Minnesota Department of Transportation
Office Memorandum

District: 6
Date: September 14, 2022
To: Douglas Carter, P.E., State Geometrics Engineer
From: Chad Hanson (MnDOT) & Don Demers/ Joshua Colas (SRF)
Subject: **Design Memorandum**
With Design Exception(s)

State Project Number(s) & T.H./Interstate Number(s): SP5580-99, I-90 and TH52
Federal Aid Project Number(s): NA
FHWA Contact: Abbi Ginsberg
County(s): Olmsted County City(s): Marion Township
Type of Work: Interchange reconstruction. Replace bridges 55809 and 55810. Replace box culvert/bridge 91201 and 91203. Construct new flyover bridge and directional ramp. Reconstruction Pavement.
Project Termini: TH52 - 0.3 MILES NORTH OF I-90 TO 0.4 MILES SOUTH OF I-90. I-90 - 0.6 MILES EAST OF TH52 TO 0.3 MILES WEST OF TH52
Project Reference Point (I-90): 217+00.752 to 218+00.477; (US-52): 46+00.237 to 46+653
This project is scheduled for a November 17, 2023 letting.

Design Standards Form(s) Attached:
Highway Design Standards Form
Ramp Design Standards Form

The Design Exceptions described in this Design Memo are recommended for approval by:

Chad Hanson
Digitally signed by Chad Hanson
Date: 2022.09.14 16:09:52 -05'00'

Chad Hanson, P.E. Date

I concur/approve:

Mark Schoenfelder
Digitally signed by Mark Schoenfelder
Date: 2022.09.15 22:23:35 -05'00'

District Engineer Date

Design Exceptions approved by:

Tom Styrbicki
Digitally signed by Tom Styrbicki
Date: 2022.09.16 13:52:21 -05'00'

State Design Engineer Date

PROJECT BACKGROUND

The I-90/US 52 interchange was built in the 1960s and needs geometric enhancements to address safety issues and improve mobility. MnDOT completed a study of the I-90/US 52 interchange in 2018 detailing the project needs, risks, interchange alternatives, and recommended scoping concept.

I-90 is an important east-west interstate corridor that connects southern Minnesota to US 52 at the I-90/US 52 interchange south of Rochester. US 52 is a critical north-south transportation facility that connects major population centers in Rochester and Minneapolis-St. Paul. Both I-90 bridges over US 52 will be replaced, the existing ramps will be reconstructed, and a new southbound US 52 to eastbound I-90 directional ramp will be added that includes a new bridge over US 52.

The I-90/US 52 interchange is just south of the Rochester city limits, with the land uses around the interchange varying from agricultural to low-density residential. The US 52 freeway from the north ends at I-90 and turns into a two-lane highway through the interchange. The lower speed ramps and at-grade intersections are not intuitive for high-volume movements between high-speed rural freeways.

PROJECT INFORMATION

Highway Type

(X) Two Lane Highway, Rural (X) Multi-lane Divided Highway, Rural (High Speed)
( ) Two Lane Highway, Urban ( ) Multi-lane Divided Highway, Urban (High Speed
(X) Freeway, Rural ( ) Multi-lane Divided Highway, Urban (Low Speed)
( ) Freeway, Urban ( ) Multi-lane Undivided Highway, Urban (Low Speed)

I-90: high-speed, four-lane, controlled access freeway
US-52 north of I-90: divided, four-lane controlled access freeway
US-52 south of I-90: undivided, two-lane

Functional Class (X) Principal Arterial ( ) Minor Arterial ( ) Collector
Number of Lanes (X) Two Lane (X) Four Lane ( ) Six or eight lane
( ) Single-lane ramp ( ) Multi-lane ramp
Terrain: (X) Level ( ) Rolling ( ) Mountainous

I-90 – West of US-52
Traffic Volume: Current ADT 5,400 veh./day
Based on: ( ) actual counts, (X) traffic flow map, dated 2018
Forecast ADT (2046) – 6,430 - based on based on ESALs produced by MnDOT dated 2021.

I-90 East of US-52
Traffic Volume: Current ADT 14,000 veh./day
Based on: ( ) actual counts, (X) traffic flow map, dated 2018
Forecast ADT (2046) – 15,090 - based on ESALs produced by MnDOT dated 2021.

US-52 – North of I-90
Traffic Volume: Current ADT 21,400 veh./day
Based on: ( ) actual counts, (X) traffic flow map, dated 2018
Forecast ADT (2046) – 26,880 - based on ESALs produced by MnDOT dated 2021.

US-52 – South of I-90
Traffic Volume: Current ADT 6,800 veh./day
Based on: ( ) actual counts, (X) traffic flow map, dated 2018
Forecast ADT (2046) – 7,960 - based on ESALs produced by MnDOT dated 2021.

Access Control (X) Full ( ) Partial ( ) none
I-90: Design Speed 70 mph Posted Speed 70 mph
US-52: Design Speed 60 mph Posted Speed 55 mph

(X) Existing and Proposed Typical Sections are included in the appendix.
(X) Reduced layout is included in appendix.

BRIDGE PROJECT INFORMATION
( ) This is a Bridge Preservation project
( ) This is a Bridge Improvement project
(X) This is a Bridge Replacement project
( ) This is a ramp bridge with radius of 190-ft or less, or volume of trucks greater than 10%.

( ) Preliminary Bridge Plan is included in appendix

Railroad: ( ) Yes (X) No
If yes: ( ) Highway over RR ( ) Highway under RR

Bridges are over:
( ) Non-navigable waterway ( ) Navigable waterway (X) Trunk Highway ( ) Local road

Special lanes on bridge: (X) Auxiliary lanes (X) Exit or Entrance ramps extending onto bridge

Median curb present: ( ) Yes (X) No
(X) Bridge is less than 250-ft. long and with no single span greater than 200-ft.
- BR 55826, US-52 SB to I-90 EB (Flyover)

(X) Bridges are greater than 250-ft. long or with a single span greater than 200-ft.
- BR 55823, I-90 EB
- BR 55824, I-90 WB

DESIGN STANDARDS
Based on the criteria in Design Standards and Exceptions for Controlling Design Criteria, this project will be designed to MnDOT's New Construction / Reconstruction (including New or Replacement Bridges) Standards.

DESIGN EXCEPTIONS

List of Design Exception(s):

I. Stopping sight distance along Ramp D
- Standard: 360 feet for a 45mph curve.
- Existing: N/A
- Proposed: The horizontal stopping sight distance achieved is 40 mph at bridge (#55826) due to a 36 inch barrier that interrupts sight line.

II. Ramp Pavement width for Ramp A and B.
- Standard: 26 feet including 6 feet right shoulder and 4 feet left shoulder
- Existing: 26 feet including 6 feet right shoulder and 4 feet left shoulder

- Proposed: 23 feet including 4 feet right shoulder and 4 feet left shoulder

Justification of Design Exception(s): Scoping considered many different alternatives and evaluated them in a multi-phase screening process.

I. Stopping sight distance along Ramp D.

1. Alternatives considered: Interchanges with various US-52 SB to I-90 EB geometrics were considered
    - Initial Screening: Roundabout with Existing Configuration, Diamond, Diverging Diamond, Southwest Loop, Flyover with Curved Bridge, Flyover with Tangent Bridge, Partial Turbine, Partial Turbine with 3-span Bridge, Partial Clovermill with Shared Eastbound Bridge, Partial Clovermill
    - Final Screening: Roundabouts with Existing Configuration, Flyover with Curved Bridge, Flyover with Tangent Bridge, Partial Turbine with 3-span Bridge (selected as the proposed design).
2. Cost comparison (proposed versus full standard)
    - Roundabouts with Existing Configuration: $14.7M construction, BC -1.01
    - Flyover with Curved Bridge: $31.5M construction, $53K R/W, BC 1.1
    - Flyover with Tangent Bridge: $25.7M construction, $38K R/W, BC 1.6
    - Partial Turbine with 3-span Bridge: $20.8M construction, $92K R/W, BC 1.8
3. Comparison of safety performance
    - NCHRP 783 stated “neither the HSM nor the FHWA CMF Clearinghouse includes any CMFs indicating an effect of stopping sight distance on safety.” This is a new ramp, therefore, crash history is not available.
4. Comparison of operational performance
    - NCHRP 783 stated “the HCM does not include any effect of stopping sight distance on LOS for any roadway type.”
5. Compatibility with adjacent sections of roadway (proposed versus adjacent sections of roadway)
    - The speed of this curve is a compromise to minimize impact to the adjacent bluff and optimize the bridge across TH 52.
6. Any proposed mitigation measures (for proposed design)
    - Left shoulder width of ramp increased to 10 feet on bridge. Ramp profile is over 3% upgrade approaching the bridge helping slow vehicles approaching the curve and bridge.
7. Any other pertinent impacts (for proposed design):
    - The US-52 SB to I-90 EB Ramp D will require R/W acquisition. There are wetlands within the area. Muck excavations will most likely occur. There is shallow bedrock along the west side of US-52. There is a potential for shallow groundwater in the subgrade for the US-52 SB to I-90 EB underpass but ramp elevations should allow subsurface drains and outlets to US-52 ditch.

I. Ramp Pavement width for Ramp A and B

There are no measurable differences in either safety or operation performance when comparing the proposed 23-ft ramp to the standard 26-ft ramp pavement width. The proposed design will reduce the project cost by roughly $75,000. Additionally, the proposed 23-ft ramp pavement width will soon be our documented standard in the upcoming Facility Design Guide.

LAYOUT STATUS

( ) A geometric layout is not required for this project.

(X) A Level 1 Geometric Layout (and profile) ( ) will be prepared for this project
(X) has been prepared for this project

The layout has received Mn/DOT:
( ) Staff review and concurrence ( ) Staff approval (approved __/__/__)

Municipal consent (layout approval) is required: YES _____ NO X
If YES, Municipal consent has been obtained: YES_____ received on __/__/__
NO_____

INTERSTATE/STRAHNET SYSTEM
NOTE: In Minnesota the Interstate/STRAHNET system consists of all Interstate highways**,** TH 61 north of Duluth, and TH 10 from TH 24 to TH 371.

( ) This project does not involve work on the Interstate/STRAHNET system.

(X) This project involves work on the Interstate/STRAHNET system. At the completion of this project:

( ) All bridges will meet the 16-foot standard for vertical clearance over Interstate highways.

(X) All bridges over designated OSOW Super Load Corridors will meet the 16 feet 6 inch standard for vertical clearance.

( ) The vertical clearance of the bridge(s) **is less than 16 feet** and will remain unchanged. FHWA will be requested to coordinate with the Department of Defense/MTMCTEA at least three months before letting.

TRAFFIC HANDLING DURING CONSTRUCTION
Traffic will be maintained through staged construction. Staging concepts will be developed and analyzed for traffic operations and constructability. During five (5) Maintenance of Traffic meetings, MnDOT and select stakeholders will agree upon a staging concept that facilitates construction operations and maintains traffic at an acceptable level of service. The Transportation Management Plan (TMP) will document the preferred alternative and frame the development of traffic control and staging plans.

BICYCLE and PEDESTRIAN CONSIDERATIONS
(X) Bicycles are not legally permitted on this roadway.
( ) Preliminary layouts [will be / have been] provided to the CO Bicycle/Pedestrian Section for comment.
( ) Improvements to bicycle/pedestrian access are planned for this project.
( ) Existing access for bicycles or pedestrians will be eliminated by this project.

Highway Design Standard Form

If a proposed condition is a Design Exception put an asterisk (*) in front of the proposed condition.

I-90: Rural Freeway

Critical Design Element	Existing Condition, Minimum	Proposed Condition, Minimum	MnDOT Standard for New Construction/ Reconstruction	Road Design Manual or LRFD Bridge Design Manual or Technical Memorandum
Design Speed	Design Speed selected for this project is 70 mph.			TM 17-13-TS-06
Lane Width	12 ft	12 ft	12 ft min. _12 ft max.	TM 18-08-TS-06
Shoulder Width: • Right • Left	10 ft paved 11.5 ft usable __4 ft paved 5.5 ft usable	10 ft paved 11.5 ft usable _ 4 ft paved _5.5 ft usable	10 ft paved 11.5 ft usable _ 4 ft paved 5.5 ft usable	TM 17-12-TS-05
Design Loading Structural Capacity	HS20 __ Design load	HL-93	All new bridges: HL-93 Minimum design load	LRFD Bridge Design Manual, Article 3.4 (Scroll to Page 3.4)
# Stopping Sight Distance	730 ft	>730ft	730 ft min.	Tables 2-5.08A & B (Chapter 2, Page 37)
Horizontal Curve, Radius	___3903 ft	Match Existing ft	___1810 ft min.	RDM Chapter 3-2
Maximum Grade	2.76 % maximum	2.76 % maximum	3 % maximum	Table 3-4.02A (Chapter 3, Page 3-4(2))
Cross Slope	0.010 ft/ft	0.020 ft/ft	0.015 – 0.020 ft/ft	RDM Chapter 4-3
Superelevation	0.046 ft/ft	Match Existing ft/ft	0.08 ft/ft maximum	RDM Chapter 3-3
Vertical Clearance • Highway under bridge • Railroad under bridge • Highway under sign or pedestrian bridge	N/A ft N/A ft N/A ft	N/A ft N/A ft 17 ft-4 in	16 ft-6 in 23 ft-0 in 17 ft-4 in	LRFD Bridge Design Manual, Table 2.1.3.1 (Page 11)

 # Stopping sight distance applies to horizontal and vertical alignments **except for sag vertical curves**.

*** An asterisk in front of the proposed condition indicates a Design Exception.**

Highway Design Standard Form

If a proposed condition is a Design Exception put an asterisk (*) in front of the proposed condition.

US-52: Rural Multi Arterial Lane Highway

Critical Design Element	Existing Condition, Minimum	Proposed Condition, Minimum	MnDOT Standard for New Construction/ Reconstruction	Road Design Manual or LRFD Bridge Design Manual or Technical Memorandum
Design Speed	Design Speed selected for this project is 60 mph.			TM 17-13-TS-06
Lane Width	12 ft	12 ft	12 ft min. _12 ft max.	TM 18-08-TS-06
Shoulder Width: • Right • Left (Rural) Left (Urban)	10 ft paved 11.5 ft usable ___4_ft paved 5.5 ft usable Curb Reaction	10 ft paved 11.5 ft usable ___4_ft paved _5.5 ft usable Curb Reaction	8 ft paved 9.5 ft usable __4_ft paved __5.5_ft usable Curb Reaction	TM 17-12-TS-05
Design Loading Structural Capacity	NA	NA	All new bridges: HL-93 Minimum design load	LRFD Bridge Design Manual, Article 3.4 (Scroll to Page 3.4)
# Stopping Sight Distance	570 ft	>570ft	570 ft min.	Tables 2-5.08A & B (Chapter 2, Page 37)
Horizontal Curve, Radius	___3817 ft	Match Existing ft	___1200 ft min.	RDM Chapter 3-2
Maximum Grade	1 % maximum	1 % maximum	3 % maximum	Table 3-4.02A (Chapter 3, Page 3-4(2))
Cross Slope	1.0-0.020 ft/ft	0.020 ft/ft	0.015 – 0.020 ft/ft	RDM Chapter 4-3
Superelevation	0.037 ft/ft	Match Existing ft/ft	0.08 ft/ft maximum	RDM Chapter 3-3
Vertical Clearance • Highway under bridge • Railroad under bridge • Highway under sign or pedestrian bridge	16ft-6in (55809) 16ft-6in (55810) N/A N/A	16ft-6in (55823) 16ft-6in (55824) N/A 17 ft-4 in	16 ft-6 in N/A17 ft-4 in	LRFD Bridge Design Manual, Table 2.1.3.1 (Page 11)

 # Stopping sight distance applies to horizontal and vertical alignments **except for sag vertical curves**.

*** An asterisk in front of the proposed condition indicates a Design Exception.**

Note: Complete this form for each type of ramp in the project.

Ramp Design Standard Form

Ramp Locations **Ramp Types**

Highway	Reference Point	Station	Intersecting Road	Ramp Alignment Name	Diagonal	Loop	Semi-Direct	Direct
I-90	217+01.042	EB 90 699+85	TH 52	LOOP F		X		
I-90	218+00.201	WB 90 710+50	TH 52	RAMP A				X
TH52	046+00.747	SB 52 525+80	I-90	RAMP D				X
TH 52	046+00.564	NB 52 538+42	I-90	LOOP E		X		
TH52	046+00.295	NB 52 552+60	I-90	RAMP B				X

Design Parameters:
Drainage Type: ( ) Urban (curb and gutter) (X) Rural (ditches)

*Ramps are predominantly Rural

Mainline Design Speed (Tech Memo 17-13-TS-06) **:** The Design Speed selected for the parent roadway I-90 is 70 mph. The design speed for US-52 is 60 mph.

(This speed will be used to look up the value for Ramp Design Speed)

Ramp Traffic Control: ( ) Metered ( ) Metered with HOV Bypass ( ) Traffic Signal at ramp terminal
(X) none

Note: A "No" below indicates a Geometric Design Exception. In parenthesis, list ramp alignment names that require design exceptions.

Critical Design Elements	Do all ramps of each type meet MnDOT Standards for New Construction / Reconstruction? (Yes or No)		MnDOT Standard for New Construction / Reconstruction		MnDOT Road Design Manual or MnDOT LRFD Bridge Design Manual or Technical Memorandum
	Ramp Type 1	**Ramp Type 2**	**Ramp Type 1 (Loop)**	**Ramp Type 2 (Direct)**	
Ramp Design Speed	Yes (Loop E = 25 mph. Loop F = 25 mph.)	Yes (Ramp A 50mph. Ramp B 30mph. Ramp D 45mph.)	20 mph min	50 mph min (Ramp A, D) 30mph min (Ramp B)	Table 6-3.04A (Scroll to page 48)

Critical Design Elements	Do all ramps of each type meet MnDOT Standards for New Construction / Reconstruction? (Yes or No)		MnDOT Standard for New Construction / Reconstruction		MnDOT Road Design Manual or MnDOT LRFD Bridge Design Manual or Technical Memorandum
	Ramp Type 1	Ramp Type 2	Ramp Type 1 (Loop)	Ramp Type 2 (Direct)	
Ramp Pavement Width (Single Lane)	Yes (Loop E = 28 ft. Loop F = 28 ft.)	No (Ramp A = 23 ft. Ramp B = 23 ft.) Yes (Ramp D = 25 ft.)	28 ft min.	26 ft min.	Table 6-3.04C (Scroll to page 50)
Ramp Acceleration Length[1]	Yes (Loop E = 1207 ft.)	Yes (Ramp D = 500 ft.)	Length(s) meet(s) or exceeds required length(s).	Length(s) meet(s) or exceeds required length(s).	Tables 6-2.04B & C (Scroll to page 36)
Deceleration Length[2]	Yes (Loop F = 764 ft.)	Yes (Ramp A = 340 ft. Ramp B = 360 ft.)	Length(s) meet(s) or exceeds required length(s).	Length(s) meet(s) or exceeds required length(s).	Tables 6-2.03A & B (Scroll to page 27)
Stopping Sight Distance [3]	Yes (Loop E > 200 ft. Loop F > 200 ft)	Yes (Ramp A = 740 ft. Ramp B = 397 ft.) No (Ramp D = 387 ft)	200 ft min.	360 ft min (Ramp A, D) 200 ft min (Ramp B)	Tables 2-5.08A & B (Scroll to page 37)
Horizontal Curve Radius	Yes (Loop E = 175 ft. Loop F = 160 ft.)	Yes (Ramp A = 955 ft. Ramp B = 275 ft. Ramp D = 674 ft.)	110 ft min.	760 ft min (Ramp A, D) 250 ft min (Ramp B)	RDM Section 6-3.04.01
Maximum Grade	Yes (Loop E = 3.29% Loop F = -2.62%)	Yes (Ramp A = -1.87% Ramp B = 2.50% Ramp D = -3.65%)	8 % max	5 % max	Table 6-3.04B (Scroll to page 49)

Critical Design Elements	Do all ramps of each type meet MnDOT Standards for New Construction / Reconstruction? (Yes or No)		MnDOT Standard for New Construction / Reconstruction		MnDOT Road Design Manual or MnDOT LRFD Bridge Design Manual or Technical Memorandum
	Ramp Type 1	Ramp Type 2	Ramp Type 1 (Loop)	Ramp Type 2 (Direct)	
Cross Slope	Yes (Loop E = 0.02 Loop F = 0.02)	Yes (Ramp A = 0.02 Ramp B = 0.02 Ramp D = 0.02)	0.015 – 0.020 ft/ft	0.015 - 0.020 ft/ft	TM 18-03-TS-02
Superelevation	Yes (Loop E = 0.06 Loop F = 0.06)	Yes (Ramp A = 0.059 Ramp B = 0.06 Ramp D = 0.06)	0.08 max	0.08 max	TM 17-11-TS-04
Design Loading Structural Capacity	Yes	Yes	All new bridges to have HL-93 minimum design load	All new bridges to have HL-93 minimum design load	LRFD Bridge Design Manual, Section 3.4
Vertical Clearance Highway under bridge Railroad under bridge Highway under sign or pedestrian bridge	N/A	Yes	_16 ft-_6 in __ ft-__ in 17 ft - 4 in	_16 ft - 6 in __ ft-__ in 17 ft - 4 in	LRFD Bridge Design Manual, Table 2.1.3.1 (Page 11)

[1] Measure **Ramp Acceleration Length** from the entrance terminal to the ramp terminal to the point where the taper reduces the ramp width to 12-feet. If a speed limiting horizontal curve is present, acceleration length is measured from the end of the limiting curve to the point where the taper reduces the ramp width to 12-feet.

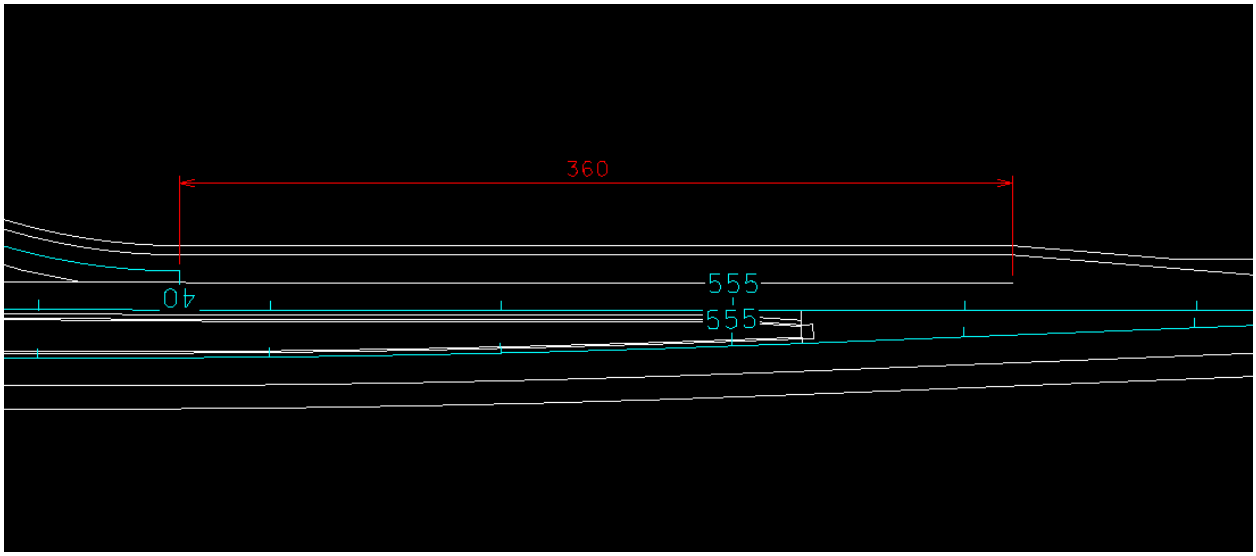
[2] Measure **Ramp Deceleration Length** from the point where the taper increases the ramp width to 12-feet to the point of inintial curvature of the exit ramp (i.e. the beginning of the ramp exit curve).

[3] **Stopping sight distance** applies to horizontal and vertical alignments, not including for sag vertical curves.

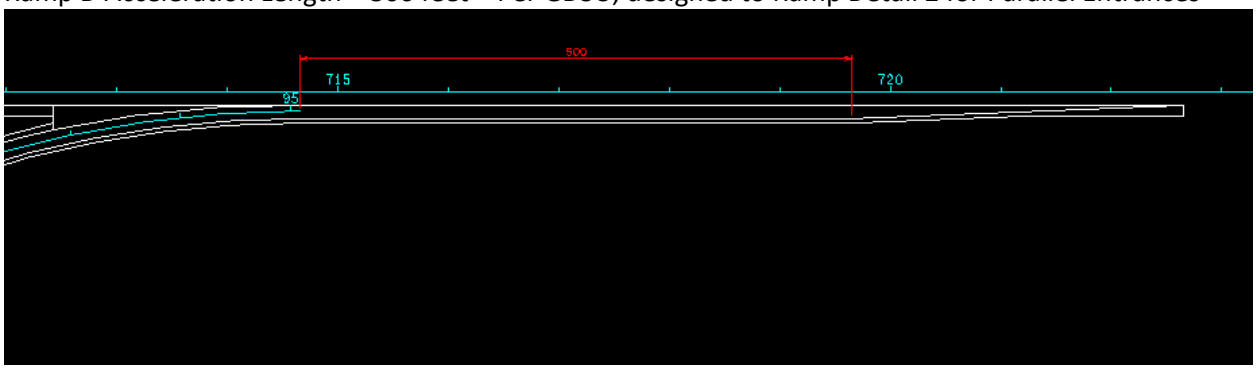
Ramp Design Standards Form Calculated Acceleration and Deceleration Lengths

Ramp A Deceleration Length – 340 feet

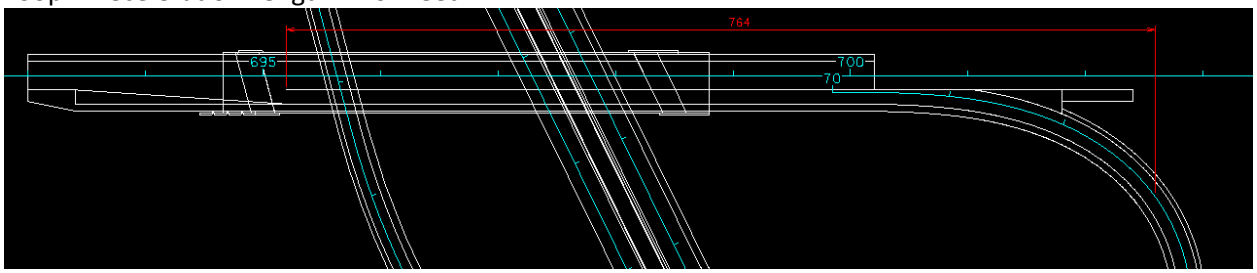
Ramp B Deceleration Length – 360 feet – Per PMT #4, District indicated the turn lane length can recognize up to a 10-mph reduction from the design speed to determine the turn lane length resulting in a shorter turn lane need.



Ramp D Acceleration Length – 500 feet – Per GDSU, designed to Ramp Detail 2 for Parallel Entrances



Loop F Deceleration Length – 764 feet



Loop E Acceleration Length – 1207 feet – Per GDSU, meets 85% of calculated acceleration length. See NCHRP Report 505 (Acceleration Lanes, pages 99 – 102).