joints and/or Cracks in PCC Pavement.

EI 94-011 Standards for Non-Freeway Resurfacing, Restoration and Rehabilitation Projects (3R) - METRIC SUPPLEMENT.

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