Appendix A

Draft Design Criteria Report

DRAFT DESIGN CRITERIA REPORT

Section 100: I-95, I-895 (N) Split to North of MD 43

Prepared For

Prepared By

JOHNSON, MIRMIRAN, AND THOMPSON
72 LOVETON CIRCLE
BALTIMORE, MARYLAND 21152-0949
410-329-3100

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Introduction

The primary purpose of this report is to highlight, clarify and supplement existing criteria pertaining to the ***Section 100: I-95, I-895 (N) Split to North of MD 43*** project. The discussions and charts that follow in this report are based on the following alternatives recommended for further study in the I-95 Master Plan Study dated February 26, 2003:

- No-Build
- Managed Lanes Alternate: Separated Two-Lane Managed Roadway in Median from I-895 to MD 543
- All General Purpose Lanes Alternate

Brief descriptions of these alternates are provided later in the body of this report.

The design criteria for the ***Section 100: I-95, I-895 (N) Split to North of MD 43*** project is compiled from the following sources:

- AASHTO – A Policy on Geometric Design of Highways and Streets, 2001 Edition
- AASHTO – Guide for the Design of High Occupancy Vehicle Facilities, 1992
- AASHTO – Roadside Design Guide, 2002 Edition
- MDSHA - Highway Policy and Procedure Manual

The project criteria for the ***Section 100: I-95, I-895 (N) Split to North of MD 43*** project is based on the following design parameters:

- The level of development for the ***Section 100: I-95, I-895 (N) Split to North of MD 43*** project is designated as "urban" on pages 42-44 of the 2002 Highway Location Reference for Baltimore County.
- Design speeds were determined through review of the I-95 Master Plan, examining level of development, and review of the following posted speeds:
  60 mph - I-895 split to MD 43
  65 mph – North of MD 43
- Terrain is designated as "rolling".

The designer should review both the text portion of this report and the respective charts and confirm acceptance of this project design criteria by the Authority, prior to development of horizontal alignments, vertical alignments, and typical sections. The designer should be vigilant in expanding this set of criteria into the study as needed to address the potential affect of future intermodal transportation facilities, such as park-and-ride lots and light rail stations.

I. No-Build Alternate

The No-Build Alternate retains the existing I-95 highway and associated interchanges in their present configurations while allowing for routine maintenance and safety upgrades. Any improvements in alignment or cross-section would conform to the charts provided for the All-General Purpose Alternate. The existing I-95 roadway would remain four lanes per direction from the I-895 (N) split to MD 24.

II. Managed Lanes Alternate Design Criteria

A. Managed Lanes Alternate Overview

The Managed Lanes Alternate, as defined in the I-95 Master Plan Study, provides a two-lane per direction, barrier separated managed facility from the I-895 split to beyond New Forge Road within the interior of the I-95 cross-section. However, an additional option that reflects all general-purpose lanes south of I-695 will also be investigated as requested by the Authority. The managed lanes could operate either under one permanent use or be managed by time-of-day for separate uses such as HOV, toll, and truck-use only. Direct access ramps could be provided to connect the managed facility with selected interchange movements and intermodal transit/park-and-ride facilities. South of I-695, the existing four general purpose lanes of I-95 in each direction would remain in number, but be shifted to the outside to provide space for the managed facility. North of I-695, three of the four existing general-use lanes of I-95 in each direction would be shifted to the outside to provide space for the managed facility as well. A two-lane collector-distributor roadway will replace the fourth existing general-use lane, resulting in an additional lane in each direction of I-95.

B. Horizontal Alignment – Managed Lanes Alternate

The horizontal geometry of the mainline and ramps should allow sufficient distance between reverse curves to transition directly between opposing plane sections. The designer should strive to provide upper range design speeds as noted on AASHTO exhibit 10-56 (p. 830) for all outer diamond and directional ramps whenever feasible. The designer should strive for middle-range design speeds for loop ramps whenever feasible and use the lower-range as an absolute minimum. If multiple curves are used on a ramp, the designer should progressively transition radii between the exit terminal to the ramp proper and from the ramp proper to the entrance terminal as noted on pp. 834-836 AASHTO. Spirals should be replaced with circular curves to facilitate construction stakeout.

An analysis of proposed emergency crossover locations should be performed concurrent to the layout of the alignments as such locations may influence the median width. AASHTO calls for emergency crossovers when interchanges are spaced more than 5 miles (p. 514 AASHTO) and recommends a maximum spacing of 3 to 4 miles. Existing interchanges are spaced as follows:

I-95 at Eastern Avenue to I-95 at I-695 – 5.1 Miles
I-895 at Moravia Road to I-95 at I-695 – 3.7 Miles
I-95 at I-695 to I-95 at MD 43 – 3.2 Miles
I-95 at MD 43 to I-95 at MD 152 – 7.2 Miles

Because the project limits for the ***Section 100: I-95, I-895 (N) Split to North of MD 43*** project extend considerably into the 7.2 mile segment between the MD 43

and MD 152 interchanges, an emergency crossover location should be established within this area as part of the Section 100 design. When locations are required between the interchanges, they should be established in areas with good sight distance and minimal superelevation (based on rollover).

This option, as defined in the Master Plan, also includes a two-lane, barrier-separated Collector-Distributor Road in both the northbound and southbound roadways of I-95 through the I-695 and MD 43 interchanges to remove weaving movements from the general use lanes. The designer should ensure that ramp entrances, exits, and lane additions/drops are in accordance with the following criteria:

- Multi-Lane Ramps – AASHTO Exhibit 10-52
- Lane Reductions – AASHTO p. 822
- Minimum Ramp Terminal Spacing - AASHTO Exhibit 10-68

A weaving analyses should performed for the Collector-Distributor Roadway in accordance with the Highway Capacity Manual to ensure that weaving sections provide acceptable lengths, widths, and lane balance.

C. Vertical Alignment – Managed Lanes Alternate

Vertical sight distances for vertical crest curves should be based on the recently updated AASHTO criteria using a 3'-6" height of eye and a 2'-0" height of object. The designer should strive for compliance with AASHTO's headlight sight distance criteria for vertical sag curves to allow for lighting failures and power outages. The minimum vertical clearance for roadway overpasses on both mainline and ramps will be 16'-9".

D. Typical Sections – Managed Lanes Alternate

The minimum lane widths of all managed, general-use, and collector-distributor roads should be 12 feet.

Shoulder widths should conform to AASHTO criteria found on pp. 318 and 508-509. All full width shoulders on I-95 should be full-depth with a maximum shoulder rollover of 4% to allow future use as an interim capacity or maintenance of traffic improvement through restriping. Design exceptions must be submitted for further shoulder width reduction as warranted by cost-minimization of structures or reduction of impacts to adjacent environmental or development features. The number of shoulder width transitions should be kept to a minimum to ensure some measure of consistency in width.

The minimum median width will be largely determined by minimum shoulder widths, but will also be influenced by the following factors:

- Accessibility of emergency equipment at emergency crossovers (allow movement from interior lane onto opposing shoulder without significant encroachment into opposing interior lane)
- Locations of entrance and exit ramps and associated auxiliary lanes
- Toll Facilities for Managed Facility

Additionally, clear zone should be provided to properly account for the design speed, traffic volume, maximum cross-slopes on roadside grading, and horizontal curves.

Barrier design shall be in accordance with the 2002 Roadside Design Guide and the MDSHA Book of Standards. Barrier type should be selected to provide suitable height for trucks. End treatment selection should be consistent with Page D-92-2TS of the *Highway Policy and Procedure Manual* and Section 600 of the ***MD*** *Book of Standards*. All anchorages on bridge approaches shall be thrie-beam.

III. All General Purpose Alternate Design Criteria

A. Overview – All General Purpose Alternate

The All General Purpose Alternate, as defined in the I-95 Master Plan Study, provides the same number of lanes per direction as the Managed Lanes Alternate within the ***Section 100: I-95, I-895 (N) Split to North of MD 43*** project, but differs in lane use. All six lanes south of I-695 and all seven lanes north of I-695 would be general-use lanes.

B. Horizontal Alignment – All General Purpose Alternate

The mainline and ramps geometry should allow sufficient distance between reverse curves to transition directly between opposing plane sections. The designer should strive to provide upper range design speeds as noted on AASHTO exhibit 10-56 (p. 830) for all outer diamond and directional ramps whenever feasible. The designer should strive for middle-range design speeds for loop ramps whenever feasible and use the lower-range as an absolute minimum. If multiple curves are used on a ramp, the designer should progressively be transitioned between the exit terminal to the ramp proper and from the ramp proper to the entrance terminal as noted on pp. 834-836 AASHTO. Spirals should be replaced with circular curves to facilitate construction stakeout.

An analysis of proposed emergency crossover locations should be performed concurrent to the layout of the alignments as such locations may influence the median width. AASHTO calls for emergency crossovers when interchanges are spaced more than 5 miles (p. 514 AASHTO) and recommends a maximum spacing of 3 to 4 miles. Existing interchanges are spaced as follows:

I-95 at Eastern Avenue to I-95 at I-695 – 5.1 Miles

I-895 at Moravia Road to I-95 at I-695 – 3.7 Miles
I-95 at I-695 to I-95 at MD 43 – 3.2 Miles
I-95 at MD 43 to I-95 at MD 152 – 7.2 Miles

Because the limits of Section 100 extend considerably into the 7.2 mile segment between the MD 43 and MD 543 interchanges, an emergency crossover location should be established within this area as part of design for the ***Section 100: I-95, I-895 (N) Split to North of MD 43*** project. When additional locations are required, they should be established in areas with good sight distance and minimal superelevation (based on shoulder rollover).

This option, as defined in the Master Plan, also includes a Collector-Distributor Road in both the northbound and southbound roadways of I-95 through the I-695 and MD 43 interchanges to remove weaving movements from the general use lanes. The designer should ensure that ramp entrances, exits, and lane additions/drops are in accordance with the following criteria:

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- Lane Reductions – AASHTO p. 822
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A weaving analyses should performed for the Collector-Distributor Roadway in accordance with the Highway Capacity Manual to ensure that weaving sections provide acceptable lengths, widths, and lane balance.

C. Vertical Alignment – All General Purpose Alternate

Vertical sight distances for vertical crest curves should be based on the recently updated AASHTO criteria using a 3'-6" height of eye and a 2'-0" height of object. The designer should strive for compliance with AASHTO's headlight sight distance criteria for vertical sag curves to allow for lighting system failures and power outages. The minimum vertical clearance for roadway overpasses on both mainline and ramps will be 16'-9".

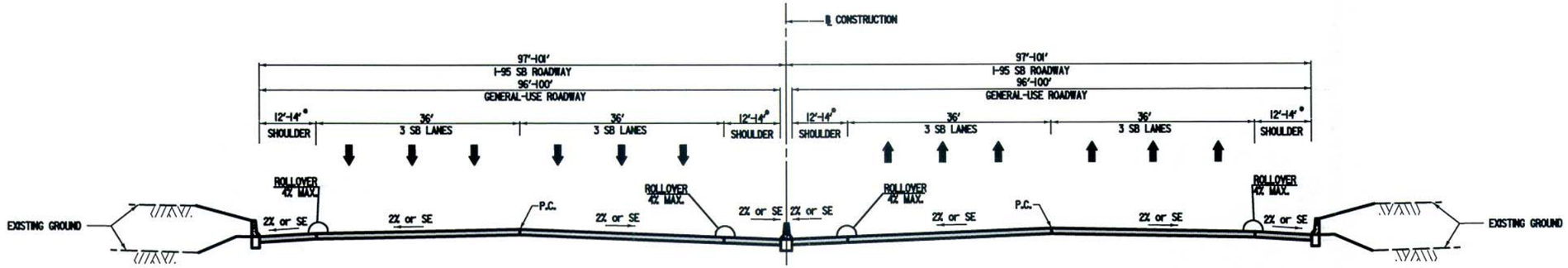
D. Typical Sections – All General Purpose Alternate

The minimum lane widths of all general-use and collector-distributor roadways should be 12 feet.

Shoulder widths should conform to AASHTO criteria found on pp. 318 and 508-509. All full width shoulders on I-95 should be full-depth with a maximum shoulder rollover of 4% to allow future use as an interim capacity or maintenance of traffic improvement through restriping. Design exceptions must be submitted for further shoulder width reduction as warranted by cost-minimization of structures or reduction of impacts to adjacent environmental or development features. The number of shoulder width transitions should be kept to a minimum to ensure some measure of consistency in width.

The minimum median width will be largely determined by minimum shoulder widths, but may also be influenced by accessibility requirements for emergency equipment at selected emergency crossover locations. Additionally, clear zone should be provided to properly account for the design speed, traffic volume, maximum cross-slopes on roadside grading, and horizontal curves.

Barrier design shall be in accordance with the 2002 Roadside Design Guide and the MDSHA Book of Standards. Barrier type should be selected to provide suitable height for trucks. End treatment selection should be consistent with Page D-92-2TS of the *Highway Policy and Procedure Manual* and Section 600 of the ***MD*** *Book of Standards*. All anchorages on bridge approaches shall be thrie-beam.



* 12' WIDTH — I-895 TO SOUTH OF I-695
12'-14' WIDTH — SOUTH OF I-695 TO I-695
14' WIDTH — I-695 TO COWENTON AVE.

I-895 TO NORTH COWENTON

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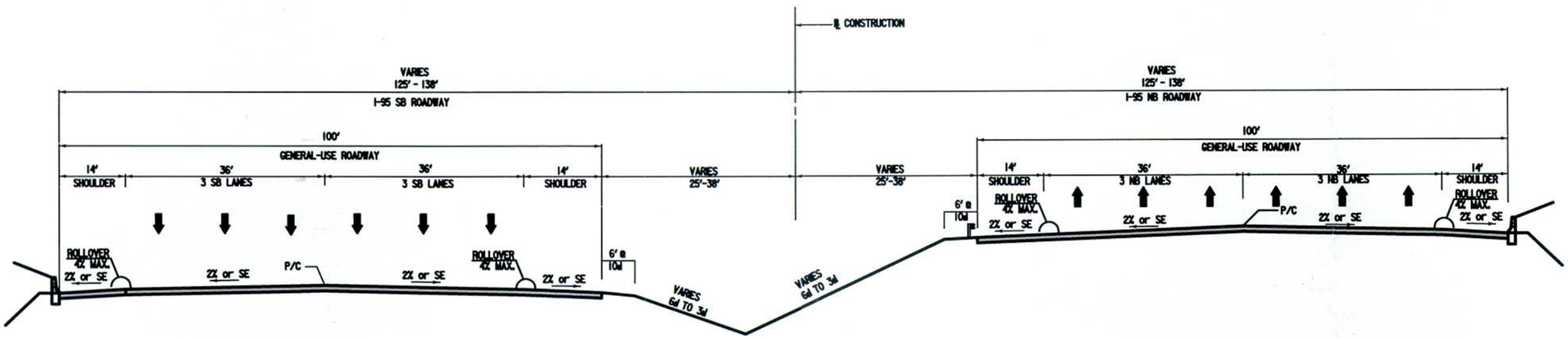

I-95 - BIFURCATED SECTION
STA. 496+87 TO 588+00

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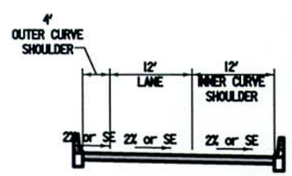
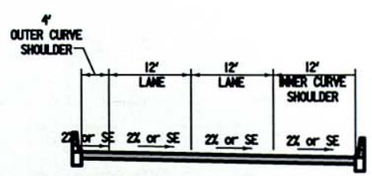
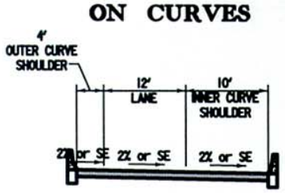


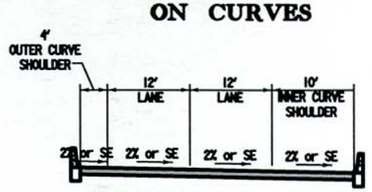
ONE LANE RAMPS ON CURVES



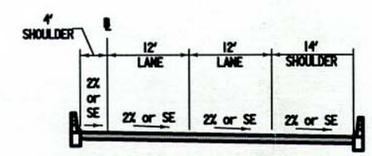
TWO LANE RAMPS ON CURVES



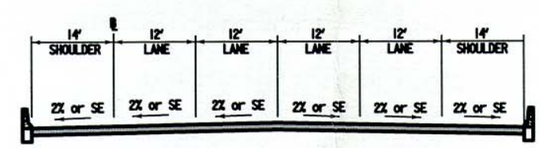
ONE LANE RAMPS ON TANGENTS



TWO LANE RAMPS ON TANGENTS



I- 695WB TYP TWO LANES



I- 695WB TYP FOUR LANES

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JOHNSON, MIRMIRAN & THOMPSON
Engineering A Brighter Future

MARYLAND TRANSPORTATION AUTHORITY
Engineering Division

ADDENDUMS & REVISIONS			
NO.	DESCRIPTION	BY	DATE

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SECTION 100: I-95, I-895(N) SPLIT TO NORTH OF MD 43

JOHN F. KENNEDY MEMORIAL HIGHWAY
BALTIMORE CITY

GENERAL PURPOSE OPTION 2A

DESIGNED BY	DRAWN BY	CHECKED BY	CONTRACT NO.
CONST. REVIEW BY	DATE	SCALE 1"= 80'	DRAWING NO. TS-1
			SHEET NO. OF

DRAFT DESIGN CRITERIA
All General Purpose Lanes Alternate
Section 100: I-95, I-895 (N) Split to North of MD 43
Maryland Transportation Authority

All General Purpose Lanes Alternate		I-95 Mainline		Cross-Roads		
	Criterion	**North of I-695**	**South of I-695**	**I-895**	**I-695**	**MD 43**
	Design Speed	70 mph	70 mph	65 mph	65 mph	60 mph
	Stopping Sight Distance	730'	730'	645'	645'	570'
Horizontal Alignment	Minimum Radius	1820'	1820'	1485'	1485'	1205'
	Desirable Length of Curve	2000	2000	2000	2000	2000
	Minimum Length of Curve	1000	1000	1000	1000	1000
	Maximum Superelevation	8%	8%	8%	8%	8%
	Maximum Rate of Transition "c"	0.0001	0.0001	0.0001	0.0001	0.0001
	Superelevation Distribution	2/3 tangent	2/3 tangent	2/3 tangent	2/3 tangent	2/3 tangent
	Emergency Crossovers	(see note 1)	(see note 1)	N/A	N/A	N/A
	Auxiliary Lane Lengths and Taper Rates	(see note 2)	(see note 2)	(see note 2)	(see note 2)	(see note 2)
	Minimum Spacing for Lane Drop from Interchange	3000'	3000'	-	-	-
Vertical Alignment	Minimum Grade	0.50%	0.50%	0.50%	0.50%	0.50%
	Maximum Grade	4%	4%	4%	4%	4%
	Sag Minimum (K Value) Desirable	181	181	157	157	136
	Crest Minimum (K Value) Desirable	247	247	193	193	151
	Highway Overpass Vertical Clearance	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"
Typical Sections	Inside Shoulder Width without Barrier	12' Paved	N/A	12' Paved	12' Paved	4' Pavt/10' Graded
	Inside Shoulder Width Including Barrier Offset	14'	12'	14'	14'	6'
	Median Width	(see note 1)	(see note 1)	-	-	-
	Lane Widths	12'	12'	12'	12'	12'
	Outside Shoulder Including Barrier Offset	14'	12'	14'	14'	12'
	Maximum Rollover					
	Pavement	4%	4%	4%	4%	4%
	Shoulder (see note 3)	4%	4%	4%	4%	7%
	Normal Cross-slope	2%	2%	2%	2%	2%
	Clear Zone	conc barrier	conc barrier	34' x Kcz	34' x Kcz	32' x Kcz
	Foreslopes & Grass Median Slopes	N/A	N/A	N/A	6:1 max.	6:1 max.
	Backslopes in Cut (within clear zone)	N/A	N/A	N/A	4:1 max.	4:1 max.
	Max. Slope at face of barrier	10:1	10:1	10:1	10:1	10:1

Note 1 - Emergency crossovers shall be placed when interchange spacing > 5 miles (3 to 4 mile intervals) and located in accordance with p. 515 AASHTO '01. Median width should take into consideration U-turn movements by emergency and snow removal (SU) vehicles.

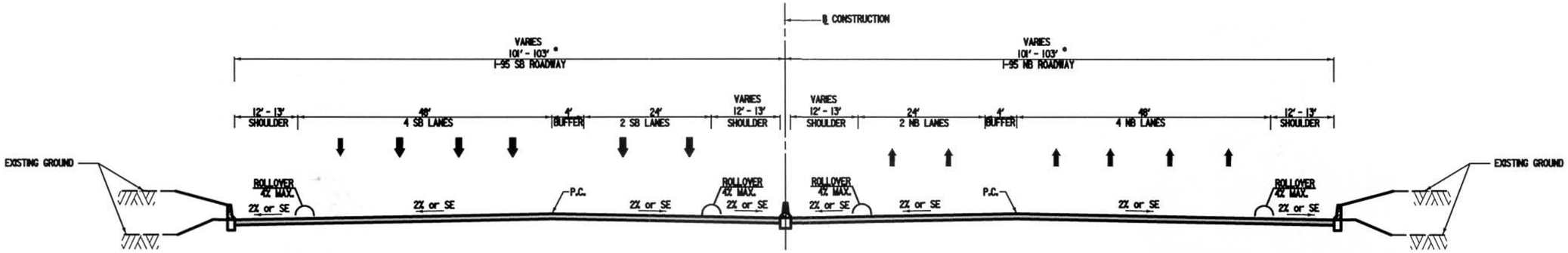
Note 2 - Use parallel type type entry ramps. Lengths and taper rates for accel/decel lanes should be in accordance with pp. 849-867 AASHTO '01 and account for adjustments due to grade and severe horizontal curvature.

Note 3 - MOT may govern shoulder cross-slope.

DRAFT DESIGN CRITERIA
All General Purpose Lanes Alternate
Section 100: I-95, I-895 (N) Split to North of MD 43
Maryland Transportation Authority

All General Purpose Lanes Alternate		North of I-695				South of I-695			
	Criterion	**Directional Ramps**	**1- Lane Outer Ramps**	**2-Lane Outer Ramps**	**Loop Ramps**	**Directional Ramps**	**1- Lane Outer Ramps**	**2-Lane Outer Ramps**	**Loop Ramps**
	Design Speed	50 mph	50 mph	50 mph	30 mph	50 mph	(see note 1)	(see note 1)	(see note 2)
	Stopping Sight Distance - Ramp Proper (see note 4)	425'	425'	425'	200'	425'	155'-250'	155'-250'	155'-200'
	Stopping Sight Distance at Gores	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)
Horizontal Alignment	Minimum Radius (see note 4)	750'	750'	750'	250'	750'	170'-750'	170'-750'	170'-250'
	Desirable Length of Curve	1600'	1600'	1600'	1600'	1600'	1600'	1600'	1600'
	Minimum Length of Curve	800'	800'	800'	800'	800'	800'	800'	800'
	Maximum Superelevation	8%	8%	8%	8%	8%	8%	8%	8%
	Maximum Rate of Transition "c"	0.0002	0.0003	0.0002	0.0004	0.0002	0.0003	0.0002	0.0004
	Superelevation Distribution	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent
	Auxiliary Lane Lengths and Taper Rates	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)
	Minimum Lane Drop Spacing from Two-Lane Entrance	3000'	n/a	3000'	n/a	3000'	n/a	3000'	n/a
	Minimum Length of Auxiliary Lane for Two-Lane Exit	1500'	n/a	1500'	n/a	1500'	n/a	1500'	n/a
Vertical Alignment	Minimum Grade	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
	Maximum Grade (see note 4)	3%-5%	3%-5%	3%-5%	5%-7%	3%-5%	4%-6%	4%-6%	5%-7%
	Sag Minimum (K Value) Desirable (see note 4)	96	96	96	37	96	26-49	26-49	26-37
	Crest Minimum (K Value) Desirable (see note 4)	84	84	84	19	84	12-29	12-29	12-19
	Highway Overpass Vertical Clearance	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"
Typical Sections	Inside Shoulder Width	1'	1'	4'	1'	1'	1'	4'	1'
	Lane Width (based on noted Design Speed)	14'	14'	2 @ 12'	15'	14'	14'	2 @ 12'	15'
	Outside Shoulder Width	8'	8'	8'	8' to curb	8'	8'	8'	8' to curb
	Maximum Rollover								
	Pavement	4%	4%	4%	4%	4%	4%	4%	4%
	Shoulder (see note 6)	4%	4%	4%	4%	4%	4%	4%	4%
	Normal Cross-slope	2%	2%	2%	2%	2%	2%	2%	2%
	Clear Zone	20' x Kcz	20' x Kcz	20' x Kcz	16' x Kcz	20' x Kcz	16' x Kcz	16' x Kcz	16' x Kcz
	Foreslopes & Grass Median Slopes (without barrier)	6:1 max	6:1 max	6:1 max	6:1 max	6:1 max	6:1 max	6:1 max	6:1 max
	Backslopes in Cut (within clear zone and without barrier)	4:1 max	4:1 max	4:1 max	4:1 max	4:1 max	4:1 max	4:1 max	4:1 max
	Max. Slope at face of barrier	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1

Note 1 - Minimum design speeds of 25 mph, 30 mph and 35 mph for mainline design speeds of 50 mph, 60-65 mph, and 70 mph, respectively, as per p. 830 AASHTO '01.
Note 2 - Minimum design speeds of 25 mph and 30 mph for mainline speeds of 50 mph and 60-65 mph, respectively, p. 830 AASHTO '01.
Note 3 - Note that Sight Distance at ramp gores should equal Stopping Sight Distance + 25% +Decision Sight Distance as per pp. 116 and 832 AASHTO '01.
Note 4 - Use upper range value when design constraints permit. Note AASHTO '01 guidelines (p. 833) regarding length and direction of grade.
Note 5 - Use parallel type. Lengths and taper rates for accel/decel lanes should be in accordance with pp. 849-867 AASHTO '01 and account for adjustments due to grade and severe horizontal curvature.
Note 6 - MOT may govern shoulder slope



I-95: I-895 TO SOUTH OF I-695

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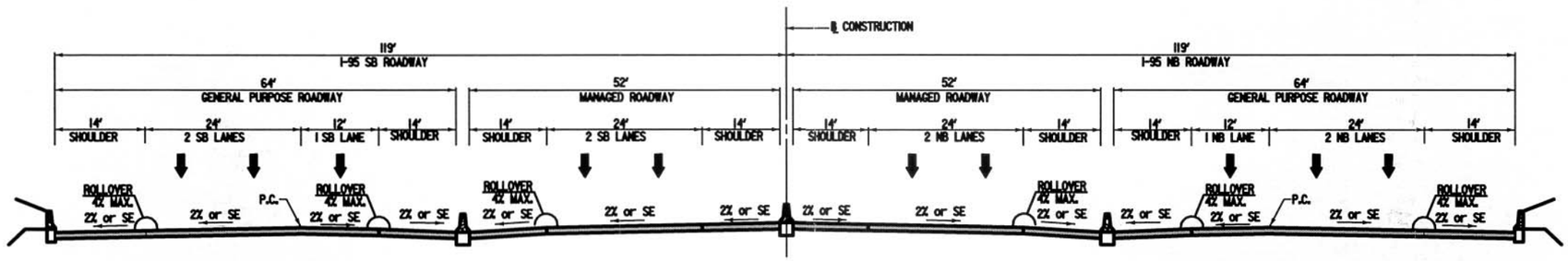
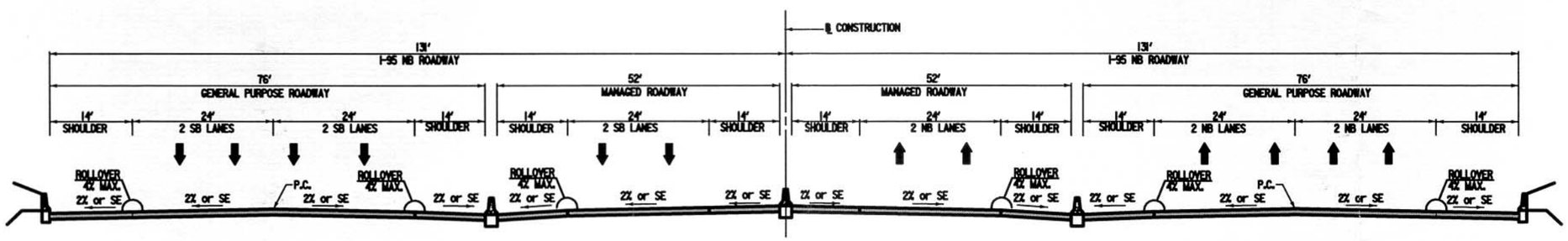
* 101' SECTION - I-895 TO CHESACO AVE.
103' SECTION - CHESACO AVE. TO I-695



I-95: SOUTH OF I-695 TO NORTH OF I-695

NTS



I-95: NORTH OF I-695 TO SOUTH OF MD 43
NORTH OF MD 43 TO NORTH OF COWENTON ROAD

NTS

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MANAGED LANES ALTERNATE

TS-1

DRAFT DESIGN CRITERIA
Managed Lanes Alternate
Section 100: I-95, I-895 (N) Split to North of MD 43
Maryland Transportation Authority

	Managed Lanes Alternate	**I-95 Mainline**						**Cross-Roads**		
		North of I-695			**South of I-695**					
	Criterion	**General Purpose Lanes**	**Managed Lanes**	**Collector Distributor Lanes**	**General Purpose Lanes**	**Managed Lanes**	**Collector Distributor Lanes**	**I-895**	**I-695**	**MD 43**
	Design Speed	70 mph	70 mph	70 mph	70 mph	70 mph	N/A	65 mph	65 mph	60 mph
	Stopping Sight Distance	730'	730'	730'	730'	730'	N/A	645'	645'	645'
Horizontal Alignment	Minimum Radius (see note 4)	1820'	1820'	1820'	1820'	1820'	N/A	1820'	1820'	1205'
	Desirable Length of Curve	2000	2000	2000	2000	2000	N/A	2000	2000	2000
	Minimum Length of Curve	1000	1000	1000	1000	1000	N/A	1000	1000	1000
	Maximum Superelevation	8%	8%	8%	8%	8%	N/A	8%	8%	8%
	Maximum Rate of Transition "c"	0.0001	0.0001	0.0001	0.0001	0.0001	N/A	0.0001	0.0001	0.0001
	Superelevation Distribution	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	N/A	2/3 Tangent	2/3 Tangent	2/3 Tangent
	Emergency Crossovers	(see note 1)	(see note 1)	(see note 1)	(see note 1)	(see note 1)	N/A	N/A	N/A	N/A
	Auxiliary Lane Lengths and Taper Rates	(see note 2)	(see note 2)	(see note 2)	(see note 2)	(see note 2)	N/A	(see note 2)	(see note 2)	(see note 2)
	Minimum Spacing for Lane Drop from Interchange	3000'	3000'	3000'	3000'	3000'	N/A	-	-	-
Vertical Alignment	Minimum Grade	0.50%	0.50%	0.50%	0.50%	0.50%	N/A	0.50%	0.50%	0.50%
	Maximum Grade	4%	4%	4%	4%	4%	N/A	4%	4%	4%
	Sag Minimum (K Value) Desirable	181	181	181	181	181	N/A	157	157	136
	Crest Minimum (K Value) Desirable	247	247	247	247	247	N/A	193	193	151
	Highway Overpass Vertical Clearance	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	N/A	16'-9"	16'-9"	16'-9"
Typical Sections	Inside Shoulder Width without Barrier	12'	12'	12'	N/A	N/A	N/A	12'	12'	4' Paved/10' Graded
	Inside Shoulder Width Including Barrier Offset	14'	14'	14'	4' Buffer	12'	N/A	12'	12'	6'
	Median Width	(see note 1)	(see note 1)	(see note 1)	(see note 1)	(see note 1)	N/A	-	-	-
	Lane Widths	12'	12'	12'	12'	12'	N/A	12'	12'	12'
	Outside Shoulder Including Barrier Offset	14'	14'	14'	14'	4' Buffer	N/A	14'	14'	12'
	Maximum Rollover									
	Pavement	4%	4%	4%	4%	4%	N/A	4%	4%	4%
	Shoulder (see Note 3)	4%	4%	4%	4%	4%	N/A	4%	4%	7%
	Normal Cross-slope	2%	2%	2%	2%	2%	N/A	2%	2%	2%
	Clear Zone/Roadside Grading	conc barrier	conc barrier	conc barrier	conc barrier	conc barrier	N/A	32' x K_{cz}	34' x K_{cz}	32' x K_{cz}
	Foreslopes & Grass Median Slopes	N/A	N/A	N/A	N/A	N/A	N/A	6:1 max.	6:1 max.	6:1 max.
	Backslopes in Cut (within clear zone)	N/A	N/A	N/A	N/A	N/A	N/A	4:1 max.	4:1 max.	4:1 max.
	Max. Slope at face of barrier	10:1	10:1	10:1	10:1	10:1	N/A	10:1	10:1	10:1

Note 1 - Emergency crossovers shall be placed when interchange spacing > 5 miles (3 to 4 mile intervals) and located in accordance with p. 514-516 AASHTO '01. Median width should take into consideration U-turn movements by emergency and snow removal (SU) vehicles. Median width should also provide adequate space for entrance ramps and associated accel/decel lengths and toll booth or EZPass facilities if tolling of managed lanes is to be retained as an option for the Managed Lanes Alternate.

Note 2 - Use parallel type entry ramps. Lengths and taper rates of Acceleration and Deceleration Lanes should be in accordance with pp. 849-867 AASHTO '01 and account for adjustments due to grade and severe horizontal curvature.

Note 3 - MOT may govern shoulder cross-slope.

DRAFT DESIGN CRITERIA
Managed Lanes Alternate
Section 100: I-95, I-895 (N) Split to North of MD 43
Maryland Transportation Authority

	Managed Lanes Alternate	Directional Ramps				General Use and Collector Distributor Ramps					
		North of I-695		South of I-695		North of I-695			South of I-695		
	Criterion	Managed Ramps	General Purpose Ramps	Managed Ramps	General Purpose Ramps	1- Lane Outer Ramps	2-Lane Outer Ramps	Loop Ramps	1- Lane Outer Ramps	2-Lane Outer Ramps	Loop Ramps
	Design Speed	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	30 mph	(see note 1)	(see note 1)	(see note 2)
	Stopping Sight Distance - Ramp Proper (see note 4)	425'	425'	425'	425'	425'	425'	200'	425'	155'-250'	155'-250'
	Stopping Sight Distance at Gores	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)	(see note 3)
Horizontal Alignment	Minimum Radius (see note 4)	750'	750'	750'	750'	750'	750'	250'	170'-350'	170'-350'	170'-250'
	Desirable Length of Curve	1600'	1600'	1600'	1600'	1600'	1600'	1600'	1600'	1600'	1600'
	Minimum Length of Curve	800	800'	800'	800'	800'	800'	800'	800'	800'	800'
	Maximum Superelevation	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
	Maximum Superelevation Rate of Transition "c"	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0004	0.0003	0.0002	0.0004
	Superelevation Distribution	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent	2/3 Tangent
	Auxiliary Lane Lengths and Taper Rates	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)	(see note 5)
	Minimum Lane Drop Spacing from Two-Lane Entrances	3000'	3000'	3000'	3000'	n/a	3000'	n/a	n/a	3000'	n/a
	Minimum Length of Auxiliary Lane Approach for Two Lane Exit	1500'	1500'	1500'	1500'	n/a	1500'	n/a	n/a	1500'	n/a
Vertical Alignment	Minimum Grade	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
	Maximum Grade (see note 4)	3%-5%	3%-5%	3%-5%	3%-5%	3%-5%	3%-5%	5%-7%	4%-6%	4%-6%	5%-7%
	Sag Minimum (K Value) Desirable (see note 4)	96	96	96	96	96	96	37	26-49	26-49	26-37
	Crest Minimum (K Value) Desirable (see note 4)	84	84	84	84	84	84	19	12-29	12-29	12-19
	Highway Overpass Vertical Clearance	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"	16'-9"
Typical Sections	Inside Shoulder Width	1'	1'	1'	1'	1'	4'	4' to curb	1'	4'	1'
	Lane Width	14'	14'	14'	14'	14'	2 @ 12'	15'	14'	2 @ 12'	14'
	Outside Shoulder Width	8'	8'	8'	8'	8'	8'	8' to curb	8'	8'	8' to curb
	Maximum Rollover										
	Pavement	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	Shoulder (see note 6)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	Normal Cross-slope	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
	Clear Zone/Roadside Grading	*20' x Kcz*	*20' x Kcz*	*20' x Kcz*	*20' x Kcz*	*20' x Kcz*	*20' x Kcz*	*16' x Kcz*	*20' x Kcz*	*20' x Kcz*	*16' x Kcz*
	Foreslopes & Grass Median Slopes	*6:1 max*	*6:1 max*	*6:1 max*	*6:1 max*	*6:1 max*	*6:1 max*	*6:1 max*	*6:1 max*	*6:1 max*	*6:1 max*
	Backslopes in Cut (within clear zone)	*4:1*	*4:1*	*4:1*	*4:1*	*4:1*	*4:1*	*4:1*	*4:1*	*4:1*	*4:1*
	Max. Slope at face of barrier	*10:1*	*10:1*	*10:1*	*10:1*	*10:1*	*10:1*	*10:1*	*10:1*	*10:1*	*10:1*

Note 1 - Minimum design speeds of 25 mph, 30 mph and 35 mph for mainline design speeds of 50 mph, 60-65 mph, and 70 mph, respectively, as per p. 830 AASHTO '01.
Note 2 - Minimum design speeds of 25 mph and 30 mph for mainline speeds of 50 mph and 60-65 mph, respectively, as per p. 830 AASHTO '01.
Note 3 - Note that Sight Distance at ramp gores should equal Stopping Sight Distance + 25% +Decision Sight Distance as per p. 116 and 832 AASHTO '01.
Note 4 - Use upper range value when design constraints permit. Note AASHTO '01 guidelines (p.833) regarding length and direction of grade.
Note 5 - Use parallel type. Lengths and taper rates for accel/decel lanes should be in accordance with pp. 849-867 AASHTO '01 and account for adjustments due to grade and severe horizontal curvature.
Note 6 - MOT may govern shoulder cross-slope