CHAPTER SIX

STRUCTURE DESIGN

BRIDGE POLICY 6-1

This policy complies with the latest guidelines in the new "A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS", (2011) edition.

The policy included in this Manual was approved by the FHWA and the State Design Engineer. Therefore, some of the information will be repeated in other locations in the Design Manual.

See the next sheet for an Index of the Bridge Policy.

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BRIDGE DECK WIDTH CHARTS

HORIZONTAL CLEARANCE CHARTS

BRIDGE POLICY

This Bridge Policy establishes the controlling design elements of new and reconstructed bridges on the North Carolina Highway System. It is intended that this policy be for general use. In special cases where sound engineering judgment so dictates, the requirements of this policy will be adjusted upward or downward as necessary. It will be necessary to examine each individual structure to provide the most economical and safest design.

Background information was obtained from:

1. Standard Specifications for Highway Bridges, AASHTO 2002

2. Department of Transportation Division of Highway Bridge Policy, August 24, 1981, March 5, 1985, November, 1994, and March, 2000.

3. A Policy on Geometric Design of Highways and Streets, AASHTO 1984, 1990, 1994, 2001, 2004 and 2011.

4. A Policy on Design Standards-Interstate System June 1967, December 1988, July 1991, and January 2005

5. Metropolitan Planning Organization (MPO) – Recommendations from the Local MPO'S.

Where there was an overlap, gap or lack of information, engineering judgment has been used to resolve questionable areas.

The primary factors governing the design elements of a bridge are:

1. Functional Classification of Highway Facility
2. Volume of Traffic
3. Design Speed
4. Safety and Accident Experience
5. Urban Area Boundary (Bicycle and Pedestrian Movement)

This policy addresses each of these factors and establishes the design elements accordingly.

Box culvert type vehicular underpasses are considered for construction in special cases, however, they are not addressed in this policy. (See the Structure Design Unit for Design Information.)

For determining bridge design elements, the functional classification of highway facilities is divided into the following systems:

1. Interstate System - The national system of fully controlled access freeways which accommodates high volumes of traffic for the purpose of facilitating interstate commerce and mobility. The design of this system is subject to more stringent standards than other similar systems to assure nationwide uniformity, and encourage higher safety standards.

2. Freeway System - A divided arterial highway for through traffic with fully controlled access. Access is limited to interchanges. These highways may be staged constructed with some initial at grade intersections.

3. Arterial System - These highways, including expressways, accommodate moderate to high volumes of traffic for travel between major points. These highways are primarily for through traffic, usually on a continuous route, and are generally the top 10% of the total highway system based on relative importance for statewide travel. They usually have at grade intersections. Access can be partially controlled.

4. Collector System - Provides primarily intra-county service with shorter travel distances and generally more moderate speeds. These routes provide service to county seats and towns not on the arterial system. Routes which carry traffic from local roads to arterials are collectors. They usually have at grade intersections. Access is not controlled.

5. Local System - Provides access to farms, residences, businesses, or other abutting properties. The traffic volumes generated by the abutting land uses are largely short trips or a relatively small part of longer trips where the local road connects with major streets or highways of higher classifications. They usually have at grade intersections. Access is not controlled.

The entire North Carolina Highway System has been classified by these functional classifications. The Environmental Planning Document will include the proper classification for each roadway that is being improved.

Bridges Within Urban Area Boundaries

Urban Area Boundaries represent the outer limit of potential urban growth over the long-term planning period – generally 20 to 25 years – and include more than enough land to accommodate anticipated growth. The full approach curbed width is to be provided for bridges with existing urban – type roadway sections (curb and gutter). On urban – type roadways without control of access, ADA acceptable sidewalks shall be provided on new bridges. Sidewalks shall be provided on one or both sides in accordance with the project Environmental Planning Document. If future roadway widening is anticipated, additional bridge width should be considered to accommodate the planned curbed width.

Bridges within the Federal-aid urban boundaries with rural-type roadway sections (shoulder approaches) may warrant special consideration. To allow for future placement of ADA acceptable sidewalks, sufficient bridge deck width should be considered on new bridges in order to accommodate the placement of sidewalks. As part of the planning process, the functional classification will be reviewed to determine if its planning designation is applicable for the facility over the 20-year design period. In some cases, a new classification may be established for design purposes and approved in the Environmental Planning Document. Design exceptions would be required for any design elements that do not meet the standards for the functional classification approved for design in the Environmental Planning Document.

EXCEPTIONS TO POLICY

Any bridge with special design requirements such as long span lengths, locations with special significance such as close proximity to historic sites or public parks, movable spans, bridge lengths greater than 200′ or other special features, will be designed on an individual basis and may not conform to criteria included elsewhere in this policy. The Environmental Planning Document will include an analysis to determine approximate length, width, median type, navigational clearances or any other pertinent design features. Accident experience or potential will be examined when considering exceptions to the Bridge Policy.

Deck widths exceeding those shown in this policy may be used when future facility upgrading is anticipated and justified in the Environmental Planning Document.

Special consideration should be given to horizontal clearances underneath the structure. If minimum clearance is used, any future widening will require replacement of the structure. Therefore, in areas where traffic growth is anticipated, horizontal clearance shall allow for additional growth.

Bridges improved under the 3-R program shall conform to North Carolina's "Guide for Resurfacing, Restoration and Rehabilitation (R-R-R) of Highways and Streets", and the Subdivision Roads Policy and may not conform to criteria included in this policy.

Minimum bridge width will be the same as the total paved approach.

EXISTING BRIDGES TO REMAIN IN PLACE

Highway geometric and roadway improvements encourage higher speeds and attract larger vehicles to the highway. Existing substandard structures must be considered for improvement correspondingly. Because of the high cost of new structures, existing bridges and culverts that meet acceptable criteria should be retained as outlined in this chapter.

Where an existing highway is to be reconstructed or widened to dual lanes, an existing bridge which fits the proposed alignment and profile may remain in place if it meets the following criteria: The bridge is structurally sound, bridge rails meet or can be upgraded to meet current criteria and standards, its safe load carrying capacity and clear deck width are equal or greater than values shown in this chapter, and there is no significant accident experience.

Existing bridges which are structurally sound and provide safe loading capacity but are deficient for roadway width will be considered for widening. If it is determined to widen an existing bridge, it shall be widened to the same dimension as recommended for a new bridge.

BRIDGE POLICY (continued) 6-1

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

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

SAFE LOAD CAPACITIES FOR BRIDGES TO REMAIN IN PLACE WHEN THE APPROACH ROADWAY IS RECONSTRUCTED

TRAFFIC		SAFE LOAD CAPACITY	
	DESIGN ADT	INTERSTATE, FREEWAY & ARTERIAL	LOCAL & COLLECTOR
	under 400	SEE NOTE (1)	SEE NOTE (2)
	400 - 2000	SEE NOTE (1)	SEE NOTE (2)
	2001 - 4000	SEE NOTE (1)	SEE NOTE (2)
	over 4000	SEE NOTE (1)	SEE NOTE (2)

NOTES:

1) The Bridge shall have a safe load capacity of 10% in excess of that required for N.C. Legal Load when rated in accordance with the Manual for Maintenance, Rating and Posting of Bridges on the North Carolina Highway System.

2) The Bridge shall be rated and posted, if necessary, in accordance with the "Manual for Maintenance Inspection, Rating and Posting of Bridges on the N.C. Highway System" to a weight limit determined to meet the needs of the route served; however, the safe load capacity shall be sufficient to carry school buses and vital services vehicles where there is no reasonable or adequate alternate route.

REFERENCES: AASHTO "Manual for Maintenance Inspection of Bridges"

"Manual for Maintenance Inspection Rating and Posting of Bridges on the North Carolina Highways System"

DESIGN LIVE LOAD

The design live load for all new, reconstructed, or rehabilitated bridges on the Highway System shall be HS-20. A design other than HS-20 shall not be used unless there are conditions which warrant or justify its use in a particular situation and will require approval by the State Bridge Design Engineer.

HYDRAULIC DESIGN

Stream crossing structures shall be designed in accordance with procedures, criteria and standards contained in the Division of Highways "Guidelines for Drainage Studies and Hydraulic Design."

BRIDGE DECK RAILING

All bridge railings shall conform to current AASHTO criteria and shall have been successfully crash-tested in accordance with FHWA guidelines. Generally bridges with no sidewalks or no anticipated sidewalks should have a Jersey barrier rail. When a sidewalk or designated bikeway is justified, appropriate railings shall be used.

BRIDGE SCOUR

Stream crossing structures shall include design to protect against bridge scour in accordance with HEC 18 (Evaluating Scour At Bridges), dated November, 1995 or subsequent updates.

EARTHQUAKE DESIGN

All structures shall be designed for earthquake forces in accordance with the AASHTO Guide, "Specification for Seismic Design of Highway Bridges."

VESSEL IMPACT

All bridges over navigable waters shall be designed in accordance with the "Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges, Second Edition 2009" or subsequent updates of this publication.

SIDEWALKS

Sidewalks shall be included on new bridges with curb and gutter approach roadways that are without control of access; in some cases, only one side may warrant a sidewalk. Sidewalks should not be included on controlled access facilities. A determination on providing sidewalks on one or both sides of new bridges will be made during the planning process according to the NCDOT Pedestrian Policy Guidelines. When a sidewalk is justified, it shall be a minimum of 5′-6″ wide. A minimum handrail height of 42″ is required.

BRIDGE POLICY (continued) 6-1

BIKEWAYS

When a bikeway is required, the bridge shall be designed in accordance with AASHTO standard bicycle accommodations and North Carolina Bicycle Facilities Planning and Design Guidelines to give safe access to bicycles where feasible. A minimum handrail height of 54″ is required where bicyclists will be riding next to the handrail.

CROSS SLOPE

The cross slope of a bridge deck shall be the same as the approach travel lane cross slope.

In an area of frequent icing, a reduction in superelevation may be in order. This situation will be dealt with on a project-by-project basis.

APPROACH SLABS

Concrete approach slabs shall be constructed at the ends of all bridges. The approach slab shall be the same width as the bridge gutter to gutter width. Additional width (5’-6’ minimum) is necessary to accommodate each sidewalk on a structure.

Bridges located on NHS routes and/or carrying a design year ADT greater than 5,000 shall have a 25’-0” approach slab. Otherwise specify a 15’-0” approach slab. The approach slab length shall be measured along the workline.

Flexible approach pavements require both ends of the approach slab to be parallel to the end bent fill face. The approach slab length shall be measured along the workline.

Rigid approach pavements require the roadway end of the approach slab to be perpendicular to the centerline of the roadway. The minimum length shall be measured along the shortest edge. On very wide bridges and/or bridges with a heavy skew, the long edge of the approach slab may become excessive. For such cases limit the length of the longer edge of the approach slab to 50’-0”. This may be accomplished by stepping in the approach slab at approach pavement lines while maintaining the minimum dimension.

BRIDGE POLICY (continued) 6-1

Bridges require approach slabs with either sidewalk or a 4" curb (like curb on shoulder berm gutter) along the entire approach slab length.

CURB AND GUTTER

The clear width for new bridges on streets with curb and gutter approaches shall be the same as the curb to curb approach width except where bikeways are carried across the structure; in such instances, AASHTO standard bicycle safety accommodations should be provided.

The 2′ gutter widths shown in this policy are based upon the use of the standard 2′-6″ curb and gutter. If other curb and gutter widths are used, bridge widths will be adjusted accordingly.

UNPAVED APPROACH

Unpaved low volume roads require 100' of approved asphalt surfacing from the ends of a newly constructed bridge.

This pavement shall be 20' wide and flare to match the approach slab width within the last 10'.

Normally 75' of guardrail is required at each corner of newly constructed bridges on unpaved roadways.

REINFORCED BRIDGE APPROACH FILLS

It is our policy to use reinforced bridge approach fills for all bridges with a few exceptions. The Geotechnical Engineering Unit will provide a letter to the Roadway Project Engineer if it specifically recommends not using the reinforced approach fills.

MEDIANS ACROSS BRIDGES

On a divided highway, separate structures shall be provided unless it can be clearly shown that it is more economical to provide a single structure or a single structure is needed for the maintenance of traffic.

On controlled access facilities and non-controlled divided facilities with design speeds greater than 50 mph, a median barrier should be provided on single structures. Where the approach roadway has a median barrier, the same type of barrier shall be continued across the structure. If there is no median barrier on the approach roadway, some type of barrier should be provided on the structure.

END BENT SLOPES

Generally, end bent slopes at all rivers and streams shall be 1.5:1; however, final consideration of rate of slope and minimum slope protection requirements will depend upon the Hydraulic Design.

At bridges where a railroad passes underneath the roadway, the end bent slope shall normally be 1.5:1 or the same as adjacent cut; however, negotiations with the railroad company may dictate otherwise. At bridges where a railroad passes over the roadway, the end bent embankment slope shall normally be 1.5:1, unless negotiations with the railroad company dictate otherwise.

End bent embankment slopes shall be 1.5:1 on all other bridges going over roads. End bent slopes occurring in cuts shall be at the same rate of slope as the adjacent roadway cut slopes but, generally no flatter than 2:1.

For bridges with large skew angles, there may be no slope transition in two opposing quadrants of the crossing. In this case, the 1.5:1 end bent slope will simply intersect the flatter end bent fill slope. Slope paving transitions will vary from bridge to bridge depending upon skew angle, type of grading around the bridge, pier placement, and the type of structure (single or dual). The Roadway and Structure Project Engineers should confer early in design of each bridge to work out slope protection paving details at each site. Close coordination at this time will also enable correct detailing in roadway plans for paved shoulder tapers, placement of concrete barrier or guardrail, and roadway shoulder and ditch transitions on the bridge approach.

If the Geotechnical investigation and laboratory results indicate that 1.5:1 slopes will be unstable at any bridge end bent, flatter slopes or special designs will be used as specified by the Geotechnical Engineering Unit.

Any bridge end bent occurring in rock may have a special slope design as specified by the Geotechnical Engineering Unit.

VERTICAL CLEARANCES

Vertical clearances for new structures shall be designed above all sections of pavement including the useable shoulder. Accommodate future lanes and future loops by providing adequate vertical clearance for the future improvements. A note should be included in the Structure Recommendation plans stating the minimum vertical clearance and any accommodations needed for future lanes.

Vertical clearances shall be as shown below. These clearances include a 6″ allowance for future resurfacing. An additional 6″ range is shown to allow for the flexibility necessary in the coordination of roadway grades with final superstructure depths.

Vertical clearances above these limits must be justified by economics or some vertical control.

1. Over Interstates and Freeways and Arterials
   Vertical Clearances – 16′-6″ to 17′-0″

   Note: “17′-0″ to 17′-6″ vertical clearance is desirable for structures located over Interstates, Freeways, or Arterials constructed with portland cement concrete pavement. If the pavement type is not known during the preliminary design phase, then the desirable clearance range should apply to structures located over these facilities having design year average daily truck traffic of 5000 or greater.”

2. Over Local and Collector Roads and Streets
   Vertical Clearance – 15′-0″ to 15′-6″

3. Over all Railroads
   Vertical Clearance – 23′-0″ to 23′-6″ or less if approved by Railroads

BRIDGE POLICY (continued) 6-1

4. Navigable Waters
   The U.S. Coast Guard permit determines the minimum clearances for navigable waters. Clearances over waters not regulated by the U.S. Coast Guard will be determined by negotiations and agreement with the appropriate interests.

5. Normal minimum clearance above design high water should be 2′-0″ for all Interstates, Freeways, Arterials, and Secondary Crossings of Major Rivers, 1′-0″ for all other roads. Where conditions warrant, less than the above may be permitted.

6. Pedestrian overpasses and sign structures vertical clearance – 17′-0″ to 17′-6″

DECK WIDTHS AND HORIZONTAL CLEARANCES

Two primary elements of any bridge are the deck width on the bridge and the horizontal clearance between piers underneath the bridge. For determining these dimensions, the functional classification of highway facilities described in this chapter shall be used.

A study will be made to determine the deck width on any bridge having a high unit cost.

A cost analysis will be made by Structure Design to determine pier necessity and location. The factors included in this analysis are construction cost, maintenance cost, accident cost, future widening potential, for both the mainline and road underneath it, and continuity of section. Consideration should be given to allow sufficient lateral offset for placement of a future greenway, sidewalk, or rail trail where the project Environmental Planning Document has justified the need for additional lateral offset. Structure Design will coordinate with Roadway Design as necessary.

A study will be made at each interchange to insure that adequate sight distance is available. Special attention should be given to the bridge rail design, offset, and the crest vertical curve on the structure so that traffic turning from the ramp has adequate sight distance. See Chapter 8-7 (Required Sight Distance at Terminals of Ramps) of the Roadway Design Manual for required sight distance.

When a ditch section is carried under a bridge, coordination will be necessary in the selection of horizontal openings and roadway typical sections so that piers are not placed in the ditch bottom, but preferably 2′ minimum behind the ditch.

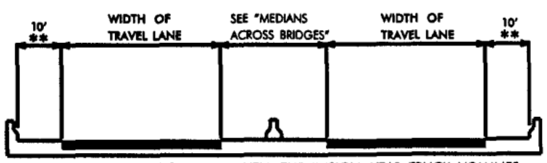
FIGURE 1 **6 – 1**

F – 1

INTERSTATE SYSTEM

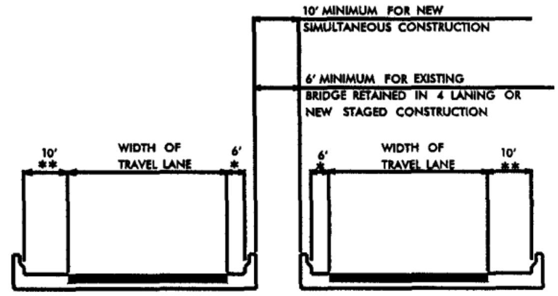
BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED
SHOULDER APPROACH

SINGLE STRUCTURE



** 12' SHOULD BE CONSIDERED WHEN THE DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV

DUAL STRUCTURE

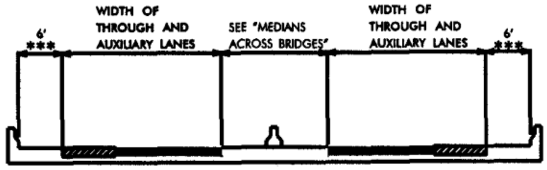


* 10' WITH SIX OR MORE THROUGH LANES
** 12' SHOULD BE CONSIDERED WHEN THE DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV

INTERSTATE SYSTEM

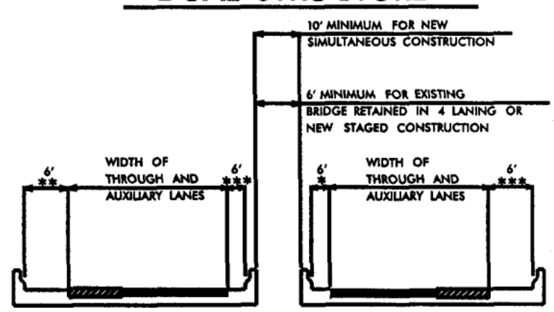
BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED
WITH AUXILIARY LANES
SHOULDER APPROACH

SINGLE STRUCTURE



*** 10' SHOULDER WHEN AUXILIARY LANE CONNECTS INTERCHANGES OR AN AUXILIARY LANE IS LONGER THAN 2500'.

DUAL STRUCTURE



* 10' WITH SIX OR MORE THROUGH LANES
** 12' SHOULD BE CONSIDERED WHEN THE DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV
*** 10' SHOULDER WHEN AUXILIARY LANE CONNECTS INTERCHANGES OR AN AUXILIARY LANE IS LONGER THAN 2500'.

LEGEND

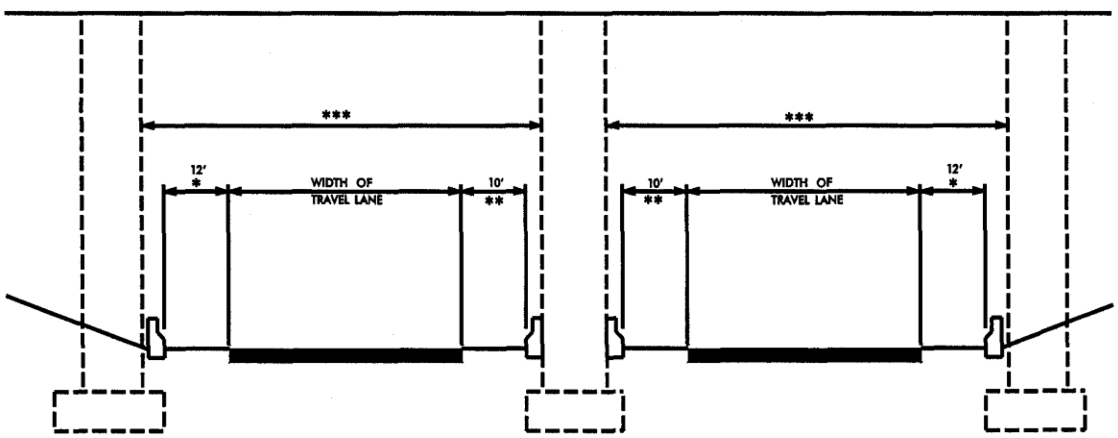
THROUGH TRAVEL LANES
AUXILIARY LANES

FIGURE 1A 6 - 1

F - 1A

INTERSTATE SYSTEM

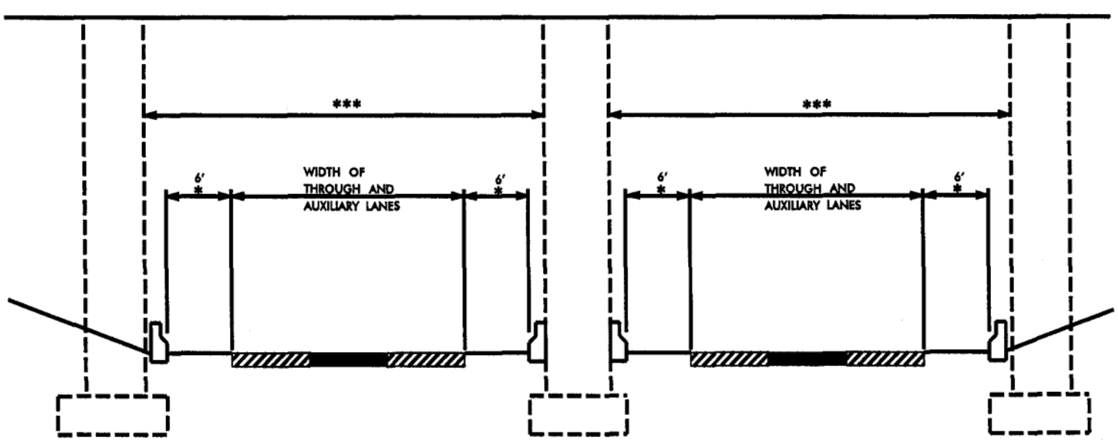
HORIZONTAL CLEARANCES FOR DIVIDED TRAFFIC



* 18' WHEN DESIGN YEAR ADT IS GREATER THAN 50,000 TO ACCOMMODATE FUTURE AUXILIARY LANES OF INTERCHANGE RAMPS OR LOOPS.

** 12' SHOULD BE CONSIDERED WHEN DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV

SHOULDER APPROACH



* 10' SHOULDER WHEN AUXILIARY LANE CONNECTS INTERCHANGES OR AN AUXILIARY LANE IS LONGER THAN 2500'.

SHOULDER APPROACH WITH AUXILIARY LANES

*** SEE EXCEPTIONS TO POLICY IN THIS MANUAL FOR ADDITIONAL INFORMATION.

LEGEND

THROUGH TRAVEL LANES

AUXILIARY LANES

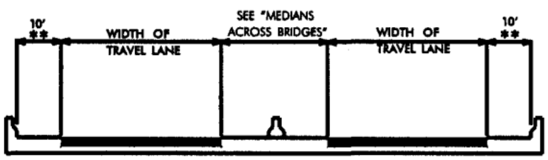
FIGURE 1B 6 – 1

F – 1B

FREEWAY SYSTEM

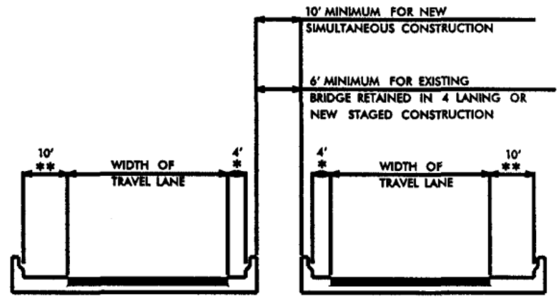
BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED
SHOULDER AND CURB AND GUTTER APPROACH

SINGLE STRUCTURE



** 12' SHOULD BE CONSIDERED WHEN THE DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV.

DUAL STRUCTURE



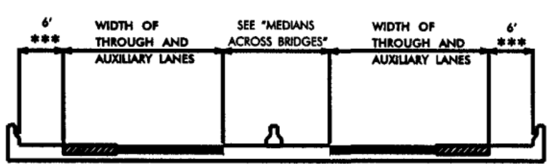
* 10' WITH SIX OR MORE THROUGH LANES.

** 12' SHOULD BE CONSIDERED WHEN THE DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV.

FREEWAY SYSTEM

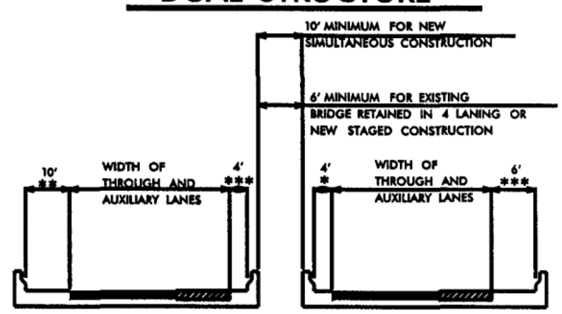
BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED
WITH AUXILIARY LANES
SHOULDER AND CURB AND GUTTER APPROACH

SINGLE STRUCTURE



*** 10' SHOULDER WHEN AUXILIARY LANE CONNECTS INTERCHANGES OR AN AUXILIARY LANE IS LONGER THAN 2500'.

DUAL STRUCTURE



* 10' WITH SIX OR MORE THROUGH LANES.

** 12' SHOULD BE CONSIDERED WHEN THE DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV.

*** 10' SHOULDER WHEN AUXILIARY LANE CONNECTS INTERCHANGES OR AN AUXILIARY LANE IS LONGER THAN 2500'.

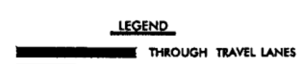
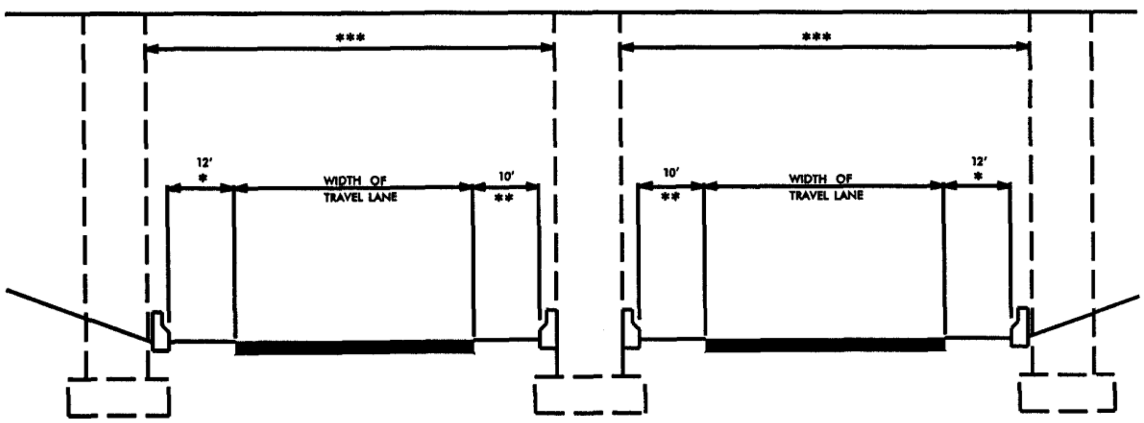


FIGURE 1C **6 – 1**

F – 1C

FREEWAY SYSTEM

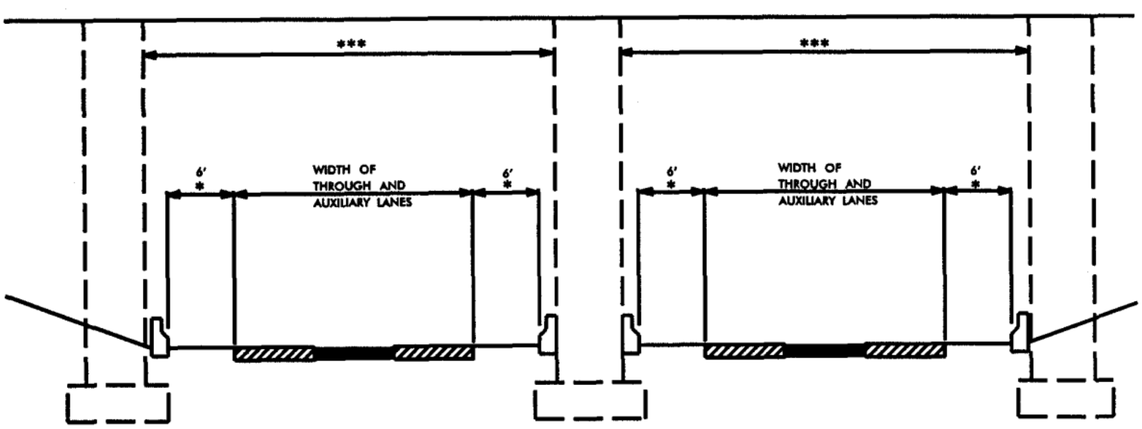
HORIZONTAL CLEARANCES FOR DIVIDED TRAFFIC



* 18' WHEN DESIGN YEAR ADT IS GREATER THAN 50,000 TO ACCOMMODATE FUTURE AUXILIARY LANES OF INTERCHANGE RAMPS OR LOOPS.

** 12' SHOULD BE CONSIDERED WHEN THE DESIGN YEAR TRUCK VOLUMES ARE GREATER THAN 250 DDHV

SHOULDER APPROACH



* 10' SHOULDER WHEN AUXILIARY LANE CONNECTS INTERCHANGES OR AN AUXILIARY LANE IS LONGER THAN 2500'.

SHOULDER APPROACH WITH AUXILIARY LANES

*** SEE EXCEPTIONS TO POLICY IN THIS MANUAL FOR ADDITIONAL INFORMATION.

LEGEND

THROUGH TRAVEL LANES

AUXILIARY LANES

FIGURE 1D 6 - 1

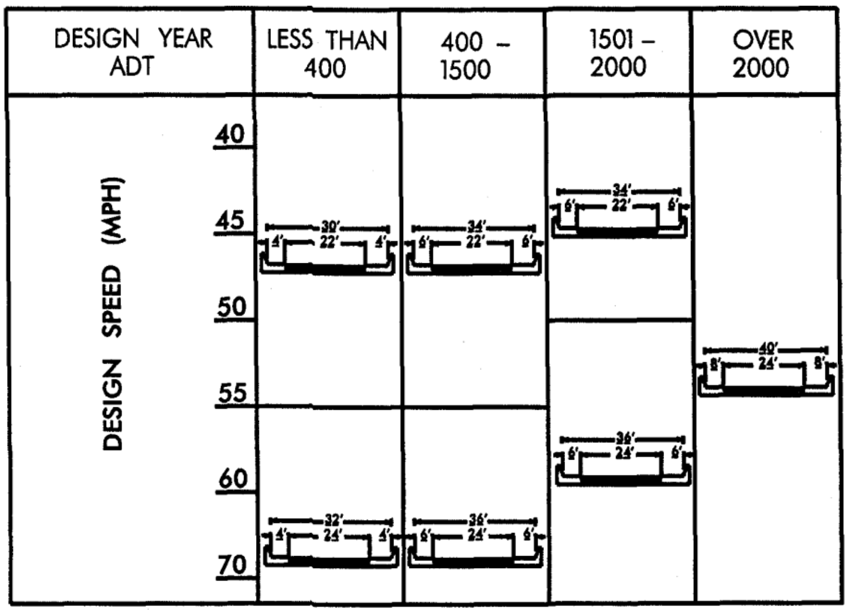
F - 1D

ARTERIAL SYSTEM

BRIDGE DECK WIDTHS (FT.)
FOR NEW AND RECONSTRUCTED BRIDGES

TWO-LANE TWO-WAY TRAFFIC

SHOULDER APPROACH



NOTE - BRIDGE DECK WIDTH CHARTS ARE BASED ON DESIGN YEAR ADT, IF ONLY CURRENT ADT IS AVAILABLE, DESIGN YEAR ADT SHOULD BE OBTAINED FROM THE TRAFFIC FORECASTING UNIT OF THE STATEWIDE PLANNING BRANCH.

BRIDGES 200' OR GREATER MAY HAVE A LESSER WIDTH, THE OFFSETS TO PARAPET, RAIL OR BARRIER SHALL BE AT LEAST 4' FROM THE NEAREST TRAVEL LANE.

SEE CHAPTER III OF THE "A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS", 2001 FOR CURVE WIDENING CONSIDERATION.

THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MIN. OF 7' - 6" TO ACCOMMODATE FUTURE SIDEWALKS. THE ENGINEER SHOULD CHECK WITH THE HYDRAULICS UNIT TO DETERMINE IF ADDITIONAL OFFSET IS NEEDED TO ACCOMMODATE FOR DRAINAGE.

CURB AND GUTTER APPROACH

CURB TO CURB WIDTH OF APPROACH, SEE THIS CHAPTER.

AUXILIARY LANES

WHEN AUXILIARY LANES ARE REQUIRED, ADD ITS WIDTH TO THE WIDTH OF THE TRAVEL LANES.

INTERCHANGES

MINIMUM SHOULDER WIDTHS OF 6' ARE DESIRED FOR STRUCTURES WHICH ARE LOCATED AT INTERCHANGES. THE MINIMUM VALUES SHOWN ABOVE MAY BE USED IF THE REQUIRED SIGHT DISTANCE CAN BE ACHIEVED.

LEGEND

THROUGH TRAVEL LANES

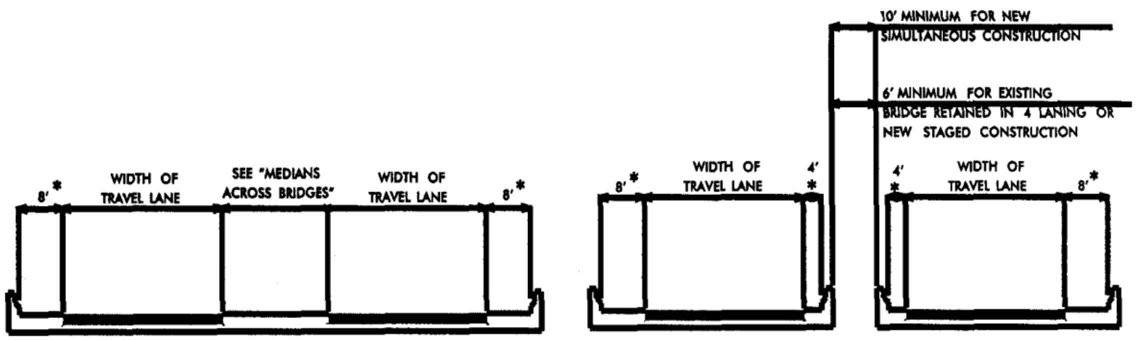
FIGURE 1E 6 - 1

F - 1E

ARTERIAL SYSTEM

BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED

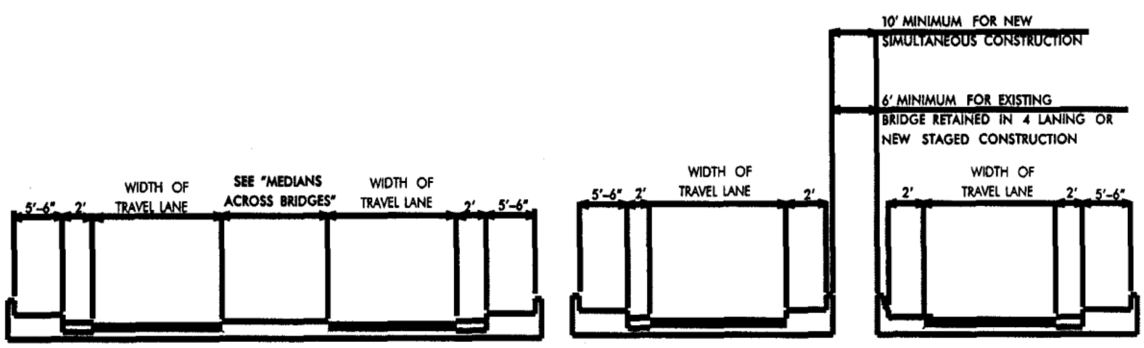
SINGLE STRUCTURE DUAL STRUCTURE



SHOULDER APPROACH

* 10' WITH SIX OR MORE THROUGH LANES

SINGLE STRUCTURE DUAL STRUCTURE



CURB AND GUTTER APPROACH

NOTE: SEE THIS MANAUAL FOR ADDITIONAL INFORMATION ON SIDEWALKS AND CURB AND GUTTER APPROACHES.

LEGEND

THROUGH TRAVEL LANES

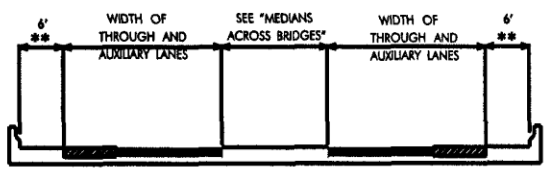
FIGURE 1F 6 – 1

F – 1F

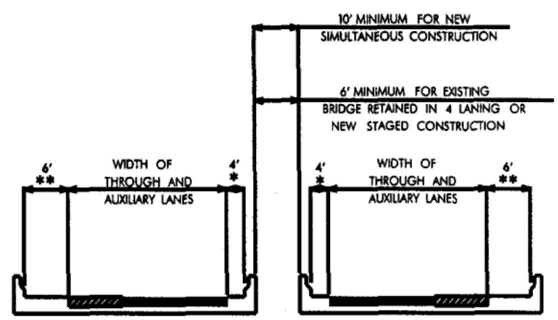
ARTERIAL SYSTEM

BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED
WITH AUXILIARY LANES

SINGLE STRUCTURE



DUAL STRUCTURE

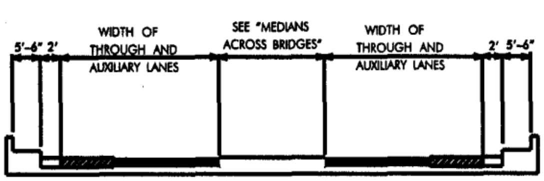


SHOULDER APPROACH

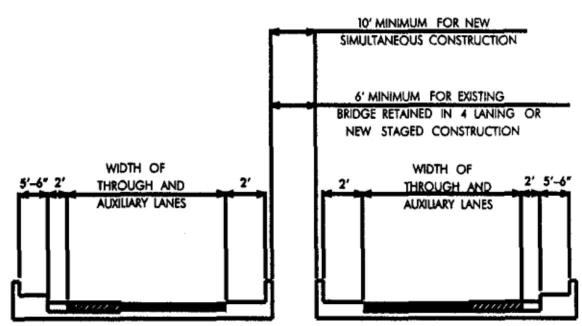
* 10' WITH SIX OR MORE THROUGH LANES

** THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MIN. OF 7'-6" TO ACCOMMODATE FUTURE SIDEWALKS

SINGLE STRUCTURE



DUAL STRUCTURE



CURB AND GUTTER APPROACH

NOTE: SEE THIS MANUAL FOR ADDITIONAL INFORMATION ON SIDEWALKS AND CURB AND GUTTER APPROACHES.

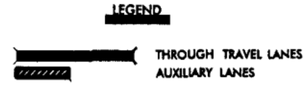


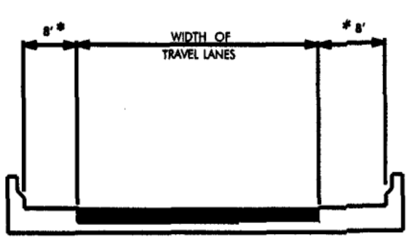
FIGURE 1G 6 – 1

F – 1G

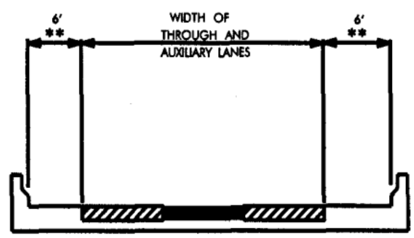
ARTERIAL SYSTEM

BRIDGE DECK WIDTHS
4 OR MORE LANES UNDIVIDED
TWO WAY TRAFFIC

WITHOUT AUXILIARY LANE



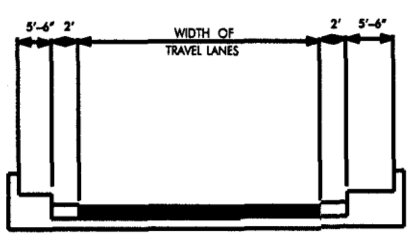
WITH AUXILIARY LANE



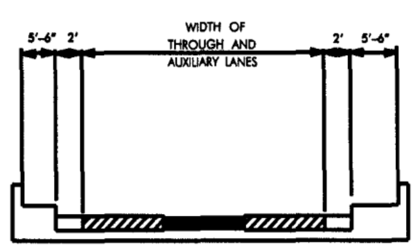
SHOULDER APPROACH

* 10' WITH SIX OR MORE THROUGH LANES AND /OR ADT < 40000.
** THE OFFSET FOR BRIDGES WITHIN THE URBAN BOUNDARY MAY BE INCREASED TO A MIN. OF 7'-6" TO ACCOMMODATE FUTURE SIDEWALKS.

WITHOUT AUXILIARY LANE



WITH AUXILIARY LANE



CURB AND GUTTER APPROACH

NOTE: SEE THIS MANUAL FOR ADDITIONAL INFORMATION ON SIDEWALKS AND CURB AND GUTTER APPROACHES.

LEGEND

THROUGH TRAVEL LANES

AUXILIARY LANES

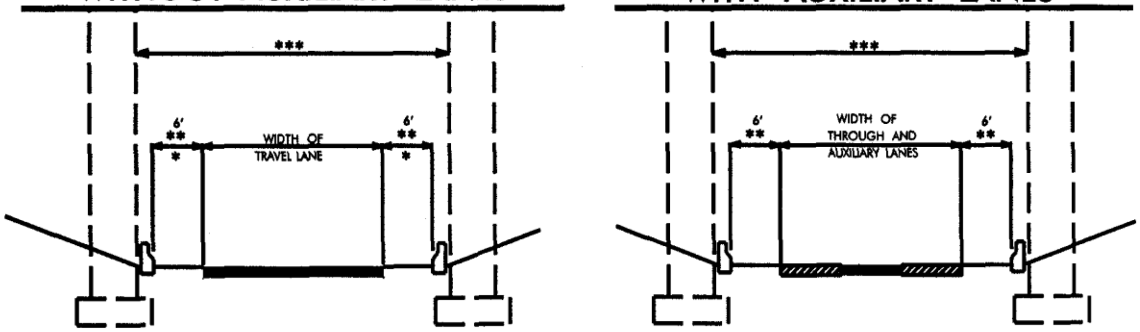
FIGURE 1H **6 – 1**

F – 1H

ARTERIAL SYSTEM

HORIZONTAL CLEARANCES FOR UNDIVIDED TWO-WAY TRAFFIC

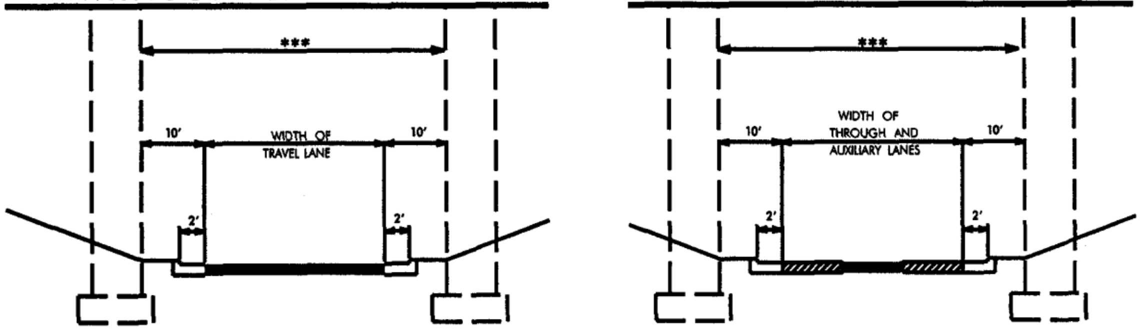
WITHOUT AUXILIARY LANES   WITH AUXILIARY LANES



SHOULDER APPROACH

* DESIGN ADT UNDER 2000 USE 6' OFFSET
DESIGN ADT 2000 AND OVER USE 8' OFFSET
** THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MIN. OF 7'-6" TO ACCOMMODATE FUTURE SIDEWALKS

WITHOUT AUXILIARY LANES   WITH AUXILIARY LANES



CURB AND GUTTER APPROACH

NOTE: SEE THIS MANUAL FOR ADDITIONAL INFORMATION ON CURB AND GUTTER APPROACHES.

*** SEE EXCEPTIONS TO POLICY IN THIS MANUAL FOR ADDITIONAL INFORMATION.

LEGEND

FIGURE 1I **6 - 1**

F - 1I

ARTERIAL SYSTEM

HORIZONTAL CLEARANCES FOR DIVIDED TRAFFIC

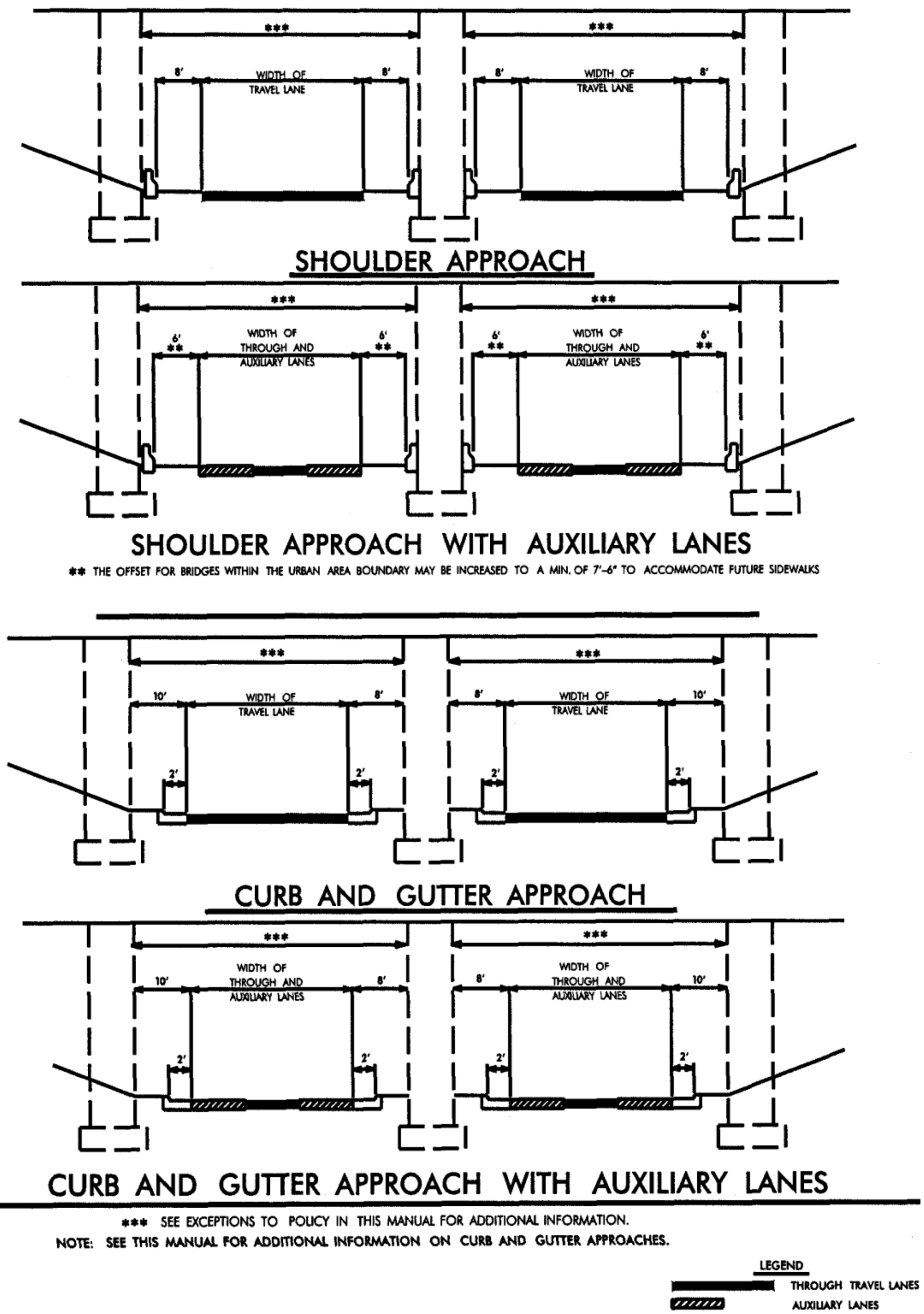
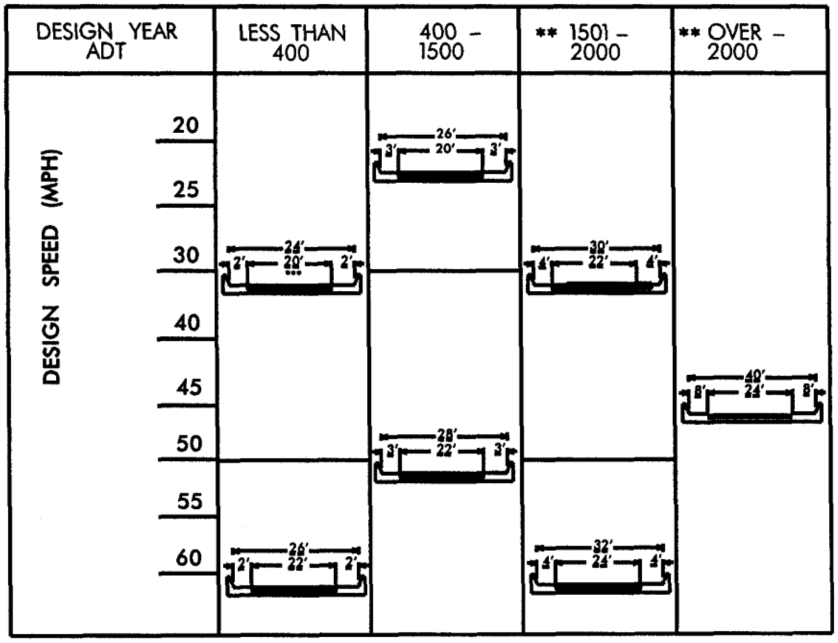


FIGURE 1J **6 – 1**
F – 1J

COLLECTOR ROADS AND STREETS

BRIDGE DECK WIDTHS (FT.)
(MINIMUM VALUES)

TWO-LANE TWO-WAY TRAFFIC



* THE WIDTH OF TRAVELED WAY MAY REMAIN AT 22' ON RECONSTRUCTED HIGHWAYS WHERE ALIGNMENT AND SAFETY RECORDS ARE SATISFACTORY.

** FOR BRIDGES IN EXCESS OF 100' IN LENGTH, THE MINIMUM WIDTH OF TRAVELED WAY PLUS 3' ON EACH SIDE IS ACCEPTABLE.

*** 18' MINIMUM FOR ADT $<$ 250 FOR SPEED $\leq$ 40 MPH.

NOTE : BRIDGE DECK WIDTH CHARTS ARE BASED ON DESIGN YEAR ADT. IF ONLY CURRENT ADT IS AVAILABLE, DESIGN YEAR ADT SHOULD BE OBTAINED FROM THE TRAFFIC FORECASTING UNIT OF THE STATEWIDE PLANNING BRANCH.

THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MIN. OF 7'–6" TO ACCOMMODATE FUTURE SIDEWALKS. ENGINEERS SHOULD CHECK WITH THE HYDRAULICS UNIT TO DETERMINE IF ADDITIONAL OFFSET IS NEEDED TO ACCOMMODATE FOR DRAINAGE.

SEE CHAPTER III OF " A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2001), FOR CURVE WIDENING CONSIDERATIONS.

WHERE THE APPROACH ROADWAY WIDTH (TRAVELED WAY PLUS SHOULDER) IS SURFACED, THAT SURFACE WIDTH SHALL BE CARRIED ACROSS ALL STRUCTURES.

CURB AND GUTTER APPROACH

FOR CURB AND GUTTER APPROACHES, SEE THIS MANUAL.

AUXILIARY LANES

WHEN AUXILIARY LANES ARE REQUIRED, ADD ITS WIDTH TO THE WIDTH OF THE TRAVEL LANES

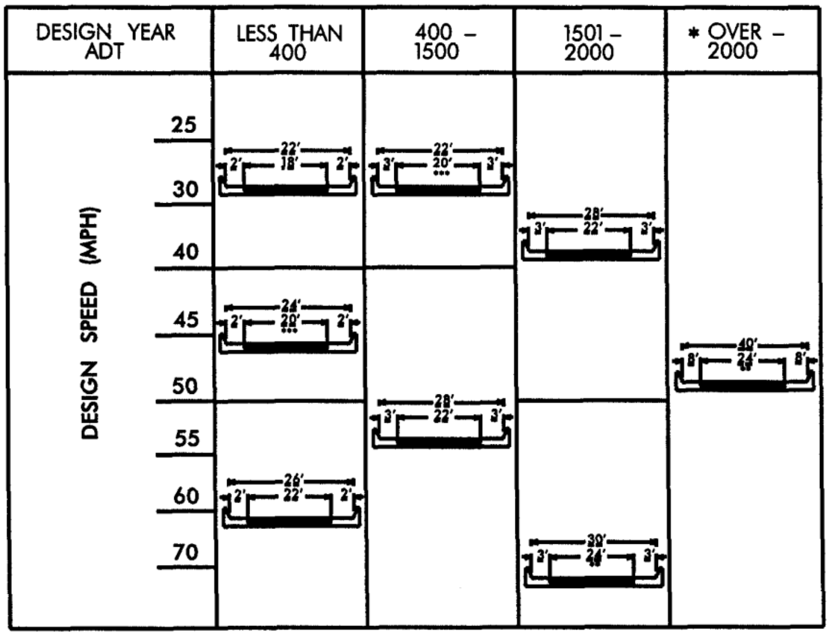
INTERCHANGES

MINIMUM SHOULDER WIDTHS OF 6' SHOULD BE USED FOR STRUCTURES WHICH ARE LOCATED AT INTERCHANGES. THE MINIMUM VALUES SHOWN ABOVE MAY BE USED IF THE REQUIRED SIGHT DISTANCE CAN BE ACHIEVED.

FIGURE 1K **6 – 1**
F – 1K

LOCAL ROADS AND STREETS

BRIDGE DECK WIDTHS (FT.)
(MINIMUM VALUES)



* FOR BRIDGES IN EXCESS OF 100' IN LENGTH, THE MINIMUM WIDTH OF TRAVELED WAY PLUS 3' ON EACH SIDE IS ACCEPTABLE.

** THE WIDTH OF TRAVELED WAY MAY REMAIN AT 22' ON RECONSTRUCTED HIGHWAYS WHERE SAFETY RESULTS AND ALIGNMENT ARE SATISFACTORY.

*** MOUNTAINOUS TERRAIN – ADT 400 – 600 USE OF 18' WIDTH AND 2' SHOULDERS IS ACCEPTABLE, SEE "A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2001)", CH.5.

NOTE : BRIDGE DECK WIDTH CHARTS ARE BASED ON DESIGN YEAR ADT. IF ONLY CURRENT ADT IS AVAILABLE, DESIGN YEAR ADT SHOULD BE OBTAINED FROM THE TRAFFIC FORECASTING UNIT OF THE STATEWIDE PLANNING BRANCH.

SEE CHAPTER 3 OF " A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2001), FOR CURVE WIDENING CONSIDERATIONS IN THE BRIDGE POLICY.

THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MINIMUM OF 7'–6" TO ACCOMMODATE FUTURE SIDEWALKS. ENGINEERS SHOULD CHECK WITH THE HYDRAULICS UNIT TO DETERMINE IF ADDITIONAL OFFSET IS NEEDED TO ACCOMMODATE DRAINAGE.

CURB AND GUTTER APPROACH

FOR CURB AND GUTTER APPROACHES, SEE THIS MANUAL.

AUXILIARY LANES

WHEN AUXILIARY LANES ARE REQUIRED, ADD ITS WIDTH TO THE WIDTH OF THE TRAVEL LANES

INTERCHANGES

MINIMUM SHOULDER WIDTHS OF 6' SHOULD BE USED FOR STRUCTURES WHICH ARE LOCATED AT INTERCHANGES. THE MINIMUM VALUES SHOWN ABOVE MAY BE USED IF THE REQUIRED SIGHT DISTANCE CAN BE ACHIEVED.

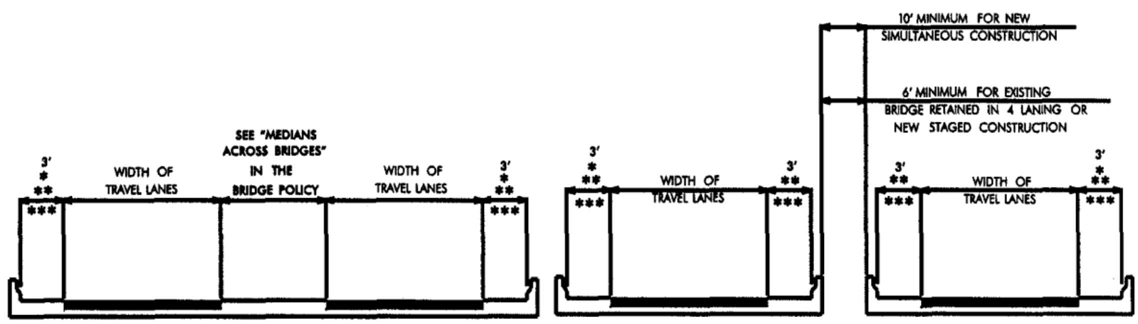
FIGURE 1L 6 – 1

F – 1L

LOCAL AND COLLECTOR SYSTEM

BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED

SINGLE STRUCTURE / DUAL STRUCTURE



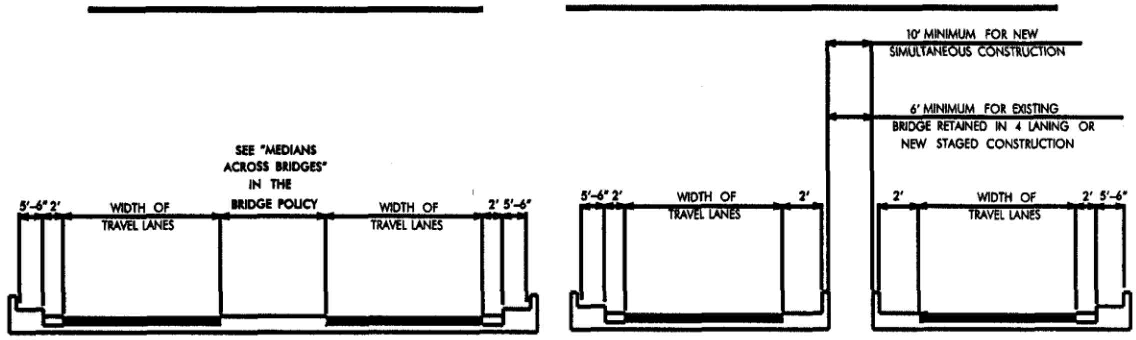
SHOULDER APPROACH

* MINIMUM SHOULDER WIDTHS OF 6' ARE DESIRED FOR STRUCTURES WHICH ARE LOCATED AT INTERCHANGES. THE MINIMUM VALUES SHOWN ABOVE MAY BE USED IF THE REQUIRED SIGHT DISTANCE CAN BE ACHIEVED.

** FOR STRUCTURES OF 100' OR LESS IN LENGTH AND HAVING 1501 ADT TO 2000 ADT, USE 4' SHOULDERS, FOR OVER 2000 ADT USE 8' SHOULDERS.

*** FOR STRUCTURES OF 100' OR LESS IN LENGTH AND HAVING ≥ 8000 ADT USE 4' SHOULDERS. THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MINIMUM OF 7'-6" TO ACCOMMODATE FUTURE SIDEWALKS.

SINGLE STRUCTURE / DUAL STRUCTURE



CURB AND GUTTER APPROACH

NOTE: SEE THIS MANUAL FOR ADDITIONAL INFORMATION ON SIDEWALK, CURB AND GUTTER APPROACHES.

LEGEND

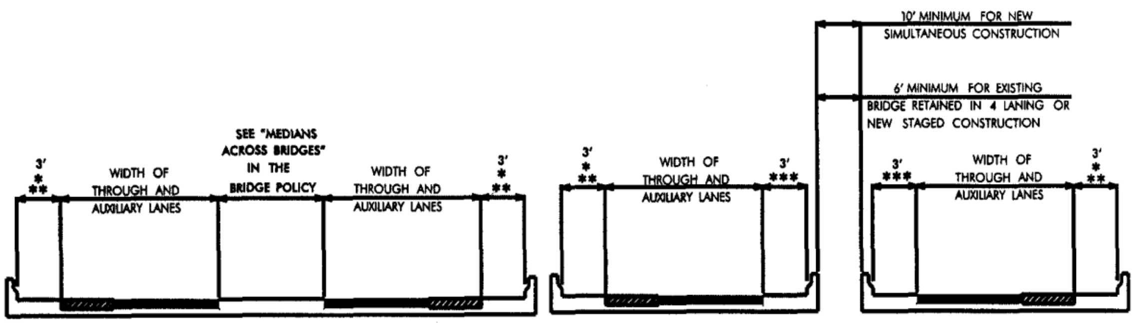
THROUGH TRAVEL LANES

FIGURE 1M **6 – 1**
F – 1M

LOCAL AND COLLECTOR SYSTEM

BRIDGE DECK WIDTHS
4 OR MORE LANES DIVIDED
WITH AUXILIARY LANES

SINGLE STRUCTURE DUAL STRUCTURE



SHOULDER APPROACH

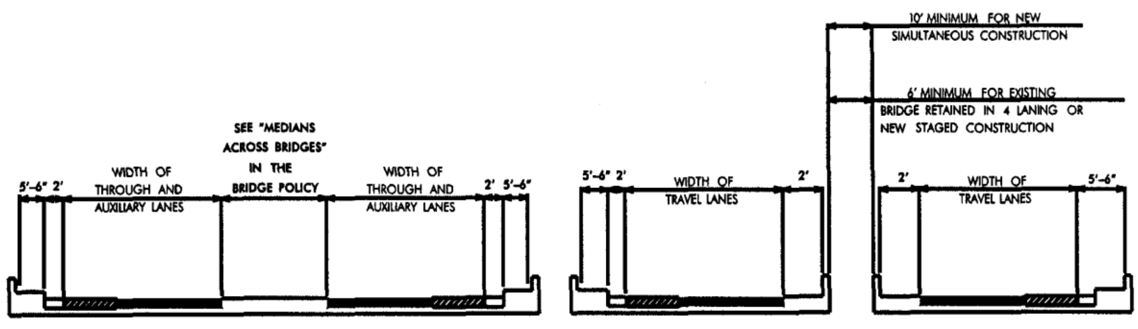
* MINIMUM SHOULDER WIDTHS OF 6' SHOULD BE USED FOR STRUCTURES WHICH ARE LOCATED AT INTERCHANGES. THE MINIMUM VALUES SHOWN ABOVE MAY BE USED IF THE REQUIRED SIGHT DISTAMCE CAN BE ACHIEVED.

** FOR STRUCTURES OF 100' OR LESS IN LENGTH AND HAVING 1501 ADT TO 2000 ADT USE 4' SHOULDERS. FOR OVER 2000 ADT, USE 8' SHOULDERS.

*** FOR STRUCTURES OF 100' OR LESS IN LENGTH AND HAVING > 8000 ADT USE 4' SHOULDERS.

THE OFFSET FOR BRIDGES WITHIN THE URBAN BOUNDARY MAY BE INCREASED TO A MINIMUM OF 7'-6" TO ACCOMMODATE FUTURE SIDEWALKS.

SINGLE STRUCTURE DUAL STRUCTURE



CURB AND GUTTER APPROACH

NOTE: SEE THIS MANUAL FOR ADDITIONAL INFORMATION ON SIDEWALK, CURB AND GUTTER APPROACHES.

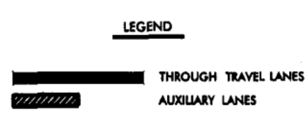
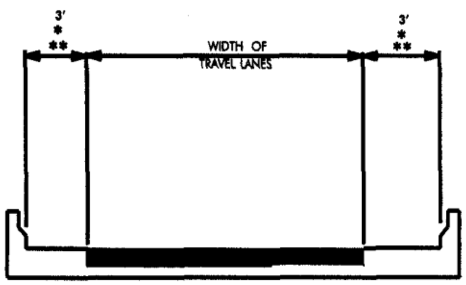


FIGURE 1N **6 - 1**
F - 1N

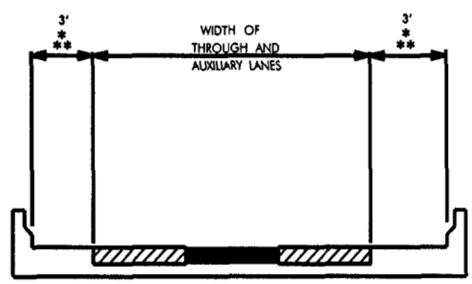
LOCAL AND COLLECTOR SYSTEM

BRIDGE DECK WIDTHS
4 OR MORE LANES UNDIVIDED
TWO-WAY TRAFFIC

WITHOUT AUXILIARY LANE



WITH AUXILIARY LANE



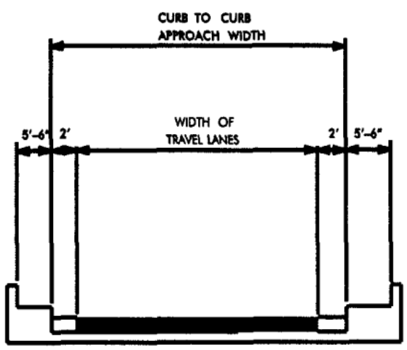
SHOULDER APPROACH

* MINIMUM SHOULDER WIDTHS OF 6' SHOULD BE USED FOR STRUCTURES WHICH ARE LOCATED AT INTERCHANGES. THE MINIMUM VALUES SHOWN ABOVE MAY BE USED IF THE REQUIRED SIGHT DISTANCE CAN BE ACHIEVED.

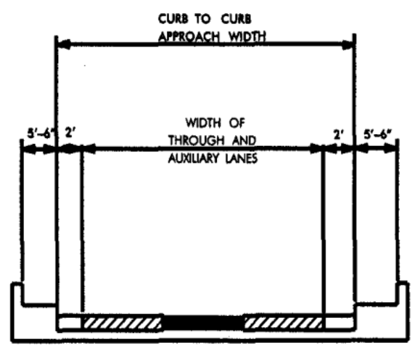
** FOR STRUCTURES OF 100' OR LESS IN LENGTH AND HAVING 1501 T0 2000 ADT, USE 4' SHOULDERS FOR OVER 2000 ADT, USE 8' SHOULDERS.

NOTE : THE OFFSETT FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MINIMUM OF 7'-6" TO ACCOMMODATE FUTURE SIDEWALKS.

WITHOUT AUXILIARY LANE



WITH AUXILIARY LANE



CURB AND GUTTER APPROACH

NOTE: SEE THIS MANUAL FOR ADDITIONAL INFORMATION ON SIDEWALKS AND CURB AND GUTTER APPROACHES.

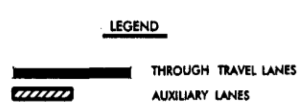
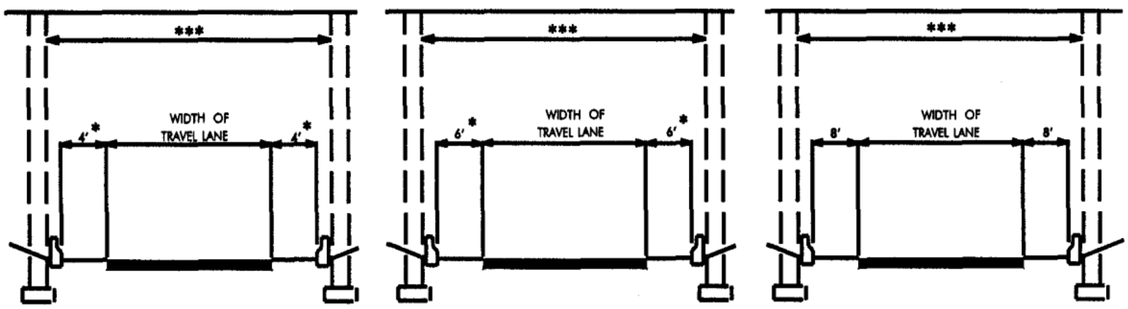


FIGURE 10 **6 - 1**
F - 10

LOCAL AND COLLECTOR SYSTEM

HORIZONTAL CLEARANCES
DESIGN YEAR ADT

UNDER 400 400 - 2000 OVER 2000



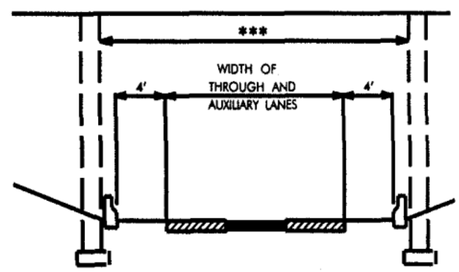
SHOULDER APPROACH

* THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MIN. OF 7'-6" TO ACCOMMODATE FUTURE SIDEWALKS. ENGINEERS SHOULD CHECK WITH THE HYDRAULICS UNIT TO DETERMINE IF ADDITIONAL OFFSET IS NEEDED TO ACCOMMODATE FOR DRAINAGE.

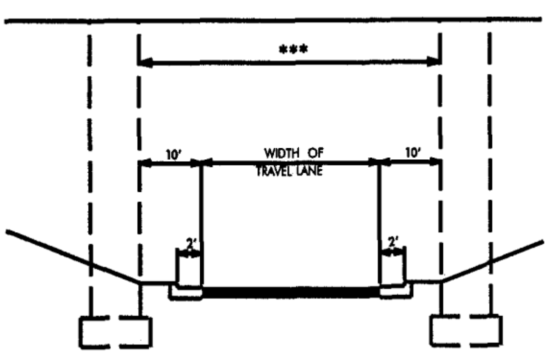
*** SEE EXCEPTIONS TO POLICY IN THIS MANUAL FOR ADDITIONAL INFORMATION.

NOTE:

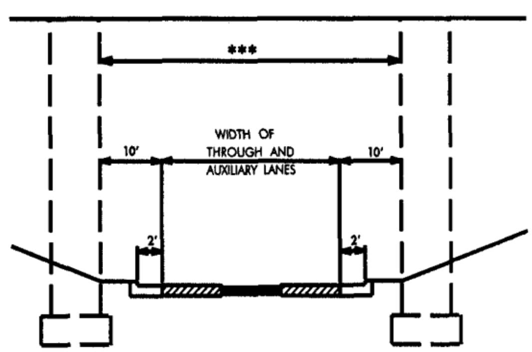
PIER NECESSITY AND LOCATION ARE TO BE DETERMINED BY THE STRUCTURE DESIGN UNIT. SEE THE ROADWAY DESIGN MANUAL FOR ENDBENT SLOPE BREAK POINT.



SHOULDER APPROACH WITH AUXILIARY LANES



CURB AND GUTTER APPROACH

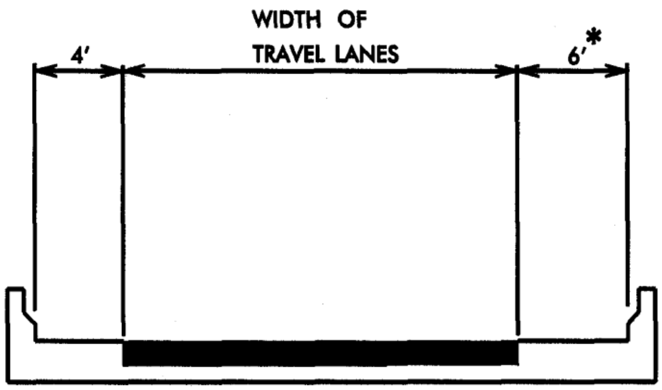


CURB AND GUTTER APPROACH WITH AUXILIARY LANES

LEGEND

ONE-WAY RAMP

BRIDGE DECK WIDTHS

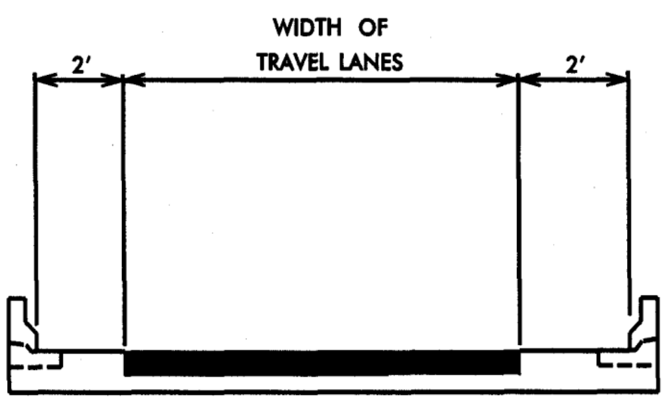


* 10' FOR DIRECTIONAL INTERCHANGE RAMPS FOR DIRECTIONAL INTERCHANGE RAMPS IT IS ACCEPTABLE TO SWITCH THE WIDENED OFFSET TO THE INSIDE OF THE CURVE WHEN NEEDED FOR HORIZONTAL SIGHT DISTANCE.

FOR ADDITIONAL INFORMATION SEE CHAPTER 10 (A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS), 2001.

SHOULDER APPROACH

NOTE: CURB AND GUTTER ON RAMPS SHOULD BE CONSIDERED ONLY TO FACILITATE PARTICULARLY DIFFICULT DRAINAGE SITUATIONS. CURB AND GUTTER IS NOT RECOMMENDED ON INTERMEDIATE OR DIRECTIONAL RAMPS, EXCEPT IN SPECIAL CASES.



CURB AND GUTTER APPROACH

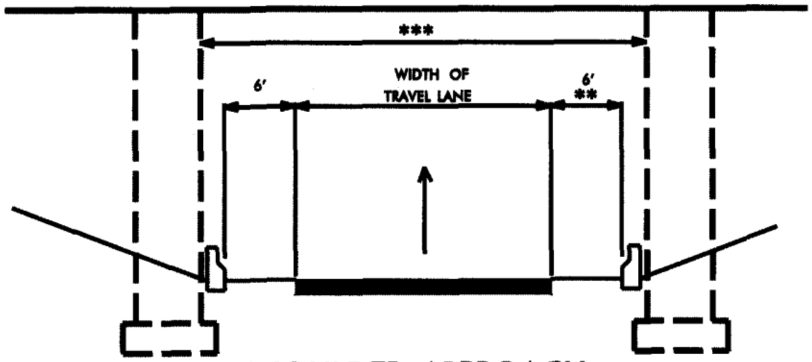
LEGEND

THROUGH TRAVEL LANES

FIGURE 1Q 6 - 1
F - 1Q

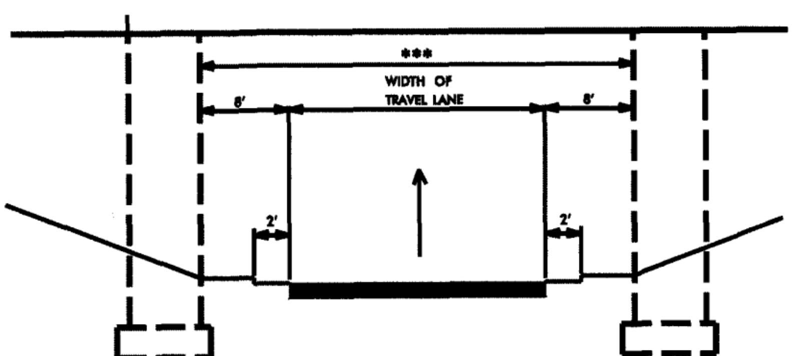
ONE-WAY RAMP

HORIZONTAL CLEARANCES



SHOULDER APPROACH

** USE 10' WITH DIRECTIONAL INTERCHANGE RAMPS. ON DIRECTIONAL INTERCHANGE RAMPS IT IS ACCEPTABLE TO SWITCH THE WIDENED OFFSET TO THE INSIDE OF THE CURVE WHEN NEEDED FOR HORIZONTAL SIGHT DISTANCE.



CURB AND GUTTER APPROACH

NOTE: CURB AND GUTTER ON RAMPS SHOULD BE CONSIDERED ONLY TO FACILITATE PARTICULARLY DIFFICULT DRAINAGE SITUATIONS. CURB AND GUTTER IS NOT RECOMMENDED ON INTERMEDIATE OR DIRECTIONAL RAMPS, EXCEPT IN SPECIAL CASES.

*** SEE EXCEPTIONS TO POLICY IN THIS MANUAL FOR ADDITIONAL INFORMATION.

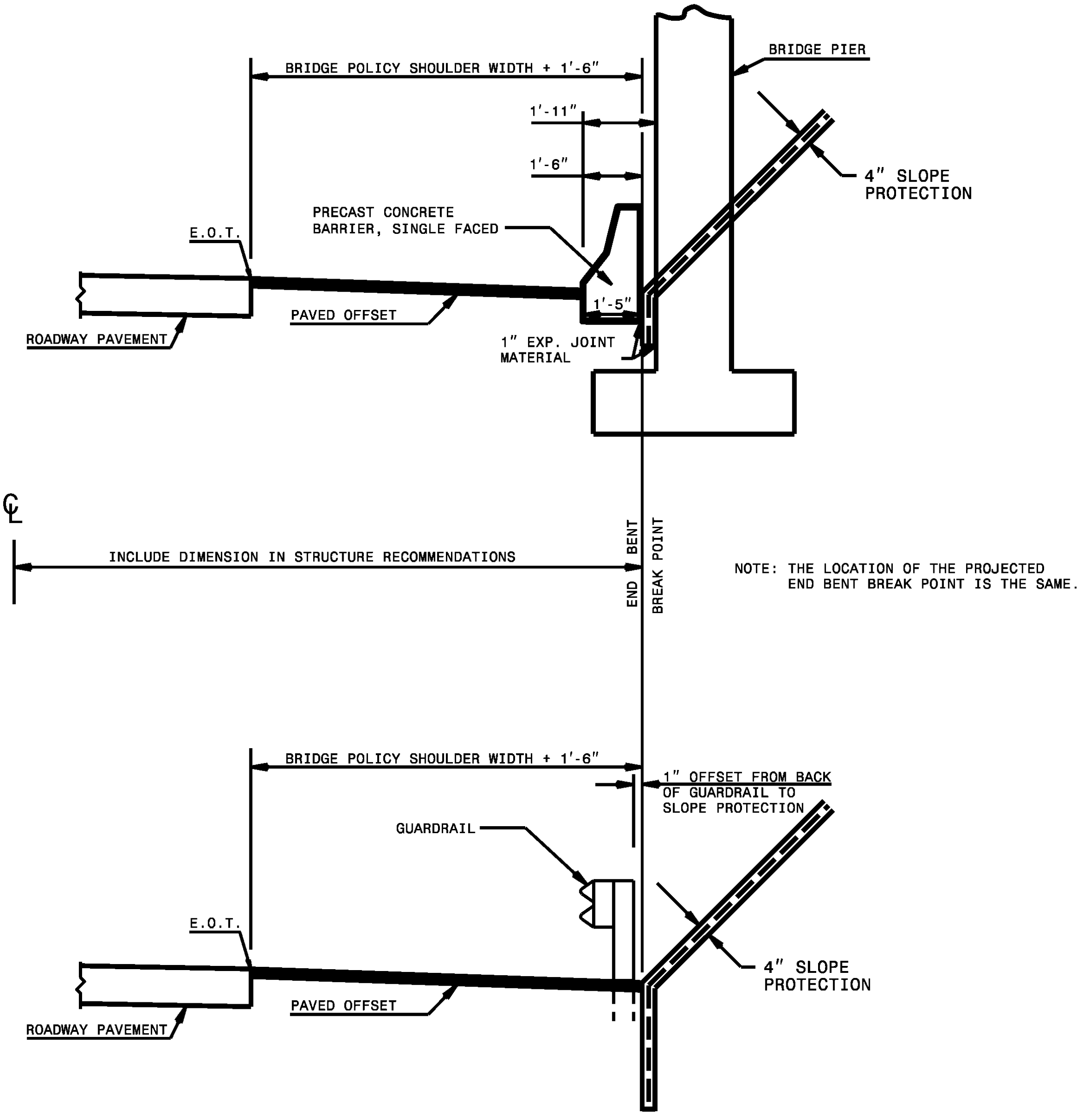
LEGEND

THROUGH TRAVEL LANES

FIGURE 1R **6–1**
F–1R

DETAIL WITH BRIDGE PIER ON OUTSIDE SHOULDER UNDER BRIDGE

TO BE USED IN CONJUNCTION WITH STANDARD DRAWING 610.01



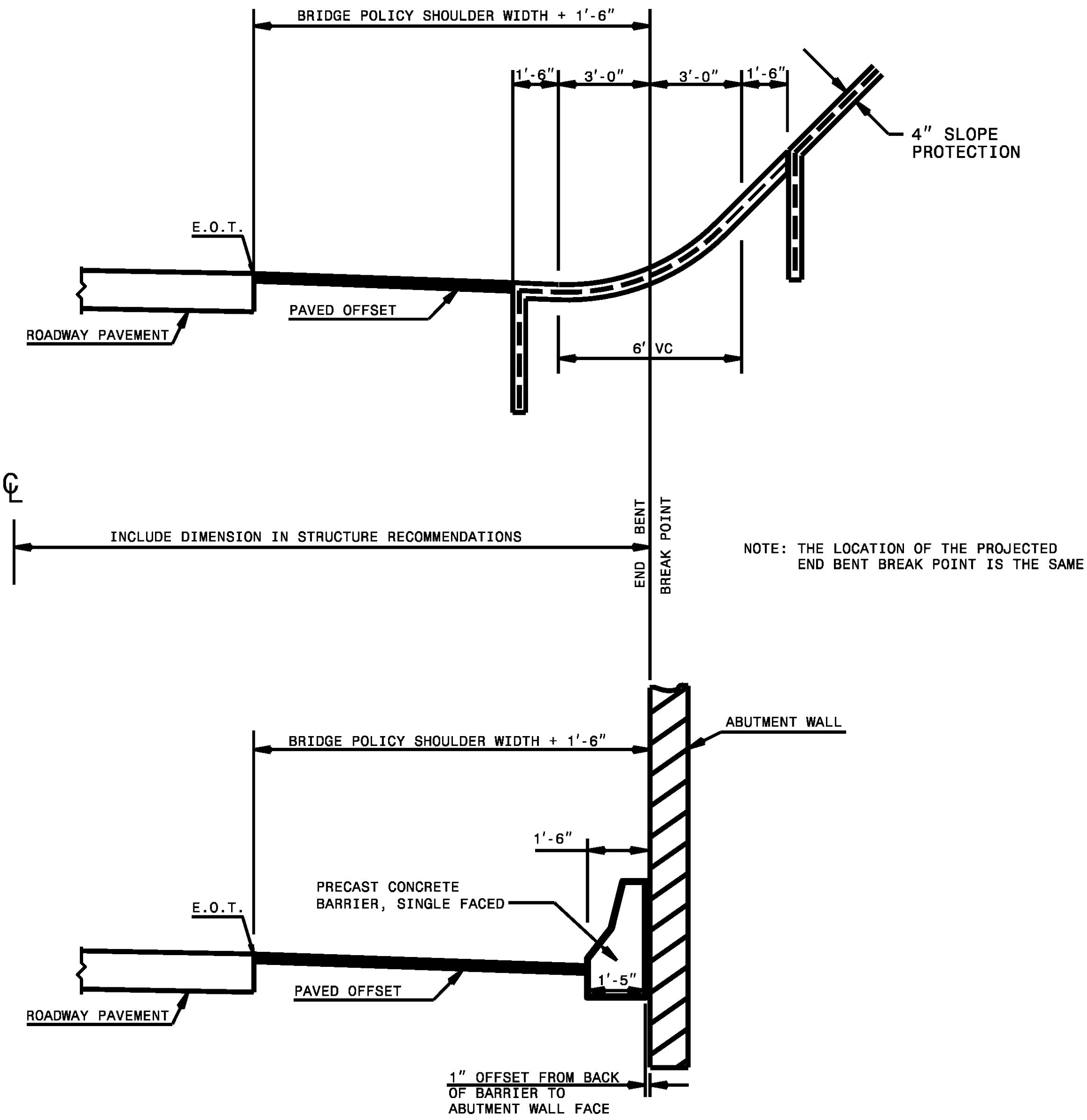
DETAIL WITH GUARDRAIL ON OUTSIDE SHOULDER UNDER BRIDGE

TO BE USED IN CONJUNCTION WITH STANDARD DRAWING 610.02

FIGURE 1S **6–1**
F–1S

DETAIL WITH 6" SLOPE PROTECTION (NO BARRIER) ON OUTSIDE SHOULDER UNDER BRIDGE

TO BE USED IN CONJUNCTION WITH STANDARD DRAWING 610.03



DETAIL WITH ABUTMENT WALL ON OUTSIDE SHOULDER UNDER BRIDGE

TO BE USED IN CONJUNCTION WITH STANDARD DRAWING 610.04

BRIDGE VERTICAL AND HORIZONTAL CLEARANCES OVER ROADS 6-1A

Bridge horizontal and vertical clearances are provided in accordance with the criteria in 6-1 of this Chapter.

The paved offset will vary based on the proposed end bent shoulder treatment under the bridge (bridge pier, guardrail, 6" slope protection, abutment wall). See 6-1, Figures F-1R and F-1S for details to be used with the Roadway Standard Drawings for clarification. The break point for the end bent slope is the same in each case. This will result in a consistent bridge length regardless of the end bent shoulder treatment.

The Roadway Design Project Engineer or Contract Standards and Development Engineer shall maintain close coordination with the Structure Management Unit during the planning stages when grades are being established. Any information that would affect the structure shall be furnished to the Structure Management Unit immediately.

Structure recommendations shall be provided to the Structure Management Unit in accordance with the sample structure recommendations that are covered in this chapter (see 6-6I).

VERTICAL AND HORIZONTAL CLEARANCES FOR HIGHWAY BRIDGES OVER RAILROADS 6-2

The vertical clearance for a highway bridge over a railroad is 23′-0″ to 23′-6″, unless otherwise approved by the Railroad Company.

The horizontal clearance shown on 6-2, Figure 1 is the general horizontal clearances required; <u>however, on the structure recommendations, no horizontal dimensions will be shown on the railroad typical section</u>.

If accommodations are required for off-track equipment, a minimum distance of 8′ shall be added to the horizontal distances. (See 6- 2, Figure 1)

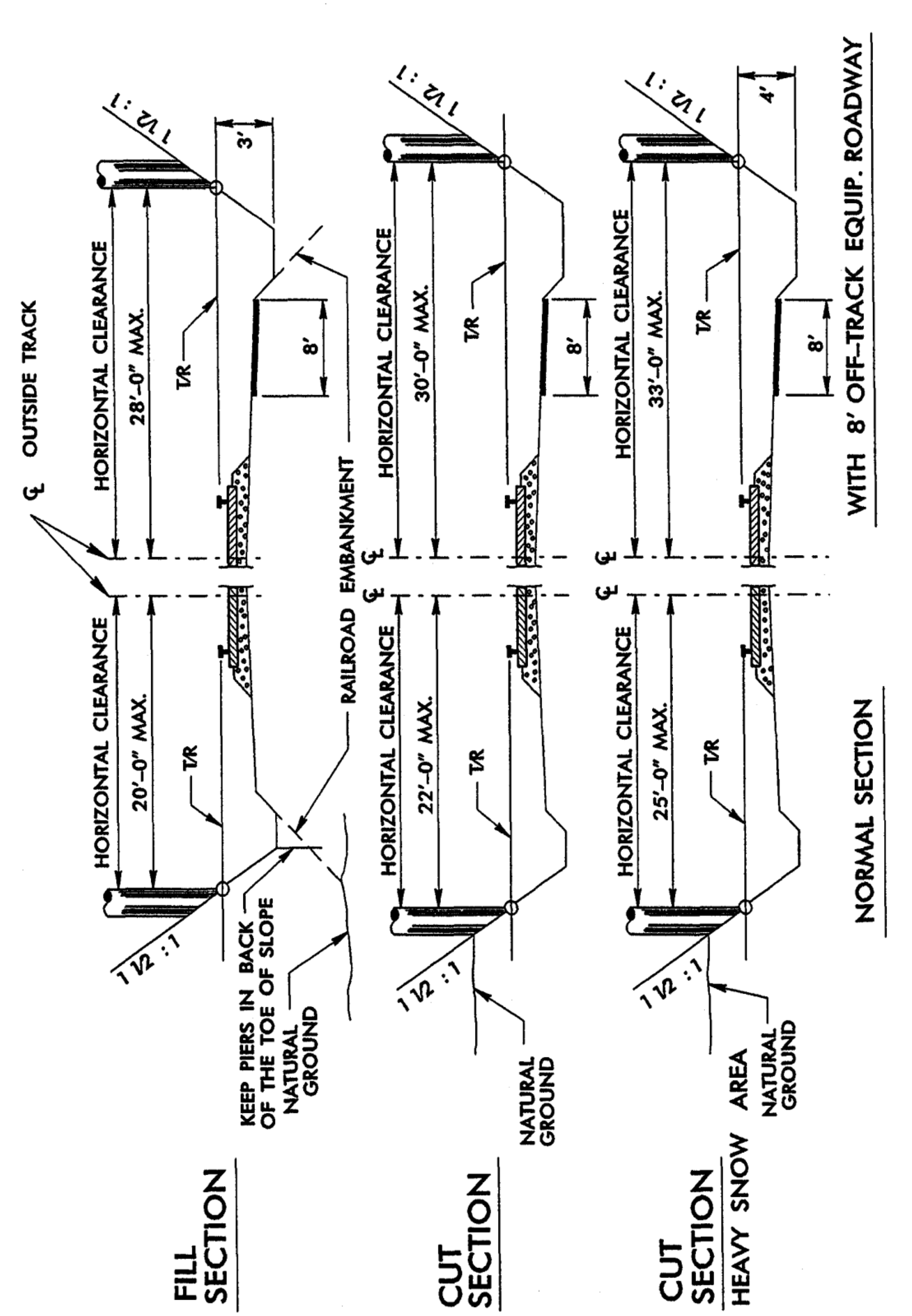
The Structure Management Unit is responsible for the coordination of the bridge vertical and horizontal clearances with the railroad companies.

When structure recommendations are prepared for railroad structures, any information that is available shall be provided. It is realized that the information that will be available when the structure recommendations are prepared will be limited. The Roadway Design Project Engineer or Contract Standards and Development Engineer shall maintain close contact with the Structure Management Project Engineer until the final vertical and horizontal clearances have been approved.

FIGURE 1 **6 – 2**

F – 1

EXAMPLE OF CLEARANCES FOR HIGHWAY BRIDGES OVER RAILROADS



HORIZONTAL CLEARANCE – RAILROAD

NOTE: WHEN REQUIRED, THE RAILROAD TYPICAL SECTION INCLUDED IN THE STRUCTURE RECOMMEDATIONS WILL ONLY SHOW THE VERTICAL CLEARANCE; NO HORIZONTAL DIMENSIONS. STRUCTURE DESIGN WILL SET THE HORIZONTAL DIMENSIONS, SUBJECT TO RAILROAD APPROVAL.

BRIDGE CLEARANCES OVER STREAM CROSSINGS 6-3

Clearances between bottom of superstructure and design high water will be determined by the Hydraulics Unit. This information will be included in the drainage report. When navigable waters are involved, the Hydraulics Unit will be responsible for proper coordination with other agencies to ensure proper clearances.

The normal minimum clearance is 2′-0″ for interstate and arterials, 1′-0″ for all other roads. Where conditions warrant, less than the above may be permitted.

MEDIAN DESIGNS ON STRUCTURES 6-4

On a divided highway, separate structures shall be provided unless it can be clearly shown that it is more economical to provide a single structure. If more economical, the median width shall be shown on the structure recommendations. See 6-1, of this Chapter.

BRIDGE SUPERSTRUCTURE DEPTHS 6-5

Bridge superstructure depths are provided for your use in setting preliminary grades. These depths are subject to revisions since the "span type" cannot be determined until The Structure Management Unit has thoroughly investigated the project. It is realized that the Roadway Design Project Engineer is frequently asked to revise the centerline grades to accommodate the final bridge grade. However, in order to provide preliminary grades, use the superstructure depths provided.

FIGURE 1 6 – 5 / F – 1

BRIDGE SUPERSTRUCTURE DEPTHS

SPAN TYPE	DESIGN SPAN	SUPERSTRUCTURE * DEPTH HS – 20
I – BEAM	40′	3.1′
	45′	3.4′
	50′	3.5′
	55′	3.6′
	60′	3.7′
	65′	3.8′
	70′	3.9′
	75′	4.0′
	80′	4.0′
	85′	4.1′
PRESTRESSED GIRDER	40′	3.9′
	45′	3.9′
	50′	4.7′
	55′	4.7′
	60′	4.7′
	65′	4.7′
	70′	5.4′
	75′	5.4′
	80′	5.4′
	85′	5.4′
	90′	5.4′
	95′	6.2′
	100′	6.2′
	105′	6.2′
	110′	6.2′
	115′	6.9′
	120′	6.9′

* DEPTHS SHOWN ARE FROM TOP OF SLAB DIRECTLY OVER EXTERIOR BEAM TO BOTTOM OF DEFLECTED BEAM. THE SUPERSTRUCTURE DEPTH MUST BE ADJUSTED FOR CROWN DROP.

FIGURE 2 6 – 5
F – 2

BRIDGE SUPERSTRUCTURE DEPTHS
–PLATE GIRDER SUPERSTRUCTURE–

THE DEPTHS LISTED BELOW ARE BASED ON THE FOLLOWING PARAMETERS, AND IF CONDITIONS DO NOT APPEAR TO MEET THESE NORMS, IT WILL BE NECESSARY TO DISCUSS THE SUPERSTRUCTURE DEPTH WITH THE STRUCTURE DESIGN UNIT.

PARAMETERS

(a) 34′, 40′, 48′, 56′, OR 64′ ROADWAY WIDTH
(b) HS 20 LIVE LOAD
(c) SIMPLE SPAN, COMPOSITE TYPE GIRDER
(d) ASTM 588 UNPAINTED HIGH STRENGTH STEEL
(e) STAY IN PLACE METAL FORMS
(f) NO TRANSVERSE STIFFENERS
(g) CONCRETE BARRIER RAILS

DESIGN SPAN (ft.)	SUPERSTRUCTURE DEPTH (ft.)*
39′ – 0″ to 45′ – 0″	4′ – 0″
> 45′ – 0″ to 65′ – 0″	4′ – 8″
> 65′ – 0″ to 90′ – 0″	5′ – 5″
> 90′ – 0″ to 105′ – 0″	6′ – 3″
> 105′ – 0″ to 120′ – 0″	6′ – 11″
> 120′ – 0″ to 150′ – 0″	7′ – 3″
> 150′ – 0″ to 160′ – 0″	7′ – 7″
> 160′ – 0″	Consult with SDU

* DEPTHS SHOWN ARE FROM TOP OF SLAB DIRECTLY OVER EXTERIOR GIRDER TO BOTTOM OF DEFLECTED GIRDER. THE SUPERSTRUCTURE DEPTH MUST BE ADJUSTED FOR CROWN DROP. THESE DEPTHS ARE BASED ON SIMPLE SPAN GIRDERS. DEPTHS FOR CURVED GIRDERS OR CONTINOUS GIRDERS SHOULD BE COORDINATED WITH STRUCTURE DESIGN.

* FOR SPAN LENGTH UP TO 160 ft., ADEQUATE VERTICAL CLEARANCE SHOULD HAVE BEEN PROVIDED TO ALLOW FLEXIBILITY IN SELECTING THE TYPE OF SUPERSTRUCTURE.

STRUCTURE RECOMMENDATIONS 6-6

Structure recommendations shall be provided to the Structure Management Unit for every bridge to be designed. The "Sample Structure" recommendations (6-6I) contained herein are for example only and are not intended to be used as design guides for Roadway plans. Strict adherence to the requirements of the Bridge Policy (6-1 of this Chapter) shall be maintained. It will be necessary to examine each individual structure to provide the most economical and safest design. The structure recommendation should include information as shown on the "sample structure recommendations." A critical dimension for the Structure Management Unit to get from Structure recommendations is the distance from survey reference line to the end bent fill slope break point. This distance is derived from the Bridge Policy (see 6-1 of this Chapter). For clarity, a direct dimension from the survey reference line to end bent slope break point shall be shown on the structure recommendations. Any other information that could affect the bridge design should be noted, also. Specifically, the following shall be required:

NOTE: "Preliminary" Structure Recommendations should be submitted as early as possible to the Structure Management Unit. This information is very beneficial in getting an early start on Structure's design activities. They are willing to accept the "preliminary/subject to change" conditions associated with these early submittals prior to FHWA or in-house approval.

BRIDGE APPROACH SLABS 6-6A

Bridge approach slabs are required at ends of all bridges.

For structures with sidewalks, approach slabs shall be full width from gutter line to gutter line plus width of sidewalk (5′- 6″ minimum width) on each side for sidewalk.

Ends of approach slab shall be parallel to the end bent with constant length as specified below:

1. For structures with 60° thru 120° skew, use 12′ length of approach slab measured along the centerline of bridge.
2. For structures with skew other than specified in paragraph (1) above, use 17′ length of approach slab measured along the centerline of bridge.
3. For special situations (e.g., very deep superstructures, etc.), consideration shall be given to increasing the length of approach slab. Coordinate with the Structure Management Unit in these cases. For unpaved approach, see the Bridge Policy (6-1).

BRIDGE APPROACH DRAINAGE 6-6B

Bridge approach drainage varies based on the situation in which it must be installed. The most common treatments are:

(1) Roadways with Shoulders

Metal funnel drains, Grated Drop Inlets or Concrete Bridge Approach Drop Inlets are the most common treatments.

Site conditions will determine which treatment is normally specified by the Hydraulics Unit to carry drainage away from the roadway.

(2) Curb and Gutter Roadways

Bridges constructed on curb and gutter roadways are usually drained by drainage systems that the Hydraulics Unit has designed for the approaching roadways.

STRUCTURE ANCHOR UNITS 6-6C

Where it is necessary to attach guardrail to structures, close coordination is required between the Roadway Design and the Structure Management Unit at the point of attachment.

When guardrail is anchored to structures, the attachment at each corner shall be specified on the Structure recommendation by the Roadway Design Project Engineer.

A structure anchor unit, Type III is normally needed for this installation.

LOW VOLUME ROADS

On low volume roads that are not paved, a distance of 100′ from the ends of a newly constructed bridge shall be paved with an approved asphalt surfacing. This paved travel lane shall be 20′ in width and flared to match the deck width of the bridge within the last 10′ of pavement. The normal length of guardrail required at bridges with unpaved roadways approaching bridge is 75′.

End bent slopes will be paved or stabilized on all bridges over roads and at other locations as stipulated in the Bridge Policy (see 6-1, of this Chapter). End bent slopes beneath bridges will be on 1.5:1 slopes, unless the Soils and Foundation Section specifies a flatter slope; or in the case of railroad and stream crossings, other considerations prevail. Therefore, on bridges over roads, the 1.5:1 end bent slope under the bridge will normally transition each way to the 2:1 (or flatter) side slopes of the bridge approach roadway fill.

The Bridge Policy specifies paving or stabilization only on the 1.5:1 end bent slopes under the bridge. However, the Soils and Foundation Section now emphasizes the need for some type of protection along the adjacent transition slopes until a 1.75:1 slope is reached. If this transition area from 1.5:1 to 1.75:1 cannot be stabilized by landscaping or vegetation, the Soils and Foundation Section will determine the type and limits of slope protection required at each individual bridge site.

For bridges with large skew angles, there may be no slope transition in two opposing quadrants of the crossing. In this case, the 1.5:1 end bent slope will simply intersect the flatter end bent fill slope. Slope paving transitions will vary from bridge to bridge depending upon skew angle, type of grading around the bridge, pier placement, and the type of structure (single or dual). The Roadway and Structure Project Engineers should confer early in design of each bridge to work out slope protection paving details at each site. Close coordination at this time will also enable correct detailing in roadway plans for paved shoulder tapers, placement of concrete barrier or guardrail, and roadway shoulder and ditch transitions on the bridge approach.

Four-inch slope protection or stabilization shall be shown on all structure recommendations except for bridges crossing streams and railroads. See Roadway Standard Drawings, Std. No's. 610.01, 610.02, and 610.03. Slope protection may be provided at stream locations if required by the Hydraulics Unit. The Hydraulics Unit will specify the type to be used and provide a high water elevation. Special details will be required for curb and gutter projects. The Project Engineer, Contracts and Estimates Project Engineer, and the Structure Management Project Engineer shall coordinate these details. For additional information, see 6-10 of this Chapter.

SPEED 6-6E

The design speed and posted speed shall be shown on the structure recommendations for each bridge.

SIGNS ON STRUCTURES 6-6F

When the Traffic Engineering and Safety Systems Branch requests that signs be placed on structures, this shall be noted on the structure recommendations. The Structure Design Unit will determine if it is possible from a structural standpoint. See Policy and Procedure Manual 17/1 for additional information for signs on structures.

ISLANDS 6-6G

When it has been determined that raised islands will be required, both construction and maintenance costs should be considered in determining the type of island to use.

When raised islands are used, they must be of a mountable type, <u>not</u> utilizing the standard 2′-6″ curb and gutter. Raised islands may be utilized for channelization at ramp terminals adjacent to the Y-line, usually at a stop or yield condition. Islands of this type must be offset the proper distance from the Y-line thru lane.

Snowplowable pavement markers may be considered for delineation in interchange areas if raised islands are not permitted.

When islands are proposed across the structure, a detail of the island shall be shown on the structure recommendations.

TRAFFIC 6-6H

The average daily traffic for the design year is shown on the structure recommendations. The design year is 20 years from the letting date.

SHEET 1 OF 20

STRUCTURE RECOMMENDATIONS

PROJECT NO. 8.U672212 SUBMITTED TO STRUCTURE DESIGN UNIT DEC. 15, 2000

COUNTY MECKLENBURG

TIP NO. R-2248C SUBMITTED TO FHWA DEC. 15, 2000

STRUCTURE NUMBER	LOCATION AND DESCRIPTION	ON STRUCTURE DATA				UNDER STRUCTURE DATA				ACCESS
		TYPICAL NO.	SUPER (m/m)	2020 ADT		TYPICAL NO.	SUPER (m/m)	2020 ADT		
				TOTAL TRAFFIC	TTST			TOTAL TRAFFIC	TTST	
1	-YREVA- OVER -L- (I-485) -YREVA- POT 10+72.908= -LREV- POS 228+67.549=	1A	NC	200	2	1B	VAR .02 LT. MAX	64,200	6420	NO
2	-LREV- (I-485) OVER LONG CREEK DUAL BRIDGES	2A	.03 RT	64,200	6,420	N/A	N/A	N/A	N/A	NO
3	-L- (I-485) OVER -Y1- (BELLHAVEN RD.) -L- POT 254+18.613= -Y1-POC 10+81.188 DUAL BRIDGES	3A	NC	64,200	6,420	3B	.05 RT	12,200	122	NO
4	-L- (I-485) OVER NC 16, (BROOKSHIRE BLVD.) -Y2- -L- POC 261+22.929= -Y2- POT 15+89.735 DUAL BRIDGES	4A	.04 RT	67,600	6,760	4B	NC	33,400	1,002	YES
5	-L- (I-485) OVER SR 2042, (OAKDALE RD.) -Y3- -L- POC 290+18.756 = -Y3REV- POT 13+18.370 DUAL BRIDGES	5A	.04 LT	67,800	6,780	5B	NC	11,400	342	YES

SAMPLE 2

NORTH CHARLOTTE OUTER LOOP FROM NC 27

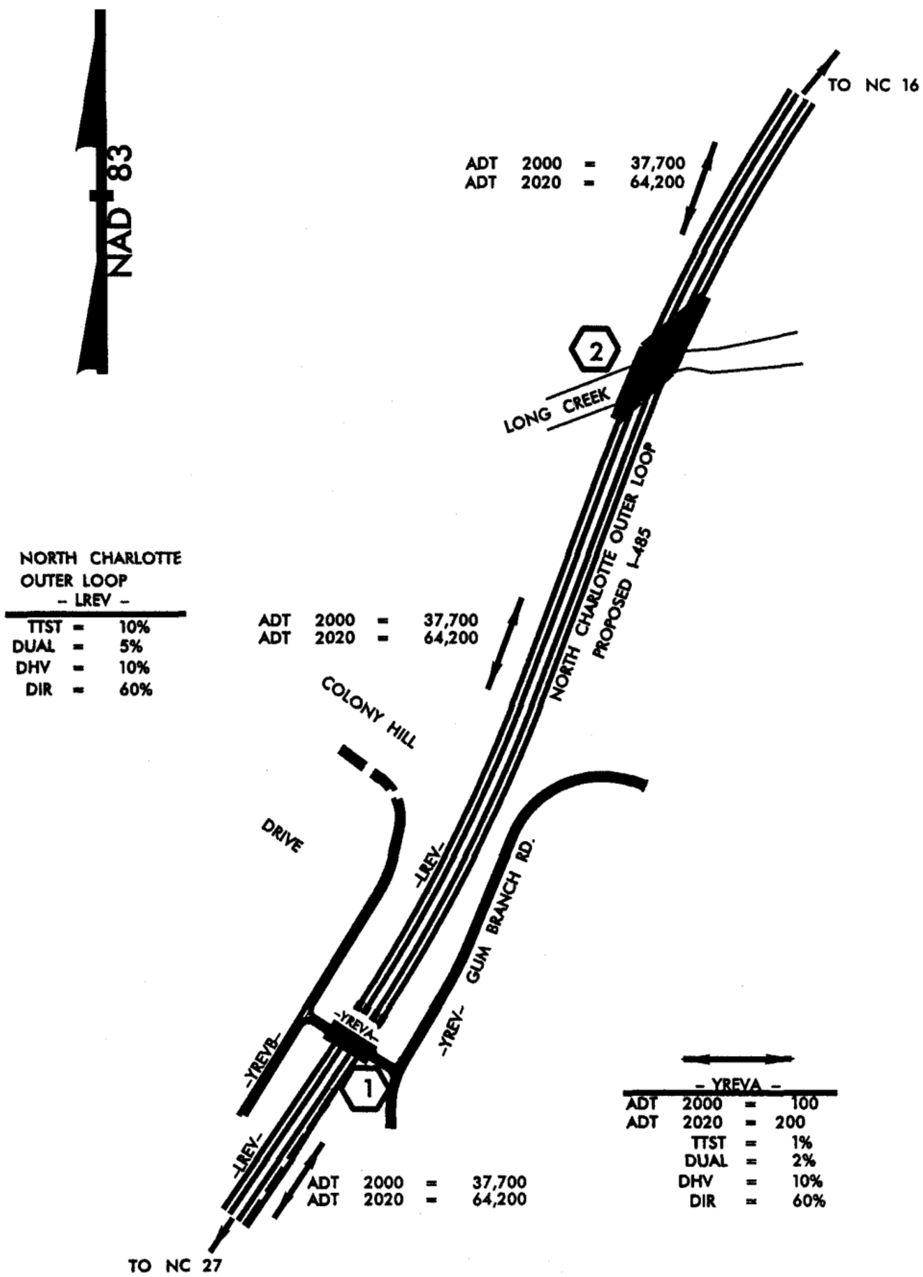
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

SHEET 2 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C



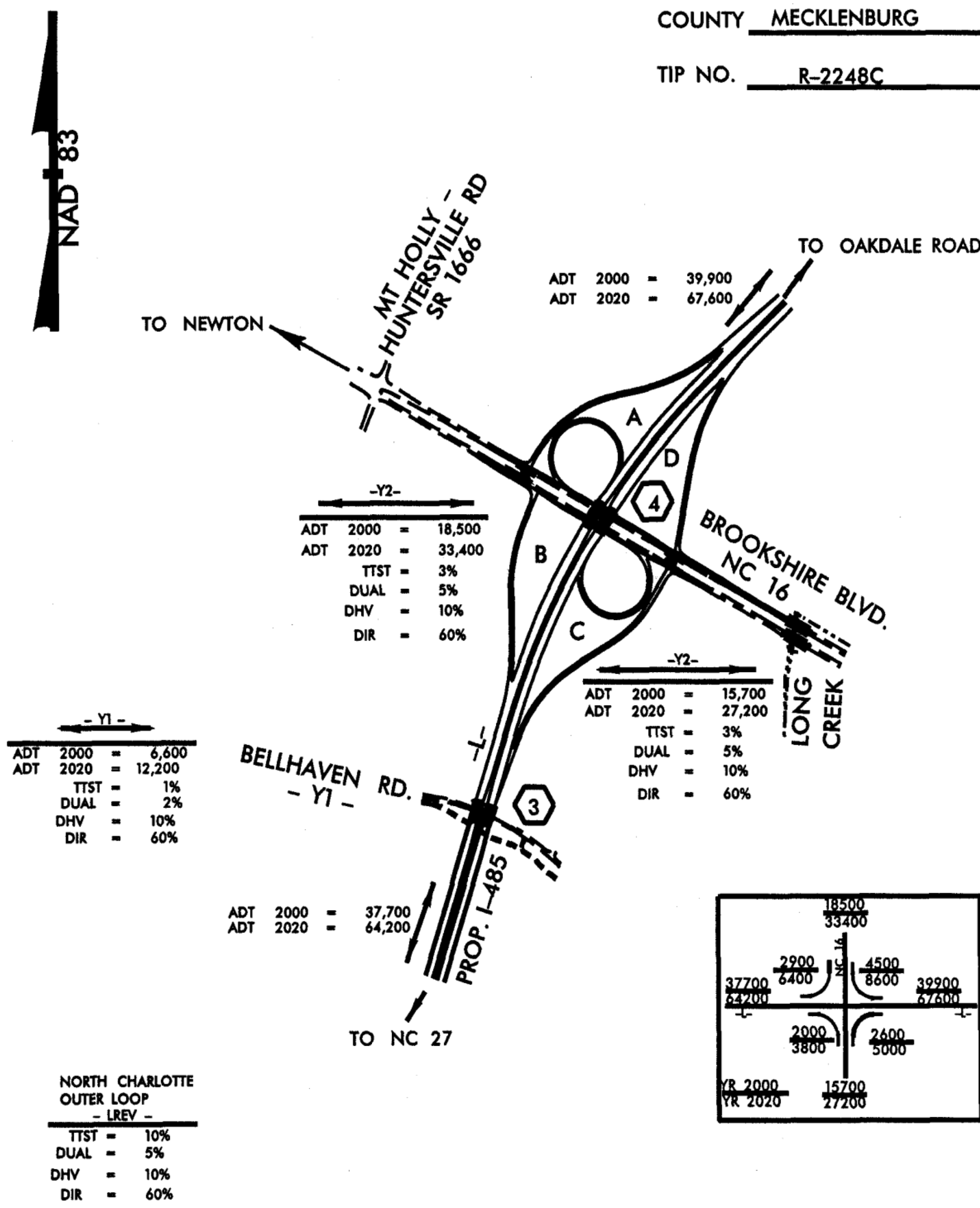
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

SHEET 3 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C



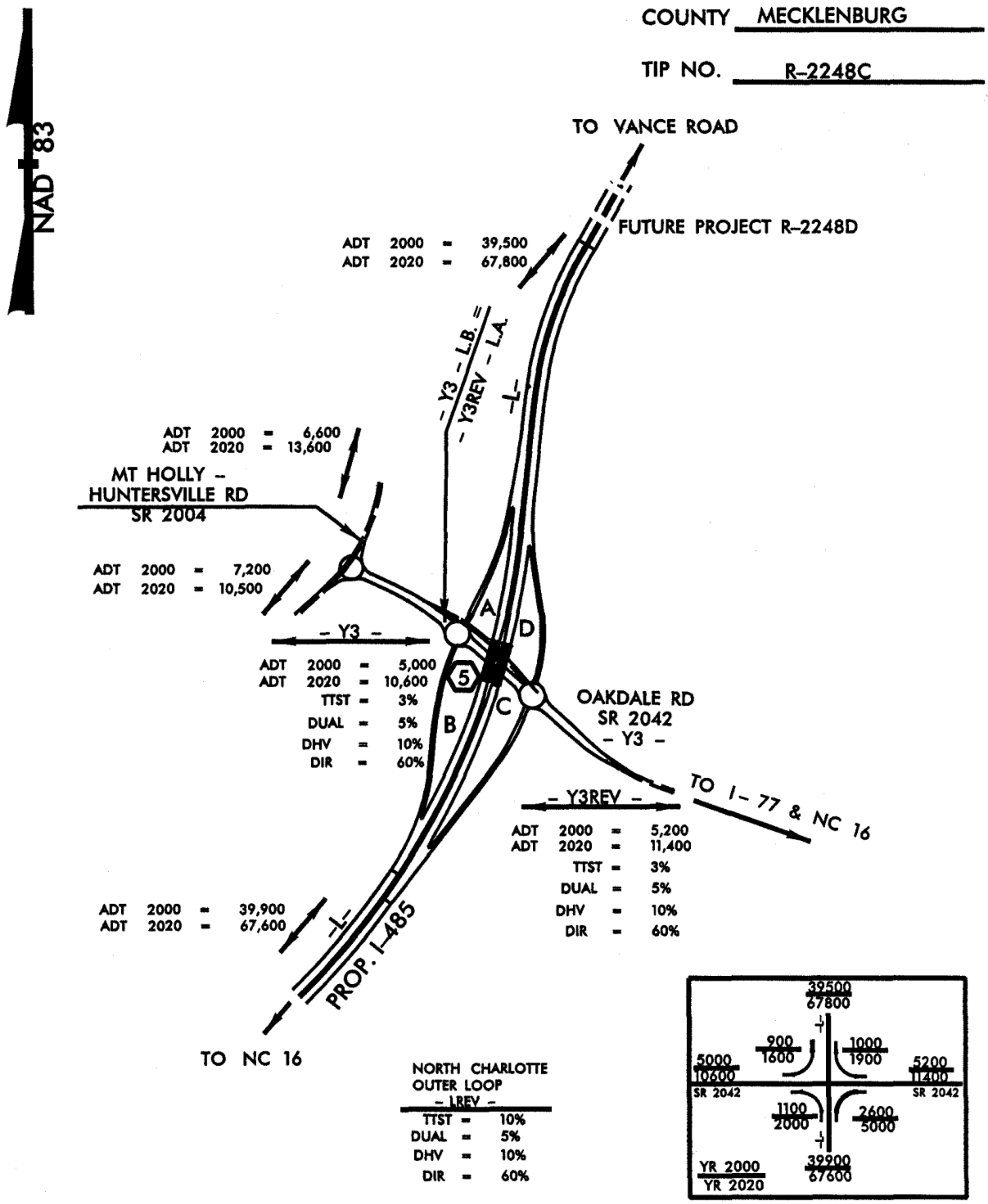
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

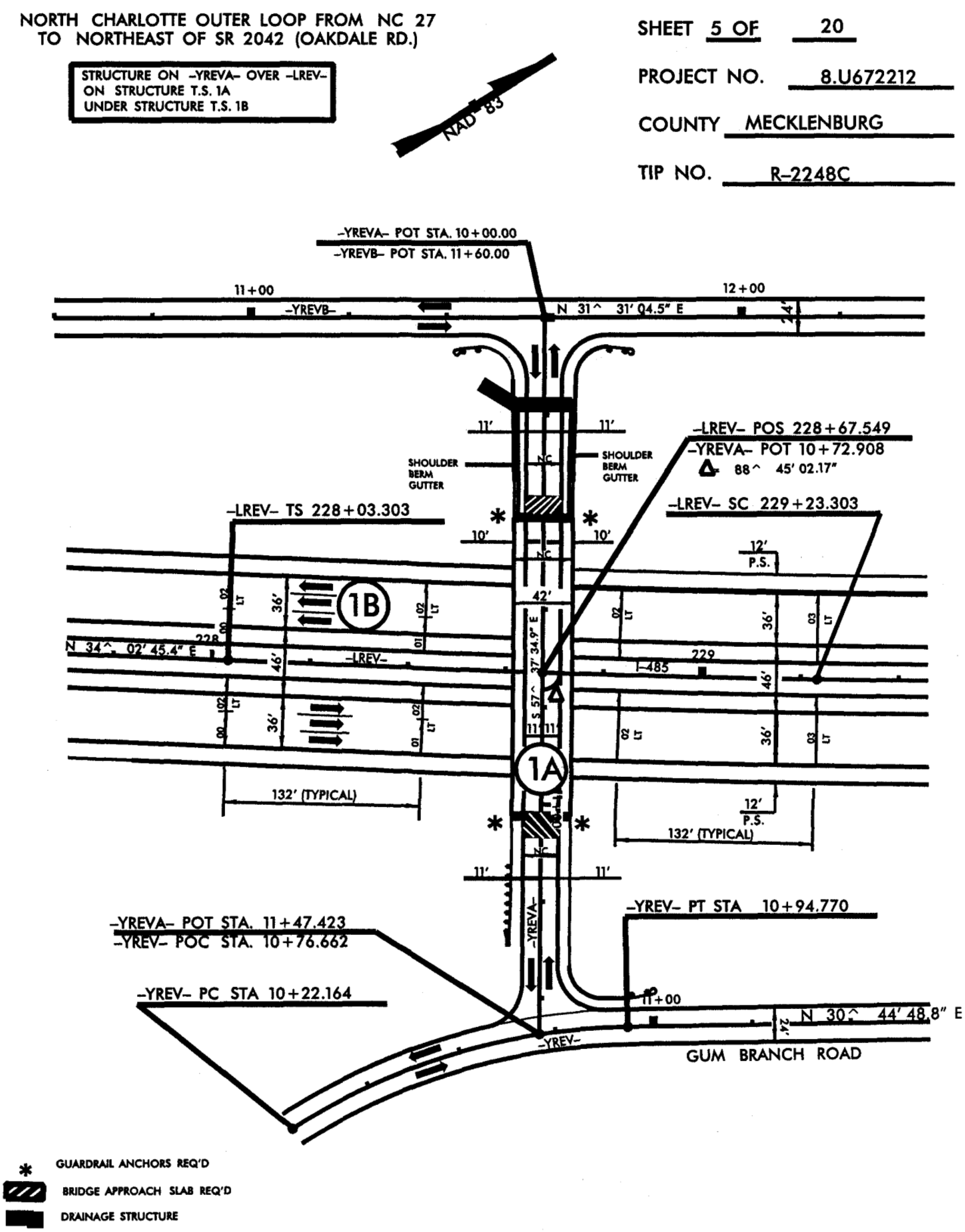
SHEET 4 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C

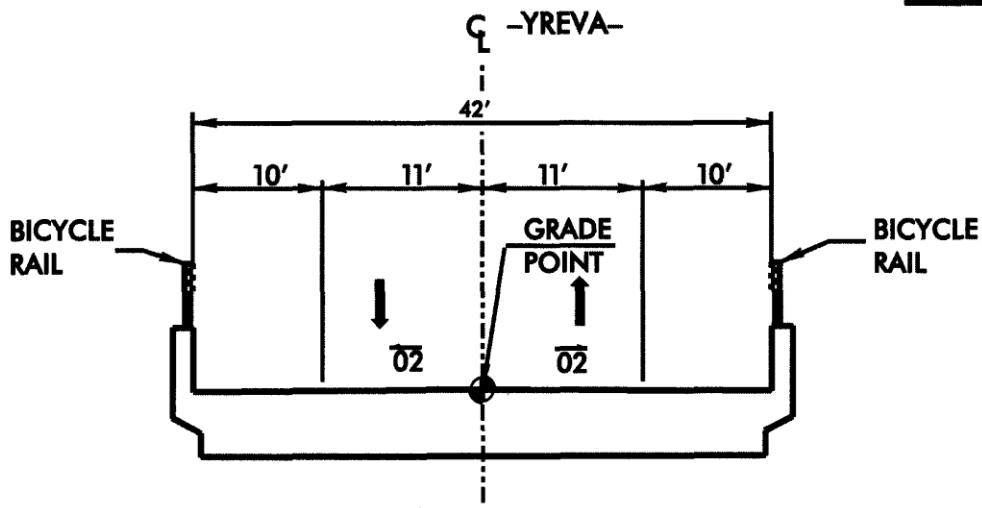



NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)
STRUCTURE ON –YREVA– OVER –LREV–
ON STRUCTURE T.S. 1A
UNDER STRUCTURE T.S. 1B
NAD 83
SHEET 5 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C
–YREVA– POT STA. 10+00.00
–YREVB– POT STA. 11+60.00
11+00
–YREVB–
12+00
N 31^ 31' 04.5" E
24'
11'
SHOULDER
BERM
GUTTER
–LREV– POS 228+67.549
–YREVA– POT 10+72.908
88^ 45' 02.17"
–LREV– TS 228+03.303
–LREV– SC 229+23.303
10'
12'
P.S.
42'
1B
36'
46'
228
N 34^ 02' 45.4" E
–LREV–
I-485
229
S 57^ 37' 34.9" E
1A
132' (TYPICAL)
–YREVA– POT STA. 11+47.423
–YREV– POC STA. 10+76.662
–YREV– PT STA 10+94.770
–YREVA–
–YREV– PC STA 10+22.164
11+00
N 30^ 44' 48.8" E
–YREV–
GUM BRANCH ROAD
GUARDRAIL ANCHORS REQ'D
BRIDGE APPROACH SLAB REQ'D
DRAINAGE STRUCTURE

SAMPLE 6

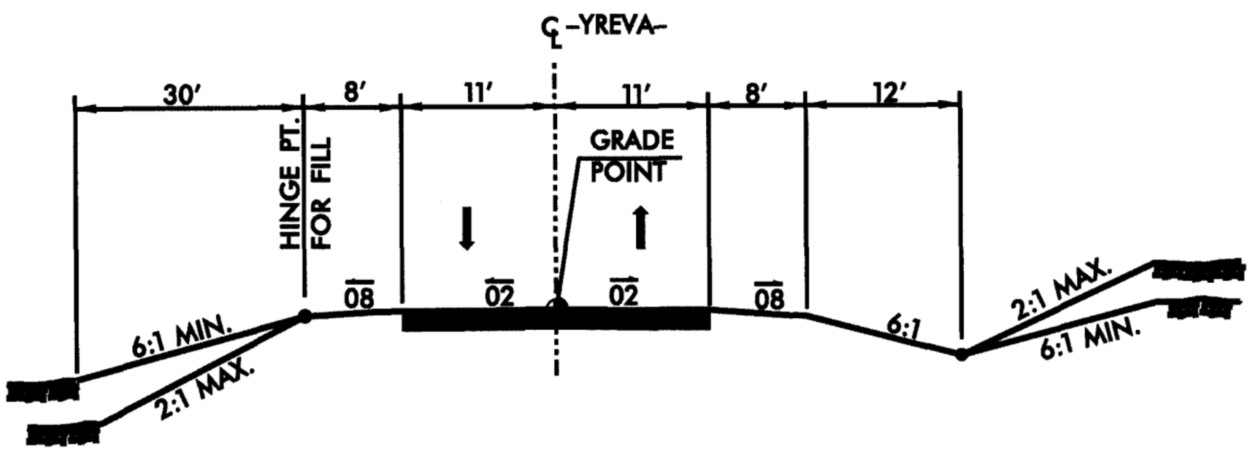
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

SHEET 6 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C



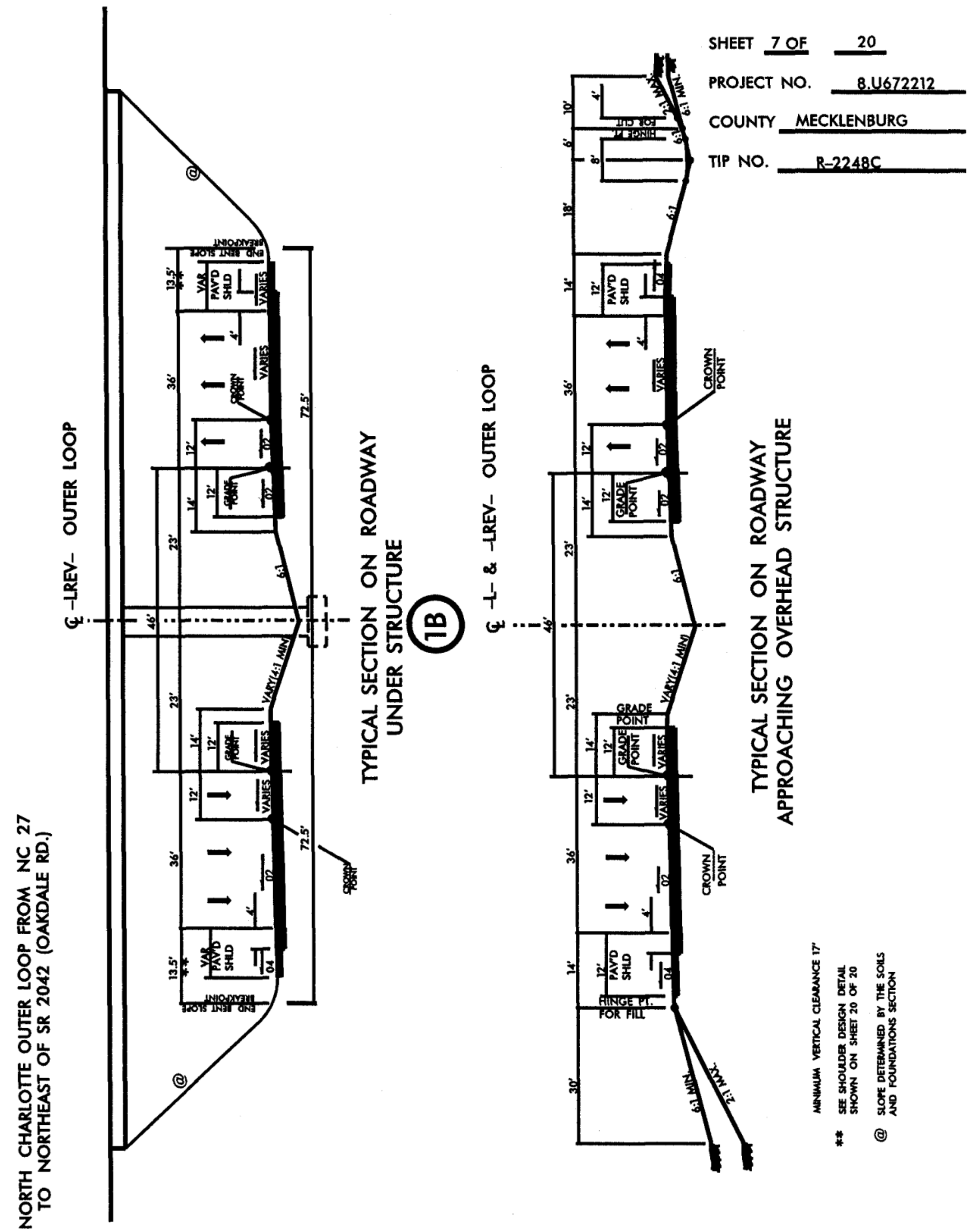
TYPICAL SECTION ON STRUCTURE

1A



TYPICAL SECTION ON ROADWAY APPROACHING STRUCTURE

SERVICE RD
LOCAL ROAD
35 mph ESTIMATED POSTED SPEED
40 mph DESIGN SPEED


SHEET 7 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)
℄ -LREV- OUTER LOOP
TYPICAL SECTION ON ROADWAY
UNDER STRUCTURE
1B
℄ -L- & -LREV- OUTER LOOP
TYPICAL SECTION ON ROADWAY
APPROACHING OVERHEAD STRUCTURE
MINIMUM VERTICAL CLEARANCE 17'
** SEE SHOULDER DESIGN DETAIL SHOWN ON SHEET 20 OF 20
@ SLOPE DETERMINED BY THE SOILS AND FOUNDATIONS SECTION

NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

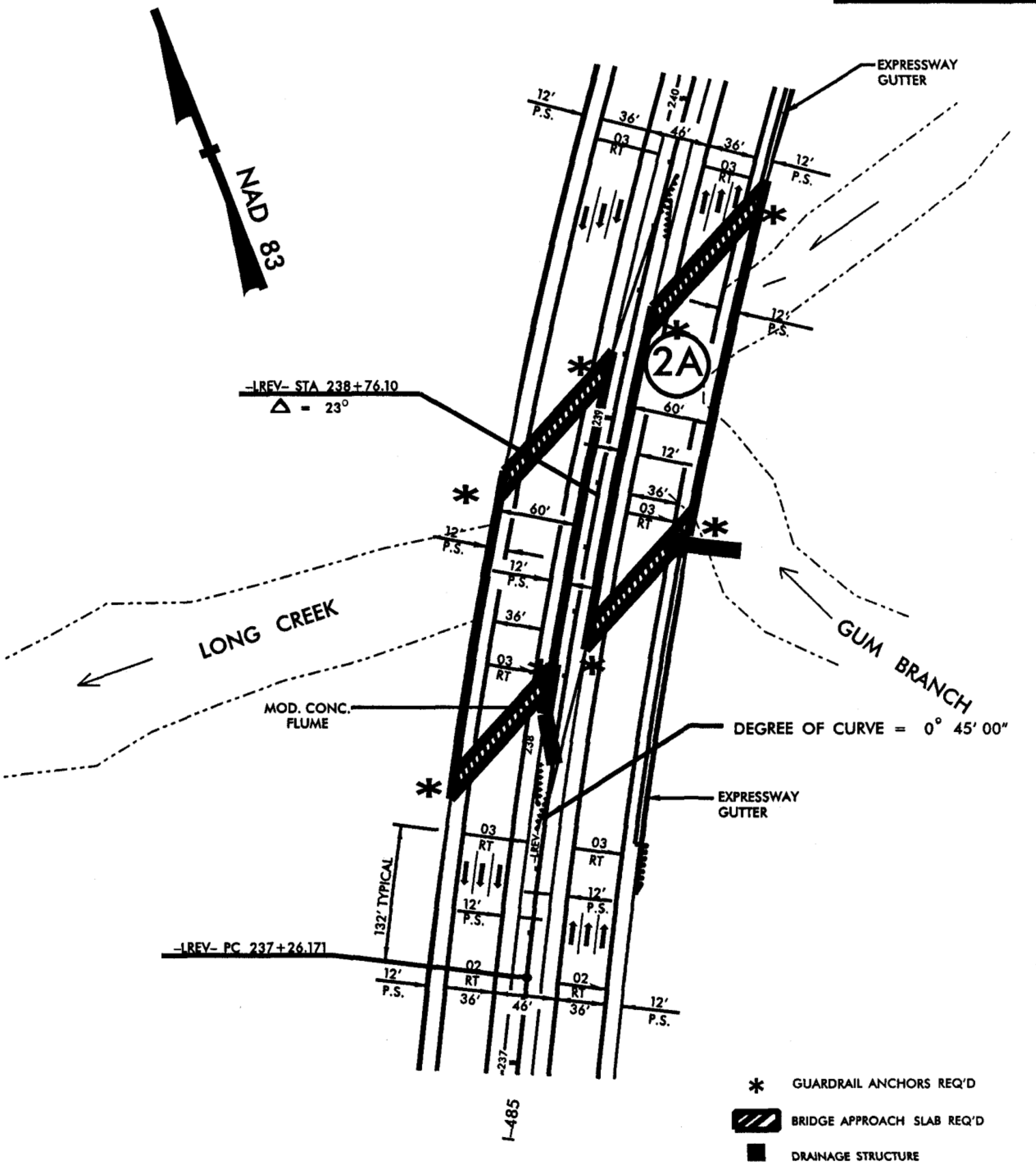
STRUCTURE ON -LREV-
OVER LONG CREEK
ON STRUCTURE T.S. 2A

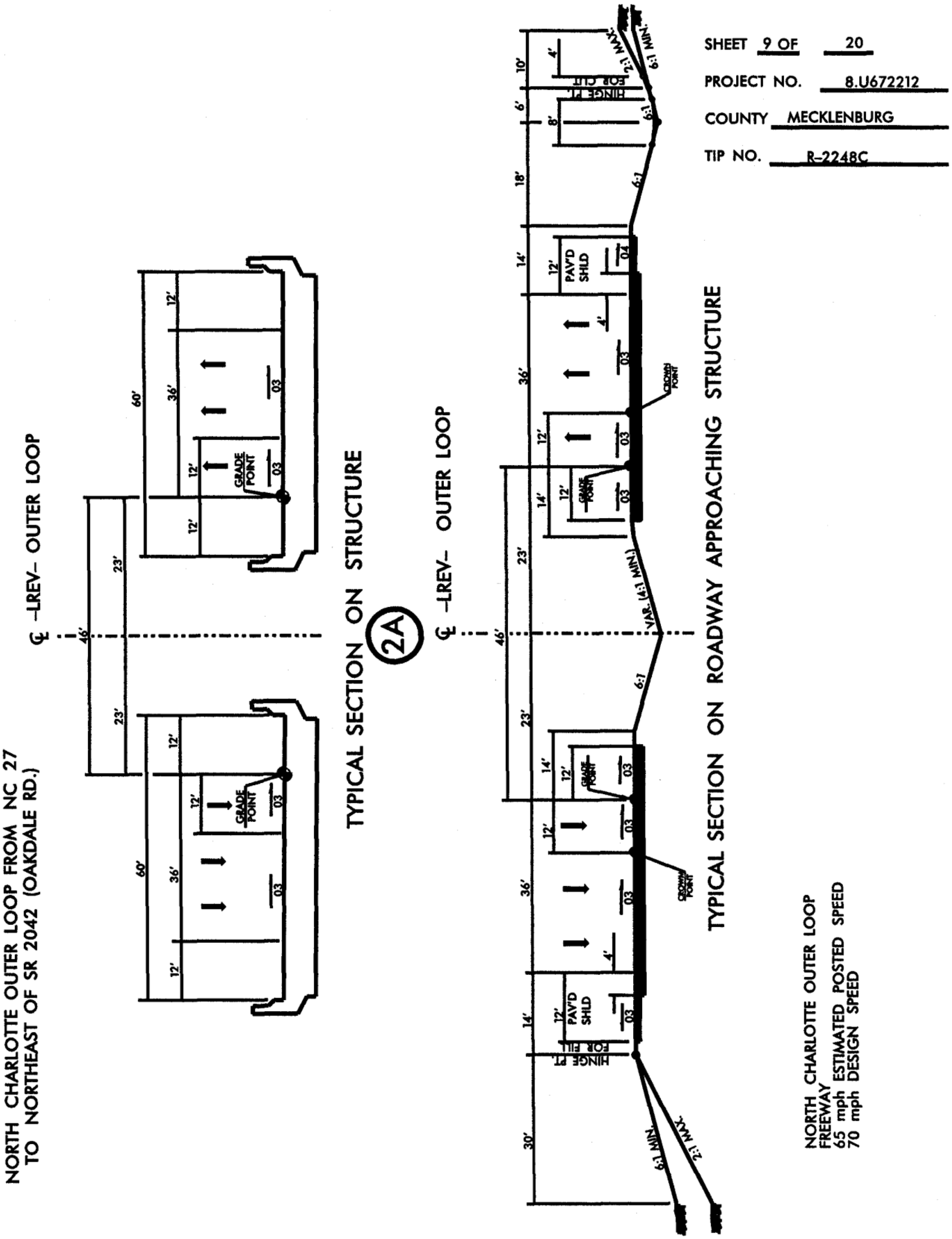
SHEET 8 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C




SHEET 9 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)
℄ -LREV- OUTER LOOP
TYPICAL SECTION ON STRUCTURE
2A
TYPICAL SECTION ON ROADWAY APPROACHING STRUCTURE
NORTH CHARLOTTE OUTER LOOP
FREEWAY
65 mph ESTIMATED POSTED SPEED
70 mph DESIGN SPEED

SAMPLE 10 6 – 61

10 of 20

NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

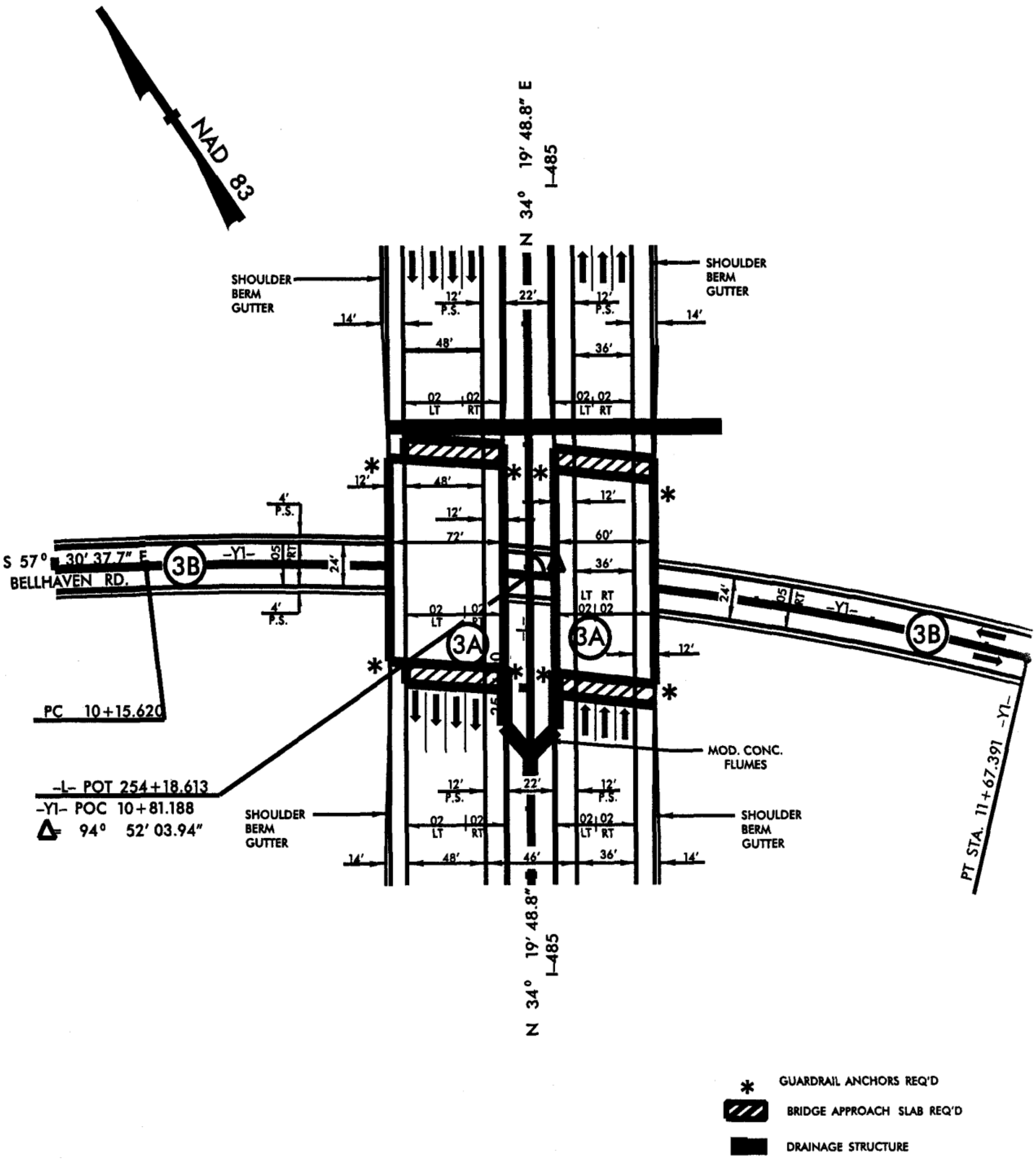
STRUCTURE ON -L- OVER -Y1-
ON STRUCTURE T.S. 3A
UNDER STRUCTURE T.S. 3B

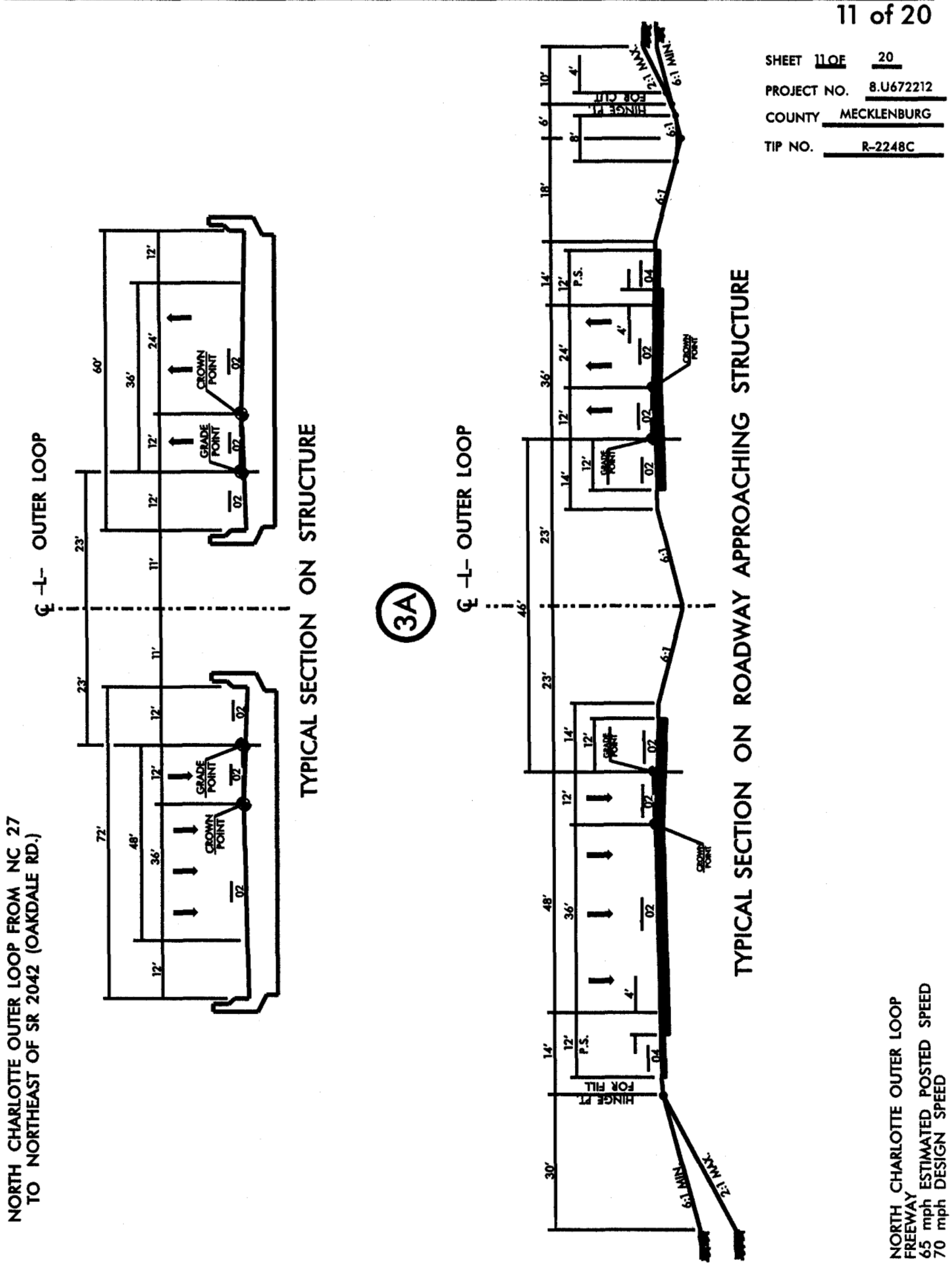
SHEET 10 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C




SHEET 11 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)
℄ -L- OUTER LOOP
GRADE POINT
CROWN POINT
TYPICAL SECTION ON STRUCTURE
3A
HINGE PT. FOR CUT
HINGE PT. FOR FILL
P.S.
2:1 MAX.
6:1 MIN.
TYPICAL SECTION ON ROADWAY APPROACHING STRUCTURE
NORTH CHARLOTTE OUTER LOOP
FREEWAY
65 mph ESTIMATED POSTED SPEED
70 mph DESIGN SPEED

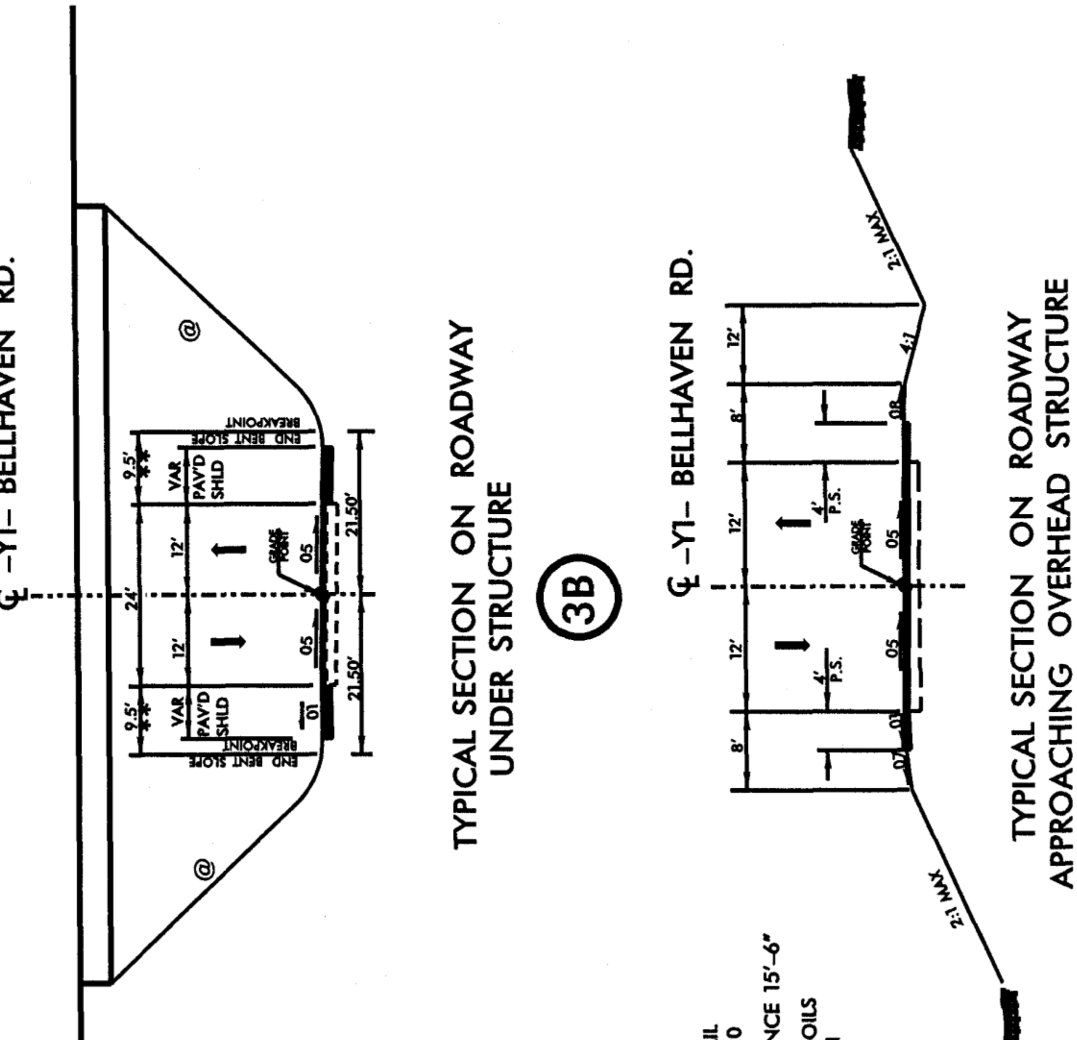
SHEET 12 OF 24

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C

NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)



TYPICAL SECTION ON ROADWAY
UNDER STRUCTURE

TYPICAL SECTION ON ROADWAY
APPROACHING OVERHEAD STRUCTURE

SEE SHOULDER DESIGN DETAIL
SHOWN ON SHEET 20 OF 20

** MINIMUM VERTICAL CLEARANCE 15'-6"

@ SLOPE DETERMINED BY THE SOILS
AND FOUNDATIONS SECTION

NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

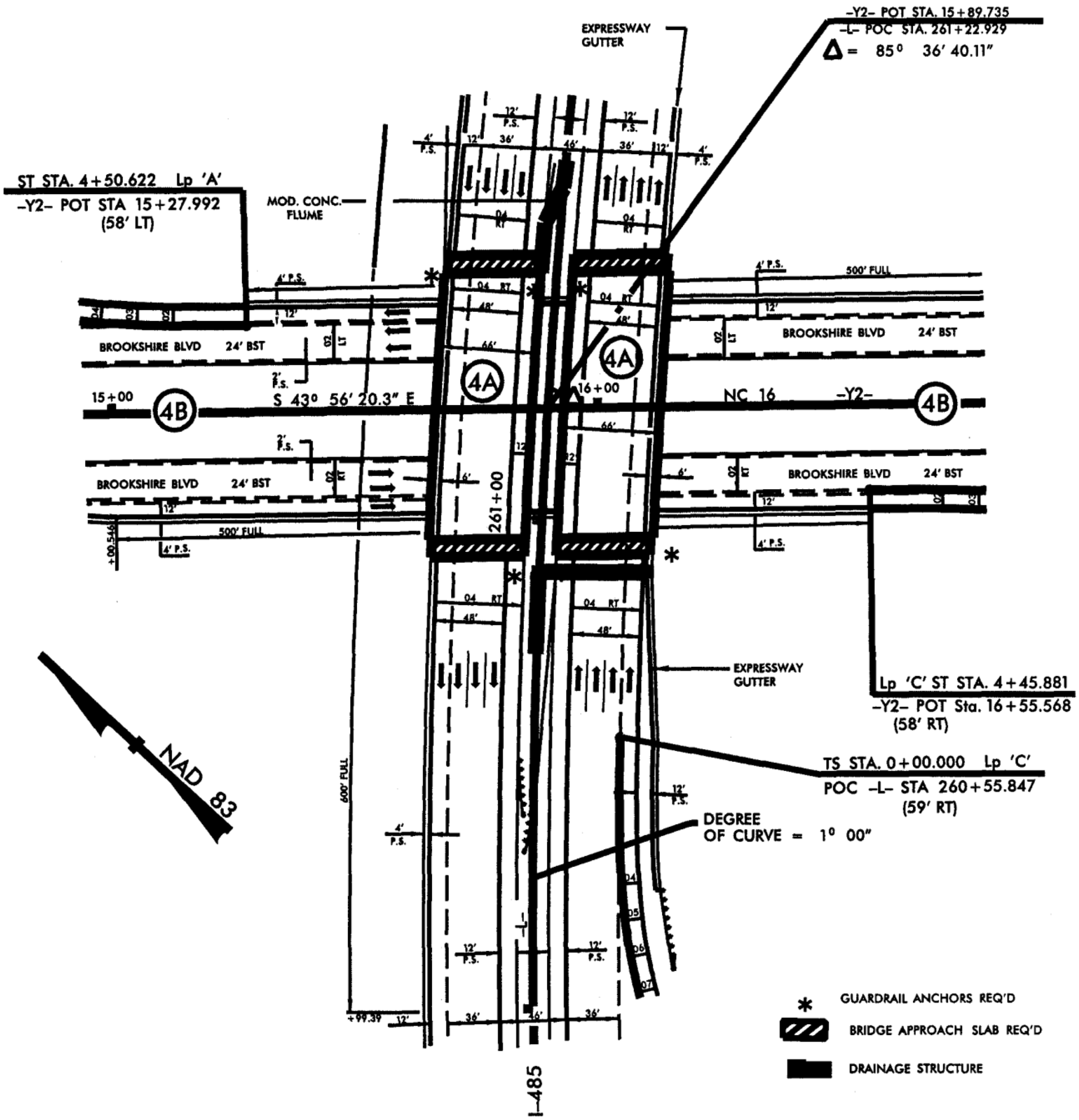
STRUCTURE ON –L– OVER –Y2–
ON STRUCTURE T.S. 4A
UNDER STRUCTURE T.S. 4B

SHEET 13 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C

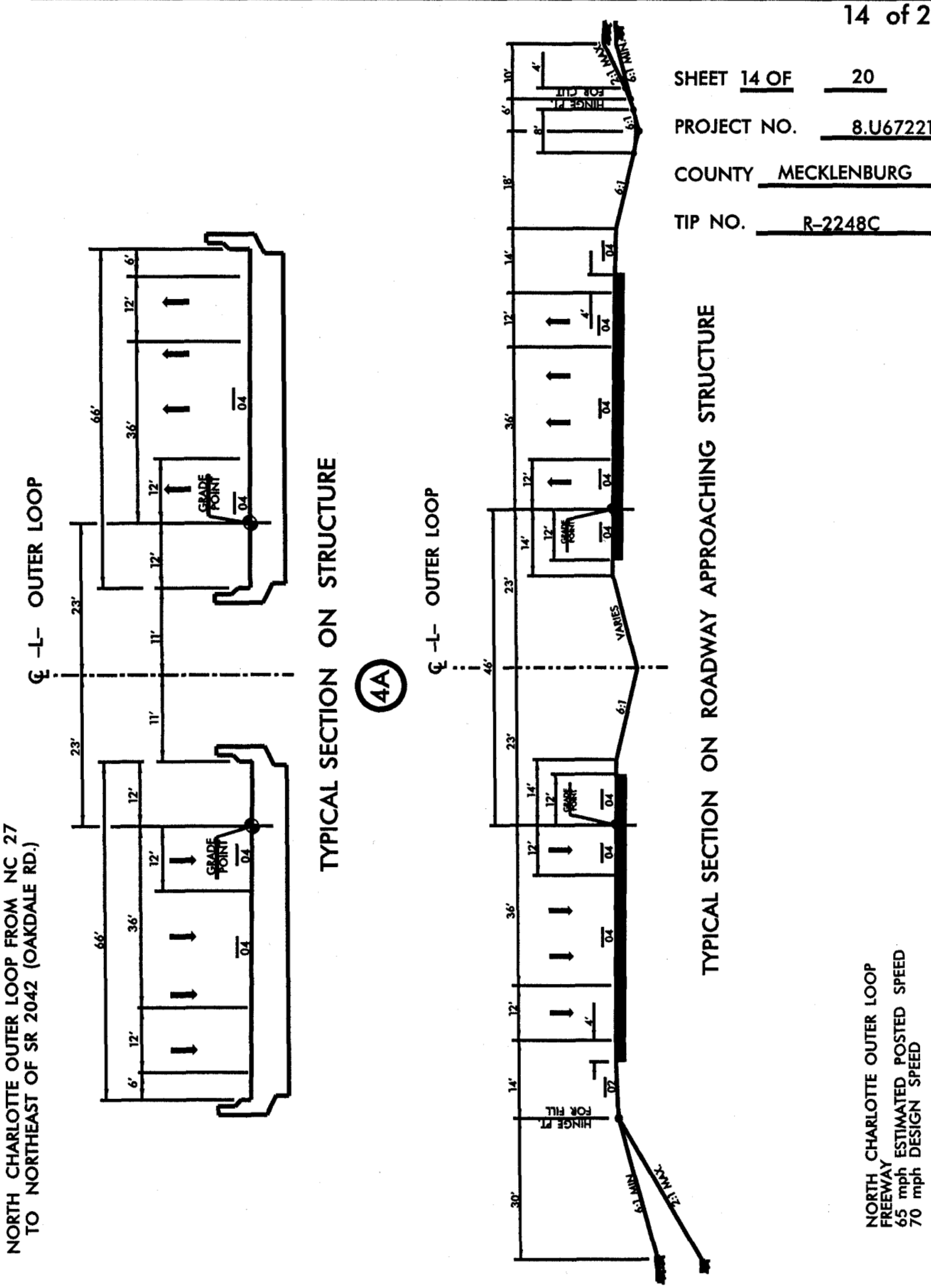


SHEET 14 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R-2248C



SAMPLE 15 6 – 61

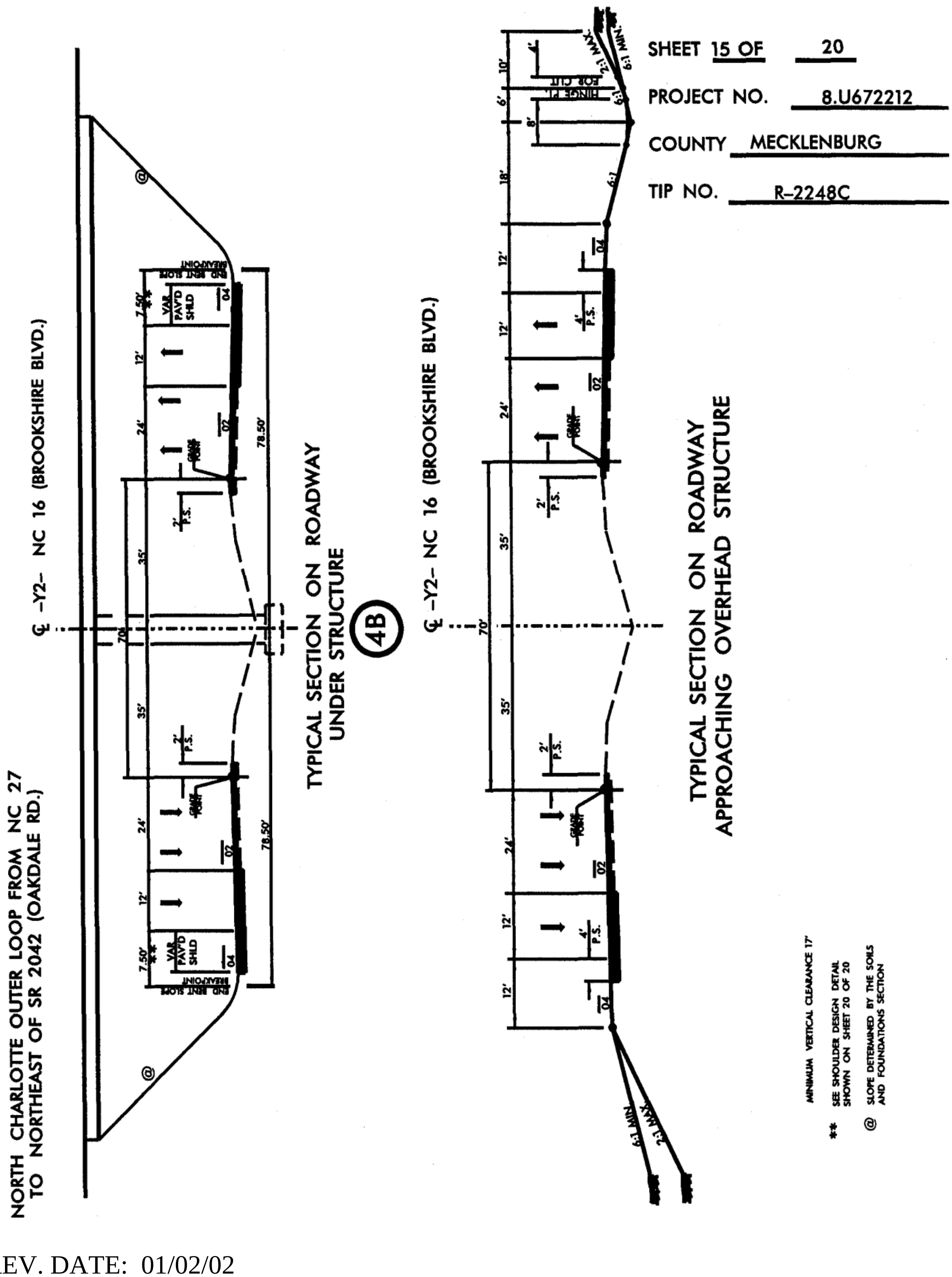
15 of 20

SHEET 15 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

TIP NO. R–2248C



NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

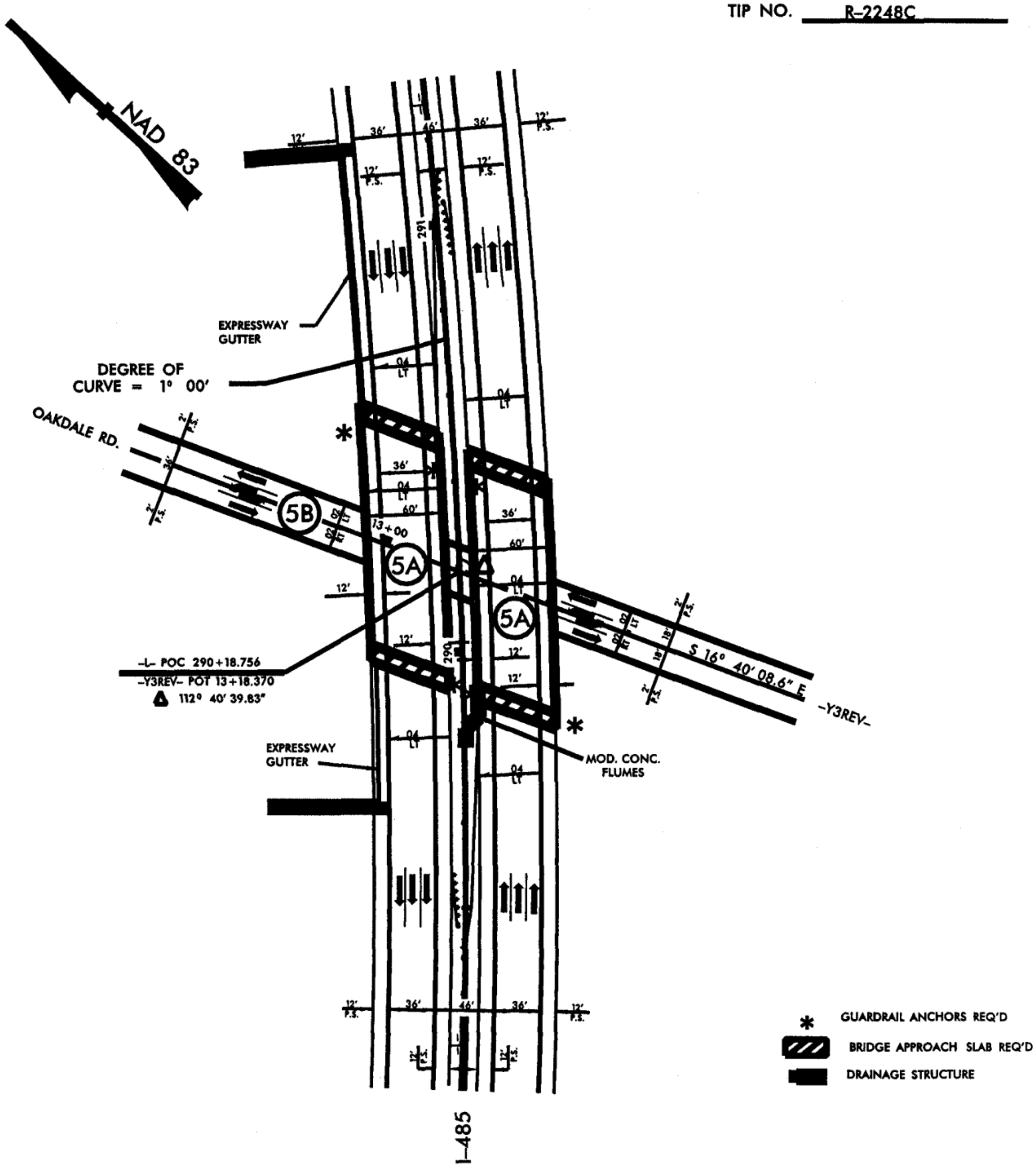
STRUCTURE ON -L- OVER -Y3REV-
ON STRUCTURE T.S. 5A
UNDER STRUCTURE T.S. 5B

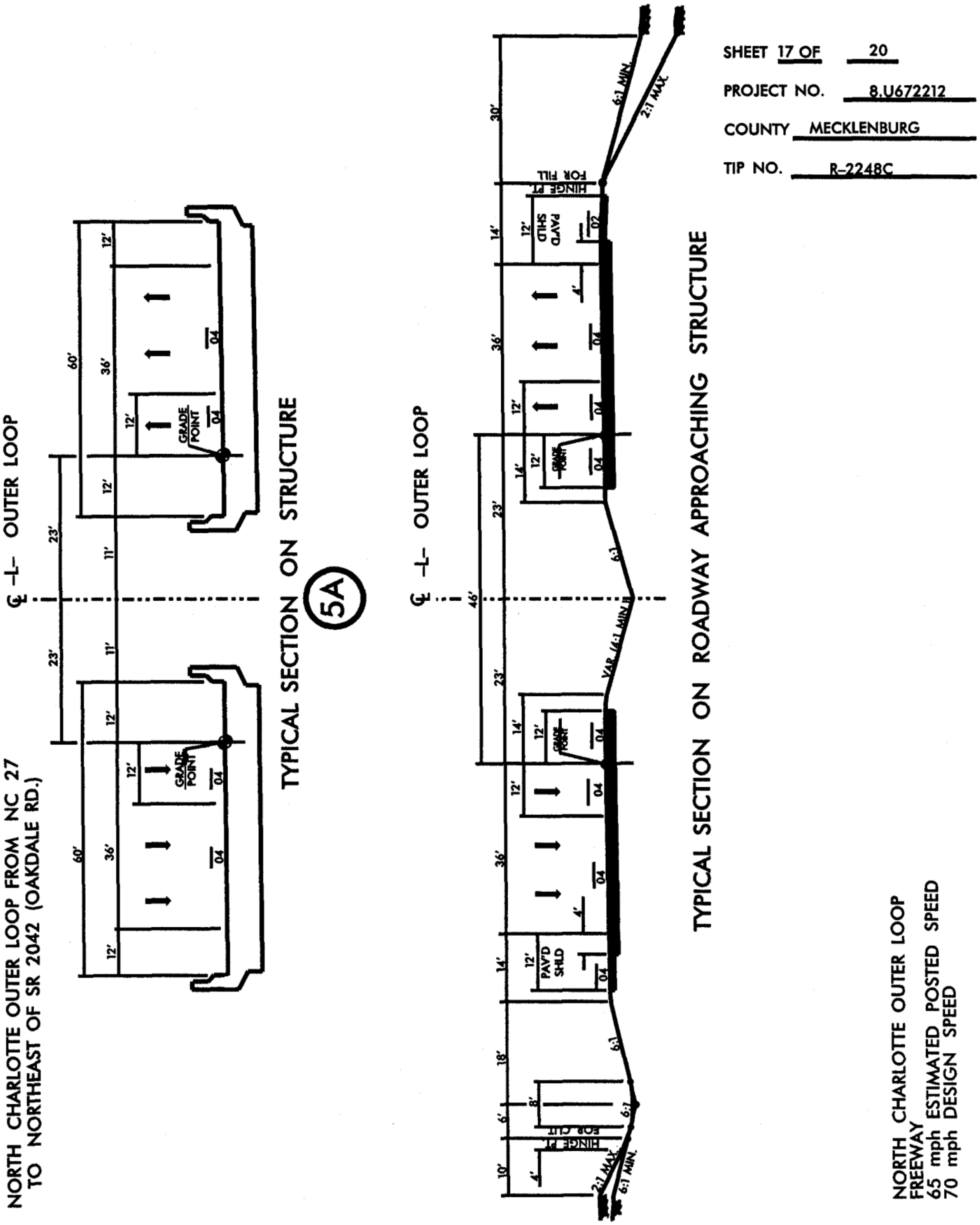
SHEET 16 OF 20

PROJECT NO. 8.U672212

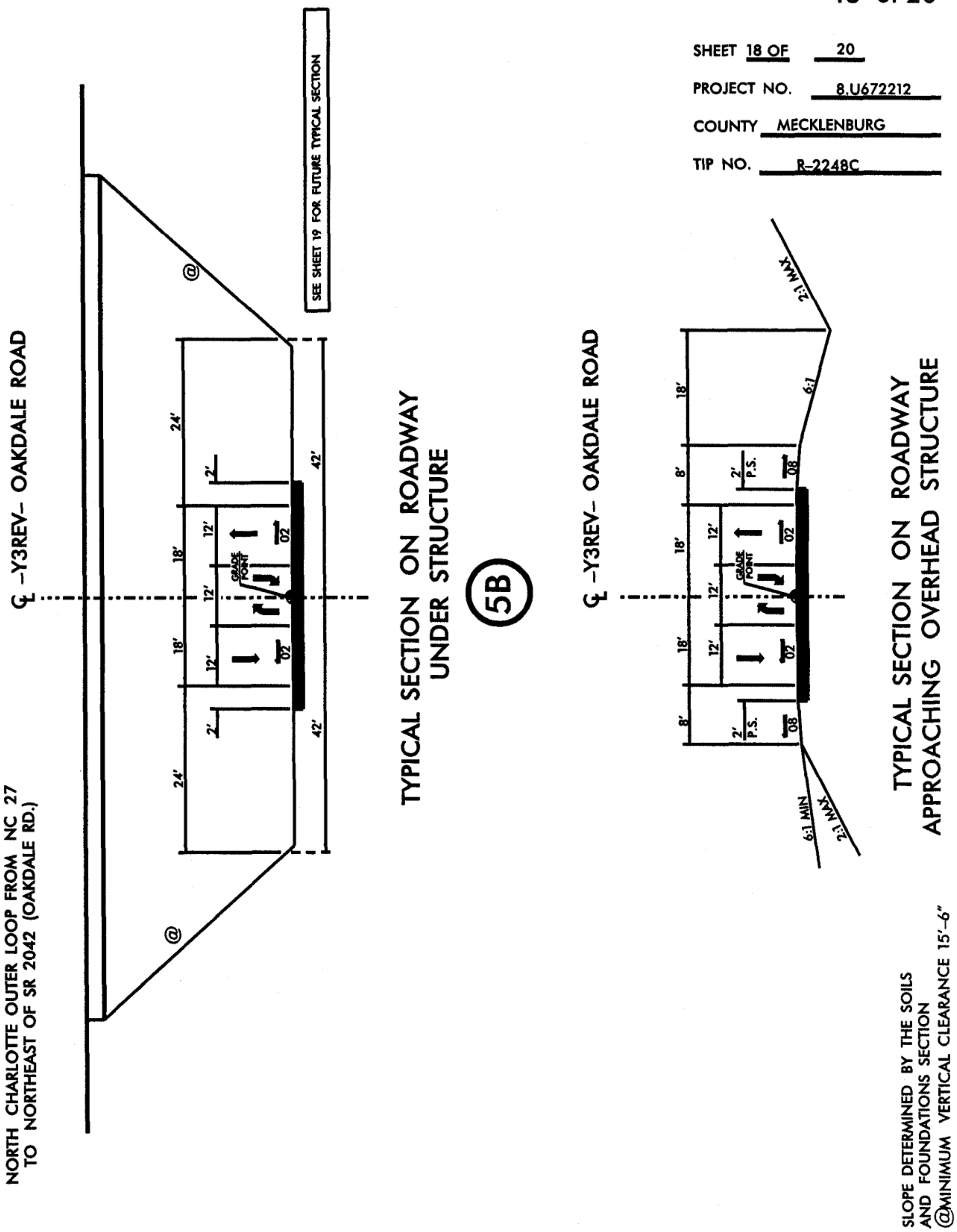
COUNTY MECKLENBURG

TIP NO. R-2248C

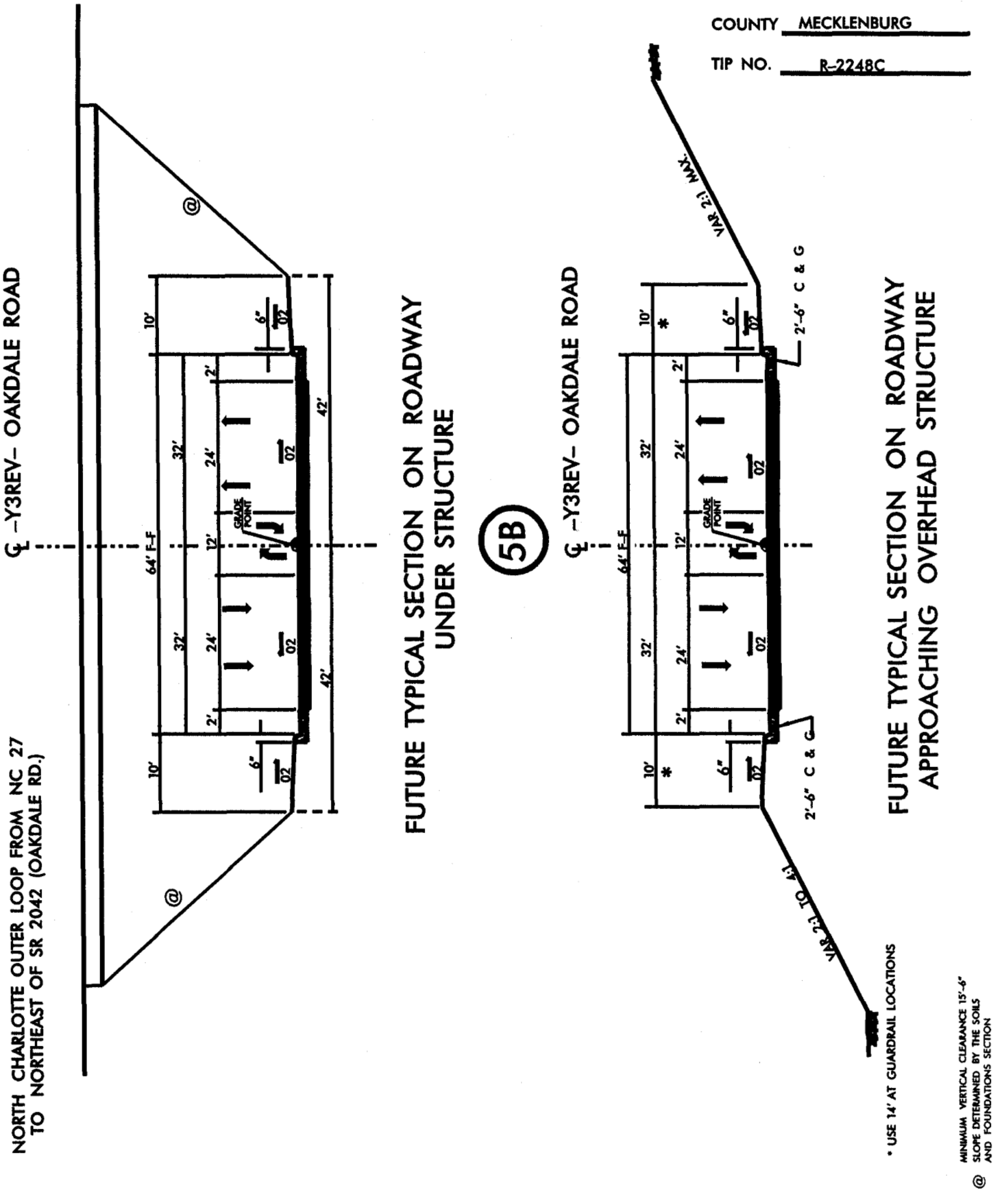



SHEET 17 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)
℄ -L- OUTER LOOP
GRADE POINT
TYPICAL SECTION ON STRUCTURE
5A
TYPICAL SECTION ON ROADWAY APPROACHING STRUCTURE
PAV'D SHLD
HINGE PT FOR FILL
HINGE PT FOR CUT
6:1 MIN.
2:1 MAX.
VAR. (4:1 MIN.)
NORTH CHARLOTTE OUTER LOOP
FREEWAY
65 mph ESTIMATED POSTED SPEED
70 mph DESIGN SPEED

SHEET 18 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C



SHEET 19 OF 20
PROJECT NO. 8.U672212
COUNTY MECKLENBURG
TIP NO. R-2248C



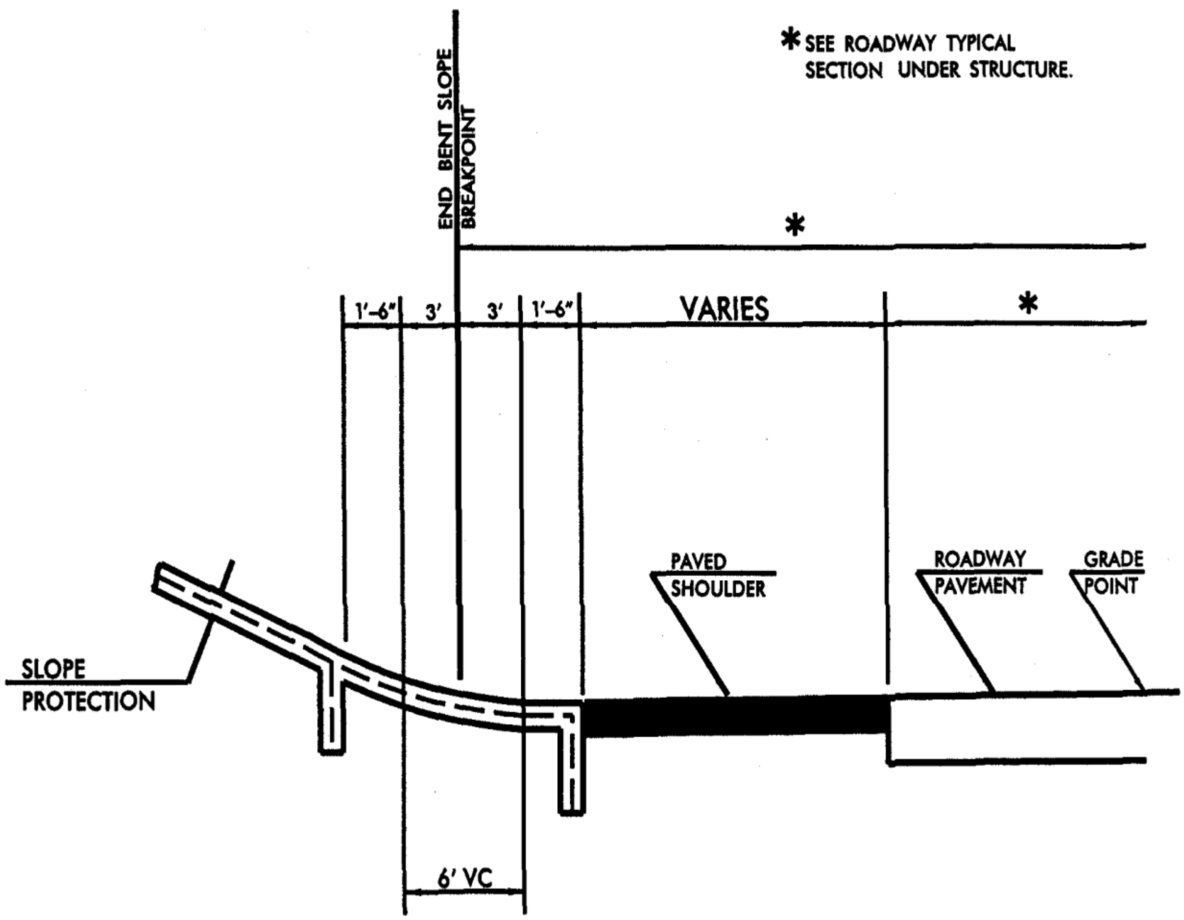
NORTH CHARLOTTE OUTER LOOP FROM NC 27
TO NORTHEAST OF SR 2042 (OAKDALE RD.)

SHEET 20 OF 20

PROJECT NO. 8.U672212

COUNTY MECKLENBURG

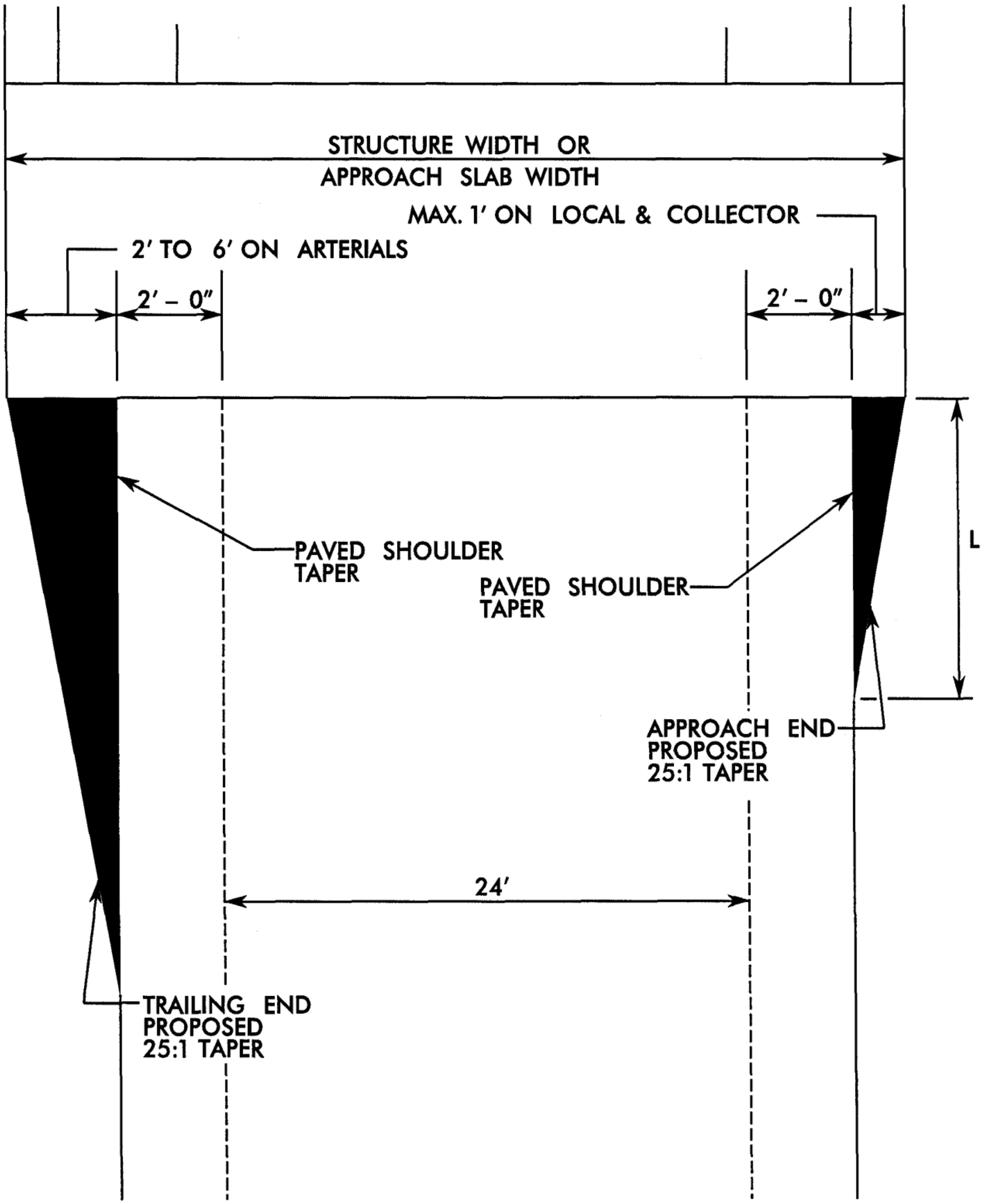
TIP NO. R-2248C



SPECIAL DETAIL WITHOUT BRIDGE PIER
(USE IN CONJUNCTION WITH STANDARD NO. 610.03)

FIGURE 1 6 - 6J
F - 1

PAVED SHOULDER TAPER AT BRIDGES



A Policy on Geometric Design of Highways and Streets, 2011 lists guidelines for the design of new and major reconstruction projects. A small percentage of projects may not meet the values listed by AASHTO. These exceptions must be approved by the Federal Highway Division Administrator or the State Design Engineer. The Project Engineer shall review the AASHTO bridge guidelines to determine if we are in conformance.

One example of the need for an exception is when lesser, more cost-effective values are used on some bridge replacement projects. These lesser values can provide continuity along an existing facility where (1) little or no approach work is necessary and (2) additional improvements of the route are not anticipated in the near future.

When values do not meet the AASHTO guidelines, the Project Engineer will submit a "Request for Exception to AASHTO Policy" to the State Design Engineer for review and signature. See Figures 1 and 2 for examples.

Figure 1

SAMPLE

MEMO TO: Ms. Debbie Barbour, PE
State Design Engineer

FROM: John Alford, PE
State Roadway Design Engineer

DATE: _______________

SUBJECT: Project _________ (______) _____________ County
F. A. Project ________________________________
____
____

Request for Design Exception

This is a request for a design exception _______________________________________ ____. See attachment for pertinent information.

If you have any questions, please contact me or ________________________________, Project Engineer.

______________________________	______________________________
Project Design Engineer	Asst. State Roadway Engineer
______________________________	______________________________
Project Engineer	State Roadway Design Engineer

JEA / _____
Attachment
cc: Project Engineer

APPROVED: ____________________
DATE: ____________________

cc: Mr. John Alford, PE
Project Engineer

Figure 2

SAMPLE

MEMO TO: Mr. Nicholas Graf, PE
FHWA Division Administrator

FROM: Debbie Barbour, PE
State Design Engineer

DATE: ________________

SUBJECT: Project _________ (______) _____________ County
F. A. Project _________________________________
____
____

Request for Design Exception

We request a design exception for ____
____. See attachment for pertinent information.

If you have any questions, please contact me or ___________________________________, Project Engineer.

____
Project Design Engineer

____
Asst. State Roadway Design Eng.

____
Project Engineer

____
State Roadway Design Engineer

DMB / _____
Attachment
cc: John Alford, PE
Project Engineer

APPROVED: _____________________
DATE: _____________________

cc: Debbie Barbour, PE

RETAINING WALLS 6-7

A retaining wall is a structure that retains or holds back a soil or rock mass. Retaining walls are used for many reasons including repairing landslides, minimizing right of way requirements, shortening bridges (abutment walls), widening roads, and providing property access. Retaining walls are typically high cost items and are only justified when other options such as purchasing right of way, constructing longer bridges, using reinforced slopes or realignment are not feasible.

The specific type of retaining wall utilized is dependent on several factors, including whether it is in a cut or fill, the subsurface conditions in the area around the proposed retaining wall, cost, aesthetics, etc. All potential retaining wall locations should be submitted to the Geotechnical Engineering Unit at an early stage of the project development process so that the Geotechnical Engineering Unit can determine the most feasible wall type and provide a preliminary cost estimate. The Project Engineer should initiate the retaining wall design process by submitting a request for retaining wall design to the Geotechnical Engineering Unit at the To Hydraulics (25% plan) stage. In all cases, the request for retaining wall design should be submitted no later than six months prior to the scheduled Combined or Final Design Field Inspection to ensure that a preliminary wall design can be prepared and any design/construction issues can be discussed at the field inspection.

Except for gravity retaining walls, walls should be shown on the cross-sections as a vertical graphic element one (1) foot thick, measured from the face of the wall, unless directed otherwise by the Geotechnical Engineering Unit. Cast-in-place gravity walls should be shown on the cross-sections as a graphical element as shown on Geotechnical Standard Drawing 453.01. Segmental and precast gravity walls should be shown on the cross-sections as a graphical element 2 and 4 feet thick, respectively, with a wall batter of 9.5 degrees per Geotechnical Standard Drawing 453.02/453.03 or geotechnical standard cells for precast gravity walls.

When referencing retaining walls on the roadway plans, each wall should be numbered sequentially along the -L- alignment (i.e., “Retaining Wall #1”, “Retaining Wall #2”, etc.). A retaining wall should be numbered, even if it is the only wall on the project. Where retaining walls are opposite each other and begin at the same station, number the wall on the left first. If a retaining wall is located along a -Y- alignment, the numbering sequence should be based on where the -Y- alignment crosses the -L- alignment. Do not renumber the retaining walls if a wall is added after preliminary wall envelope is submitted to the Geotechnical Engineering Unit. The Roadway Design Unit is responsible for showing the retaining wall(s) on the roadway plans and cross-sections.

Construction limits to determine right of way and/or easements will vary depending on the geometry and wall type. The Geotechnical Engineering Unit will provide Roadway Design with right of way and easement requirements in the roadway foundation recommendations. During preliminary design, right of way or permanent easement approximately 1.2 times the maximum wall height (1.2H) can typically be shown behind a cut wall until the foundation recommendations are received. However, for cut walls taller than 15 feet in the coastal plain (generally Divisions 1-3 and parts of 4, 6 and 8), contact the Geotechnical Engineering Unit as more than 1.2H may be needed for right of way or permanent easement. For fill walls, the right of way limit should be at least 5 feet in front of the wall.

In general, retaining walls should be laid out straight for ease of design and construction. Curved walls may be used in order to maintain a constant offset from a survey line, but the minimum radius will vary depending on the type of wall selected. If a curved wall is specified, it is advisable to contact the Geotechnical Engineering Unit prior to preparing the preliminary wall envelope in order to determine whether a specific wall alignment is feasible.

If the wall is located within the clear zone, steel beam guardrail (Section 862 of the *Standard Specifications for Roads and Structures*), single-faced reinforced concrete barrier (Section 857 of the *Standard Specifications for Roads and Structures*) or concrete barrier rail with moment slab (Structure Pay Item) should be used to protect the hazard.

<u>Steel Beam Guardrail (Top or Bottom of Wall)</u>

Steel beam guardrail may be placed at the bottom or top of a retaining wall to protect the hazard. Steel beam guardrail should be offset 5’-6” from the face of the guardrail to the nearest wall surface when standard Steel Beam Guardrail (6’-3” post spacing w/ 6 foot posts) is specified. The minimum offset distance from the face of the guardrail to the nearest wall surface is 4 feet at the top of the wall (6’-3” post spacing w/8 foot posts) and 3’-6” at the bottom of the wall (3’-1½” post spacing w/ 6’ posts). When the offset distance from the wall surface to face of guardrail is between 3’-6” and 5’-6” at the bottom of the wall, specify 3’- 1½” post spacing at a point 25 feet prior to the wall and carry the 3’-1½” post spacing throughout the length of the wall. If the offset distance at the bottom of the wall is less than 3’-6” specify single-faced concrete barrier. A special detail or notes on the guardrail summary and plan sheets should be added to clarify the areas where 3’- 1½” post spacing and extra depth 8 foot posts are required. Coordinate with the Geotechnical Engineering Unit to ensure guardrail posts do not conflict with the retaining wall design. Figure 1 illustrates the offset requirements for steel beam guardrail in relation to the wall.

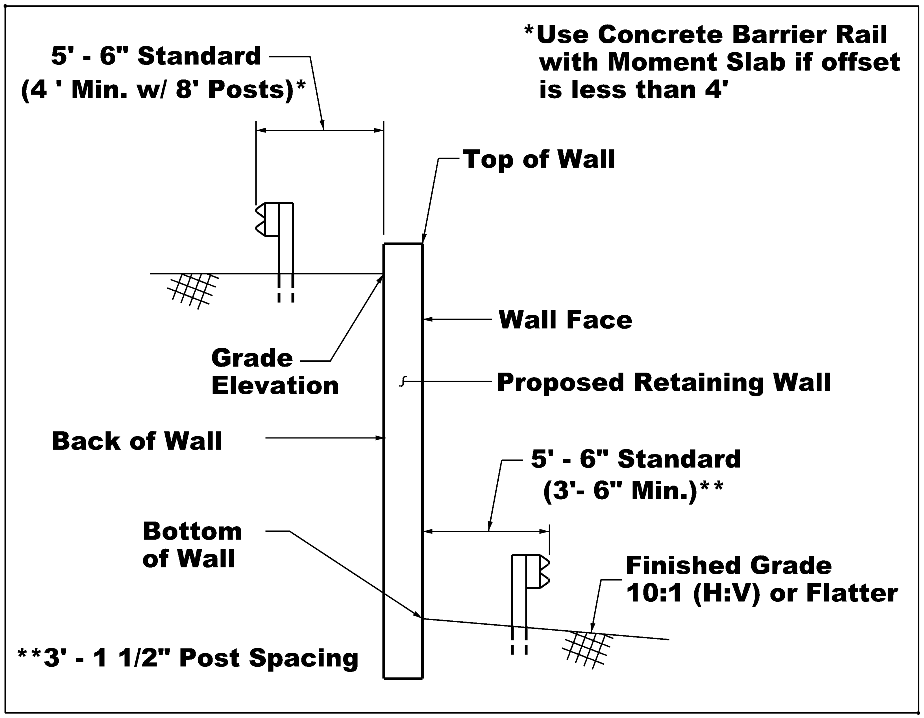


Figure 1

<u>Concrete Barrier Rail with Moment Slab (Top of Wall Only)</u>

If the offset distance from the face of the guardrail to the top of a retaining wall is less than 4 feet, a concrete barrier rail with moment slab is required. Concrete barrier rail with moment slab should be located on top of the wall with no offset as illustrated in Figure 2. When concrete barrier rail with moment slab is required, coordinate with the Geotechnical Engineering Unit and the Structures Management Unit since the concrete barrier rail is a structure pay item.

The details for the concrete barrier rail with moment slab will be included as part of the retaining wall plans. Due to the high costs associated with a concrete barrier rail with moment slab, it should only be used when no other options are available. If guardrail is attached to the concrete barrier rail, the barrier should extend the entire length of the wall.

Guardrail with appropriate anchors can then be attached to the concrete barrier rail in accordance with the most current guardrail policies. The concrete barrier rail with moment slab is not designed to accommodate pedestrian traffic adjacent to the barrier rail. Please notify the Geotechnical Engineering Unit and Structure Management Unit if sidewalk is being proposed adjacent to the concrete barrier rail.

Single-Faced Reinforced Concrete Barrier (Bottom of Wall Only)

Single-faced reinforced concrete barrier can be located next to a wall face when placed at the bottom of a retaining wall. If guardrail needs to be attached to the single-faced concrete barrier, the barrier should extend the entire length of the wall. Guardrail with appropriate anchors can then be attached to the single-faced concrete barrier in accordance with the most current guardrail policies. Figure 2 illustrates the placement of single-faced concrete barrier in relation to the bottom of wall. In some cases, the placement of single-faced concrete barrier at the bottom of wall can result in significant cost savings by reducing the wall height, since single faced barrier allows the wall face to be placed closer to the edge of travel lane as compared to placing steel beam guardrail. If future widening is not anticipated in the vicinity of the bottom of wall, coordinate with the Geotechnical Engineering Unit to determine if the use of single-faced concrete barrier will result in any cost savings.

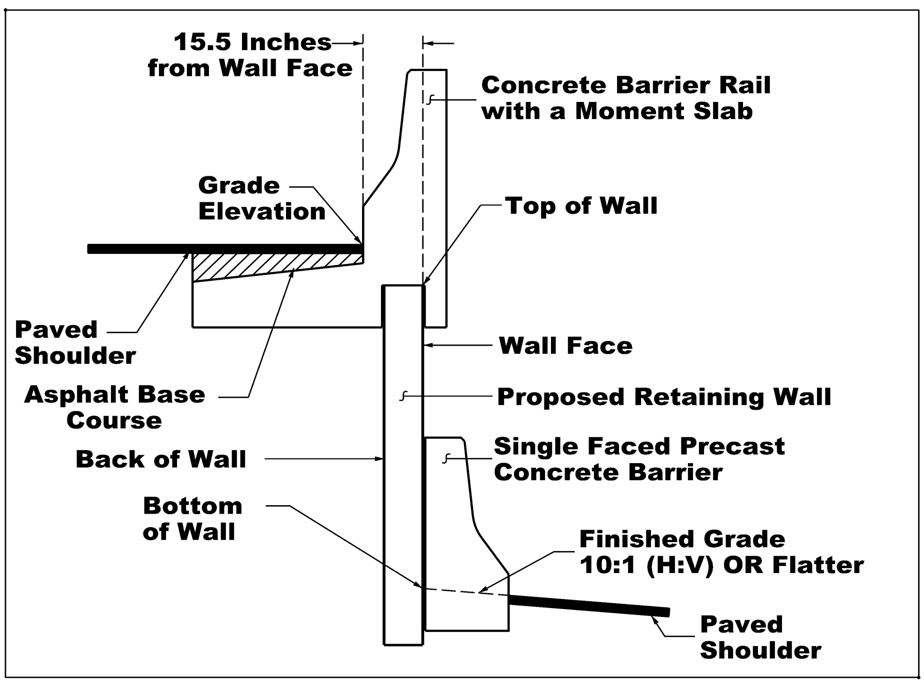


Figure 2

A typical section inset should be added to the roadway plans depicting the placement of the single-faced barrier or guardrail in relation to the retaining wall. The proposed offset distances, if any, should be clearly labeled on the inset. When a concrete barrier rail with moment slab is specified, ABC should be placed to fill the area between the subgrade and the top of moment slab.

Fence or Handrail Placement

A fence or handrail should be placed when pedestrian traffic is anticipated in the vicinity of the top of wall. The Roadway Project Engineer should determine whether handrail or fence is appropriate, based on the height of the wall and the project conditions in the vicinity of the wall. It is preferred that fence or handrail be located no closer than one (1) foot from the back of wall. However, if it is necessary to attach a fence or handrail to a wall, only chain link fence or handrail posts should be attached to the top of a retaining wall with a cast-in-place face. When chain link fence or handrail is attached to a retaining wall, the Roadway Project Design Engineer should contact the Standards Squad Leader in the Contract Standards and Development Unit to prepare details for the attachment to the wall. The fence or handrail detail(s) should be incorporated into the roadway plans as 2-Series sheets. All chain link fence that is attached to a retaining wall should be shown in the appropriate fence summary and paid for under Section 866 of the *Standard Specifications for Roads and Structures* as Chain Link Fence, ___" Fabric per linear foot. Add a label to the fence summary to reference the detail sheet number (i.e., "* SEE DETAIL SHEET 2-? FOR FENCE ATTACHMENT TO RETAINING WALL") for the section(s) of fence that are attached to a retaining wall. Standard chain link fence symbology should be used to denote the chain link fence on the roadway plans.

A generic fencing pay item, Special Provision (SP), should be used to pay for any handrail that is attached to the wall. The Roadway Project Design Engineer should list the handrail on their list of Special Provision items when they submit the final plans to the Contract Standards and Development Unit. Coordinate with the Geotechnical Engineering Unit when fence or handrails are warranted in the vicinity of a wall to ensure that the fence or handrail posts will not conflict with the retaining wall design.

The maintenance of vegetation behind the guardrail, fence, or handrail should be considered when placing these items in close proximity to the retaining wall. Asphalt or class A stone may be placed between the guardrail, fence, or handrail and the wall to help manage vegetation in inaccessible areas. A typical section inset or detail will be needed when specifying asphalt or class A stone to manage vegetation.

The Geotechnical Engineering Unit is responsible for coordinating the preparation of all retaining wall plans. The Geotechnical Engineering Unit will provide plans, special provisions, and pay item quantities for walls that they design. Retaining wall plans will be a part of the structure plans unless there are no other structures on the project. If there are no structure plans, the retaining wall plans will be placed in the roadway plans as W-series sheets.

TYPES OF RETAINING WALLS 6-7A

Most retaining walls are either fill walls or cut walls. Fill walls are generally constructed from the bottom up by placing material behind the wall. Cut walls are generally constructed from the top down by removing material from in front of the wall.

Fill Walls

The most common types of fill walls are (1) *Gravity Retaining Walls*, (2) *Mechanically Stabilized Earth (MSE) Retaining Walls*, and (3) *Cantilever Concrete Retaining Walls*.

(1) *Gravity Retaining Walls* are typically short walls (less than 10 feet in height) that develop stability from their own weight or mass. The most common types of gravity walls are *Cast-in-Place Gravity Retaining Walls*, *Segmental Gravity Retaining Walls* and *Precast Gravity Retaining Walls*.

Cast-in-Place Gravity Retaining Walls are constructed of cast-in-place unreinforced concrete and typically in accordance with Geotechnical Standard Drawing 453.01. *Segmental Gravity Retaining Walls* are constructed of segmental retaining wall (SRW) units and typically in accordance with Geotechnical Standard Drawing 453.02 or 453.03. For additional information regarding SRW units, please reference Article 1040-4 of the *Standard Specifications for Roads and Structures*. *Precast Gravity Retaining Walls* are constructed of precast retaining wall (PRW) units with typical depths ranging from 2 to 5 feet. For additional information regarding PRW units, please reference Section 1077 of the *Standard Specifications for Roads and Structures*.

(2) *MSE Retaining Walls* consist of facing elements connected to layers of soil reinforcement within the retained backfill. For permanent MSE walls, steel or geogrid reinforcements are used with facing elements consisting of precast concrete panels or SRW units. For temporary (MSE) walls, steel, geogrid or geotextile reinforcements are used and facing elements consist of geotextile and wire forms.

(3) *Cantilever Concrete Retaining Walls* are constructed of cast-in-place reinforced concrete that is connected to a footing. Cantilever concrete walls partially develop their stability from the weight of the backfill over the footing. Cantilever concrete walls are more expensive than MSE walls and as a result, are normally used only when MSE walls are not feasible.

For an all fill wall on existing ground, the existing ground line and bottom of wall are the same. A permanent underground easement or right of way is required for the reinforcement length or footing width behind the wall. Fill walls can be used in cuts but require either temporary shoring or a temporary slope to construct and may also require additional construction easements.

Cut Walls

The most common types of cantilever cut walls are *Sheet Pile Retaining Walls, Soldier Pile Retaining Walls,* and *Pile Panel Retaining Walls*.

Sheet Pile Retaining Walls consist of interlocking sheet piles driven or vibrated into the ground. Sheet pile walls are common for temporary shoring. *Soldier Pile Retaining Walls* consist of steel H-piles driven or placed in drilled holes and partially filled with concrete with either precast panels set in pile flanges or a cast-in-place reinforced concrete face connected to the front of the piles. A *Pile Panel Retaining Wall* is a type of soldier pile wall with H-piles in drilled holes and concrete panels.

The depth of the piles below the bottom of the wall is called the embedment depth. The embedment depth for cantilever cut walls is typically about twice the wall height. For soldier pile walls, timber lagging is typically used for temporary support of the excavation during construction.

Cantilever cut walls can be constructed very close to the right of way since no part of the wall extends behind or in front of the wall. These walls are also commonly used in fill situations and usually do not exceed 13 feet in height.

The most common types of non-cantilever cut walls are (1) *Soil Nail Retaining Walls* and (2) *Anchored Retaining Walls*.

(1) *Soil Nail Retaining Walls* can only be used in cut situations (no fill) and develop stability from passive elements (non-tensioned) that resist applied earth pressure on the wall. Soil nails consist of steel bars grouted in drilled holes inclined at an angle below the horizontal. A soil nail wall consists of soil nails spaced at a regular pattern and connected to a cast-in-place reinforced concrete face with nail heads embedded in the concrete. Shotcrete is used for temporary support of the excavation during construction.

(2) *Anchored Retaining Walls*, also called “tieback walls”, develop stability from tensioned anchors that resist applied earth pressure on the wall. Anchors consist of steel bars or strands in drilled holes inclined at an angle below the horizontal that are grouted and connected to steel piles. The piles are driven or placed in drilled holes filled with concrete below the bottom of the wall. The face is usually cast-in-place

reinforced concrete connected to the piles and timber lagging is typically used for temporary support of the excavation during construction. Anchored walls can be used in partial cut and fill situations, but the anchors do not develop capacity in the unbonded length through the backfill.

For an all cut wall, the grade elevation is either at or above the existing ground line. A permanent underground easement or right-of-way is required for the nails and anchors behind the wall.

Figure 3 illustrates a typical retaining wall section. Key components have been labeled and definitions are provided.

Typical sections of the different types of retaining walls can be found as standard cells on the Geotechnical Engineering Unit's website at:

https://connect.ncdot.gov/resources/Geological/Pages/Geotech_Forms_Details.aspx

TYPES OF RETAINING WALLS (CONTINUED) 6-7A

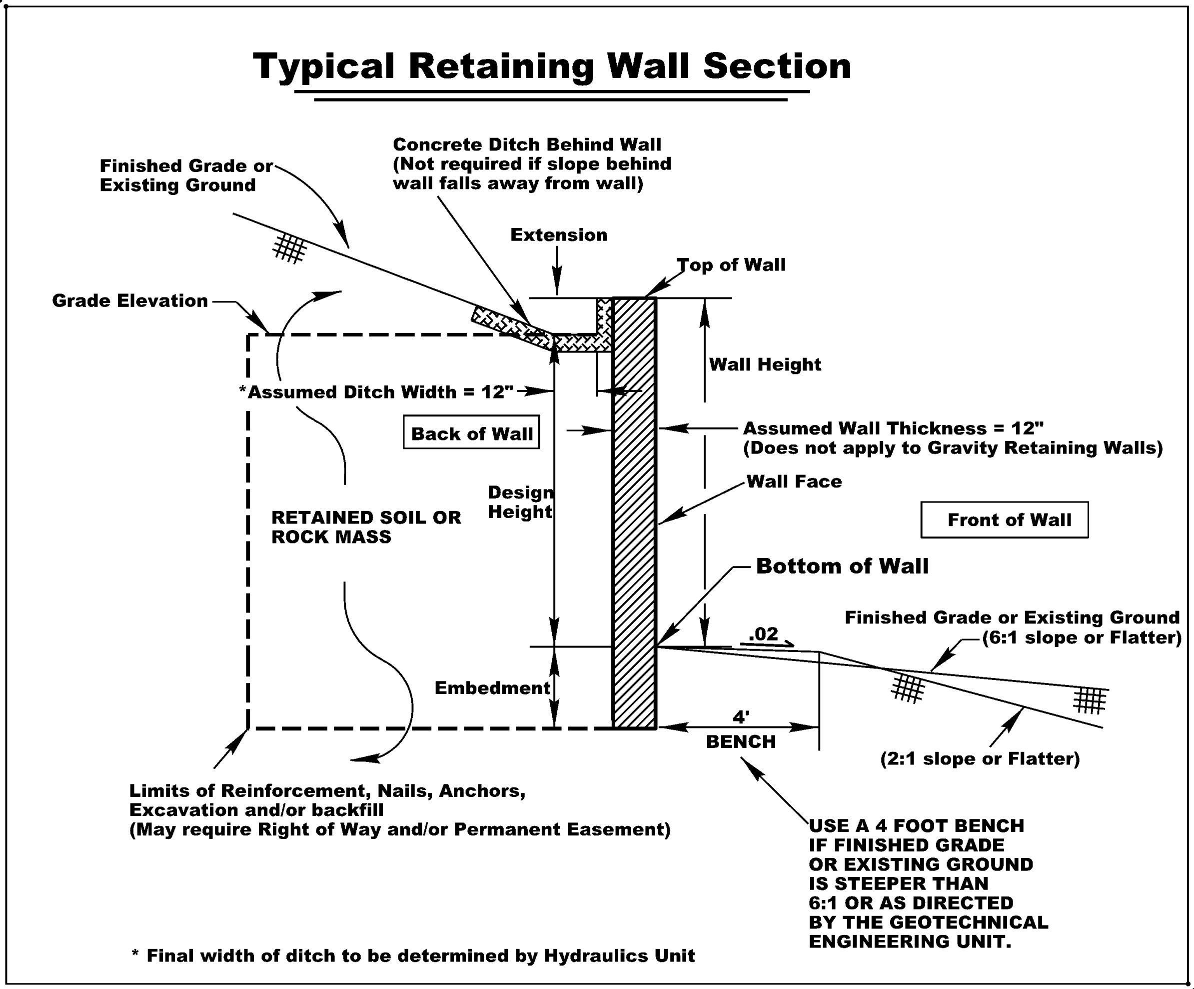


Figure 3

- **Bottom of Wall -** Where finished grade (typically cut walls) or existing ground (typically fill walls) intersects front of wall
- **Design Height -** Difference between grade elevation and bottom of wall
- **Embedment -** Difference between bottom of wall and bottom of footing, cast-in-place face or precast panels
- **Extension -** Difference between top of wall and grade elevation
- **Grade Elevation** - Elevation where finished grade (typically fill walls) or existing ground (typically cut walls) intersects back of wall
- **Top of Wall** - Top of cast-in-place face or coping (or bottom of cap if abutment wall is part of end bent or embedded in cap)
- **Wall Face** - Exposed face of front of wall
- **Wall Height** - Difference between top and bottom of wall (i.e., exposed height)

REQUEST FOR RETAINING WALL DESIGN **6-7B**

In order to initiate the retaining wall design process, the Roadway Project Engineer must prepare a request for retaining wall design. A “Request for Retaining Wall Design” form letter can be downloaded by accessing the roadway form letters. The request for retaining wall design should be submitted to the Geotechnical Engineering Unit at the To Hydraulics (25% plan) stage. The request should be submitted no later than 6 months prior to the Combined or Final Design Field Inspection to ensure that a preliminary wall design can be prepared and any design/construction issues can be discussed at the field inspection. The following information needs to be provided with the request for retaining wall design:

(1) Plan Sheet(s), Profile Sheet(s), and Cross Sections in the location of the proposed retaining wall(s)
(2) Wall plan view(s) with offset centerline(s) and distances and curve data (if applicable)
(3) Preliminary wall envelope(s)
(4) Any other factors that need to be taken into account in the design of the wall(s) (i.e., drainage, utilities, lighting, fence, guardrail, barrier, etc.)

Preliminary Wall Envelope

A wall envelope is a profile view of the exposed wall face area. A wall envelope can be defined as a scaled plot of the grade elevations and bottom of wall elevations, the existing ground elevations (if it intersects the wall) and temporary grade elevations (if applicable) on some frequent station interval along the wall. The bottom of wall elevations should reflect a 4 foot wide bench if the finished grade or existing ground in front of the wall is steeper than 6:1 or as directed by the Geotechnical Engineering Unit as shown in Figure 3. The grade and bottom of wall elevations should be shown both graphically and numerically. The existing ground line should always be depicted on the envelope, even if it differs from the grade or bottom of wall. Retaining walls should be referenced using centerline stations of offset alignments. However, separate wall alignments may be created for walls that change offset alignments such as walls around corners of intersections or walls without offset alignments such as abutment walls along streams. Please note that for some walls, the stations may be shown on the wall envelope in descending order, since the wall envelope depicts the wall face (the side of the wall that is exposed).

The grade and bottom of wall should be depicted and labeled at 50 foot station intervals (i.e., Sta. 10+00, 10+50, etc.) along the offset centerline from the beginning to the end of each wall. Where the grade lines are highly variable, the Geotechnical Engineering Unit may request that the elevations be labeled more frequently. Area calculations of the wall face should be included with the wall envelope.

REQUEST FOR RETAINING WALL DESIGN (CONTINUED) 6-7B

The following information should be labeled on the preliminary wall envelope:

- Station and offset distance at the beginning of wall, end of wall, and where the wall alignment changes (if applicable)

- The Grade and Bottom of Wall Elevation at 50 foot station intervals (i.e., 10+00, 10+50, etc.)

Figure 4 shows an example wall envelope for reference. The wall envelope also needs to show where the grade elevation intersects the bottom of wall (where the grade and bottom of wall elevations are equal, i.e. where the wall height is null). This will typically occur at the beginning and end of each wall. Station, offset, grade elevation, and bottom of wall elevation will also need to be shown at each point where the wall alignment changes (i.e., at each point where the wall alignment bends). Plus or minus station references (Sta. 10+12 +/-, etc.) can be used to label the estimated beginning and ending of each wall. The contractor that will construct the wall is required to survey the existing ground elevations shown on the wall profile view and submit a revised wall envelope to the Geotechnical Engineering Unit for review and approval prior to designing and constructing each wall.

Typically, wall envelopes are plotted with a vertical exaggeration so walls appear distorted. Also, walls that do not have a constant offset related to the centerline alignment and walls that are located in curves will not be depicted accurately on the wall envelope. For these cases, a note stating that "THE WALL ENVELOPE DOES NOT ACCURATELY DEPICT THE ACTUAL FACE OF THE WALL." should be added to the wall envelope. These wall face area calculations may need to be computed by hand, since the wall envelope will show a distorted view of the wall face.

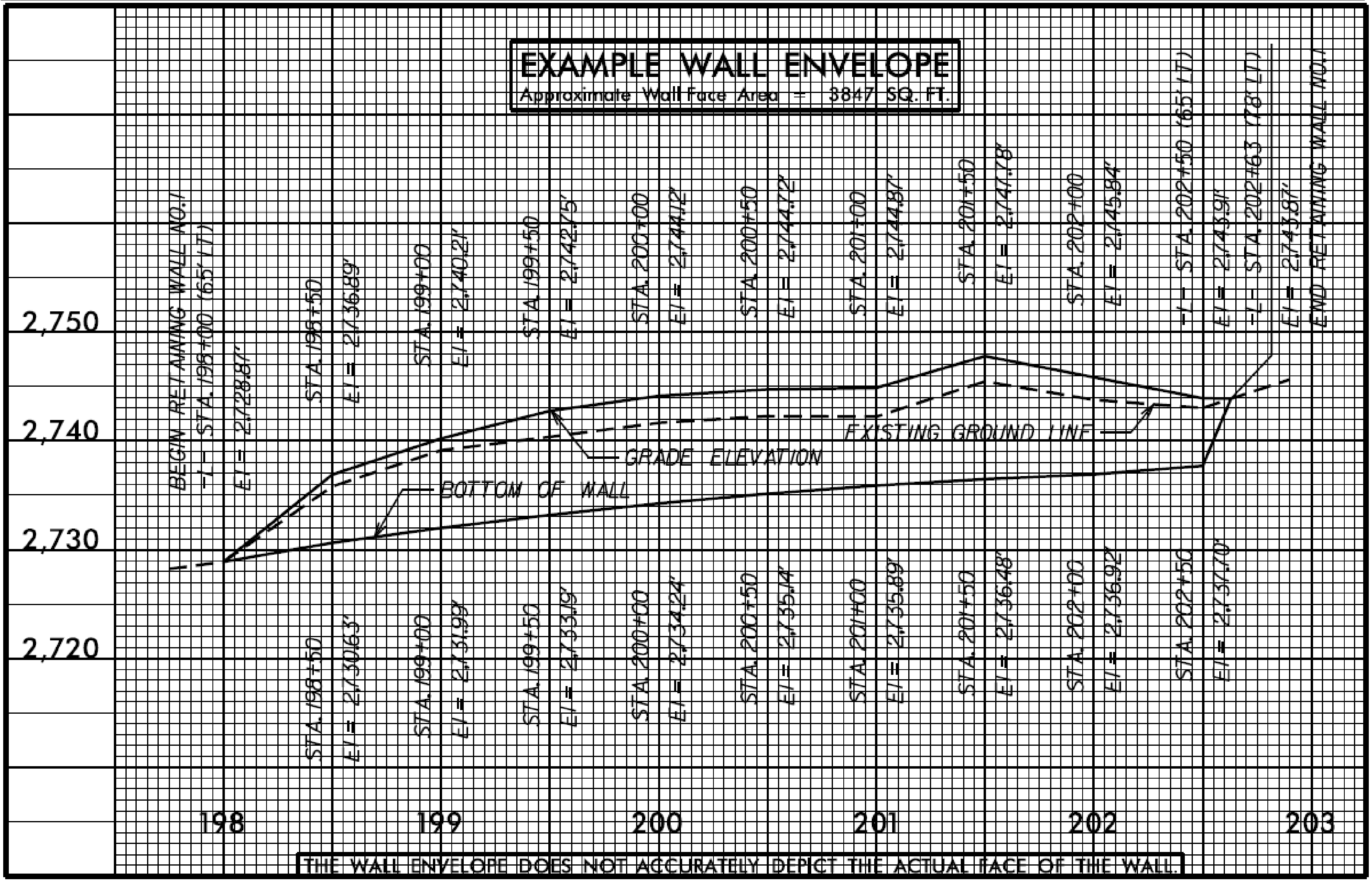

EXAMPLE WALL ENVELOPE
Approximate Wall Face Area = 3847 SQ. FT.
2,750
2,740
2,730
2,720
BEGIN RETAINING WALL NO.1
-L- STA. 198+00 (65' LT)
El = 2,728.87'
STA. 198+50
El = 2,736.89'
STA. 199+00
El = 2,740.21'
STA. 199+50
El = 2,742.75'
STA. 200+00
El = 2,744.12'
STA. 200+50
El = 2,744.72'
STA. 201+00
El = 2,744.87'
STA. 201+50
El = 2,747.78'
STA. 202+00
El = 2,745.84'
-L- STA. 202+50 (65' LT)
El = 2,743.91'
-L- STA. 202+63 (78' LT)
El = 2,743.87'
END RETAINING WALL NO.1
GRADE ELEVATION
EXISTING GROUND LINE
BOTTOM OF WALL
STA. 198+50
El = 2,730.63'
STA. 199+00
El = 2,731.99'
STA. 199+50
El = 2,733.19'
STA. 200+00
El = 2,734.24'
STA. 200+50
El = 2,735.14'
STA. 201+00
El = 2,735.89'
STA. 201+50
El = 2,736.48'
STA. 202+00
El = 2,736.92'
STA. 202+50
El = 2,737.70'
198
199
200
201
202
203
THE WALL ENVELOPE DOES NOT ACCURATELY DEPICT THE ACTUAL FACE OF THE WALL.

Figure 4

Final Wall Envelope

A final wall envelope will need to be submitted to the Geotechnical Engineering Unit after the plans have been revised based on recommendations from the various units and comments from the Combined or Final Design Field Inspection. The information shown on the final wall envelope will be the same as that shown on the preliminary wall envelope. The main difference between the preliminary and final wall envelopes would be minor changes to the stations and elevations brought about during the design of the wall. Please note that drainage ditches in the vicinity of the wall may affect the grade elevations on the final wall envelope. Roadway Design should prepare the final wall envelope based on information from the Geotechnical Engineering Unit and when applicable, other units such as Hydraulics, Work Zone Traffic Control, Utilities, etc. The final wall envelope will be shown in the retaining wall plans and should not be shown in the roadway plans. An exception would be if there are no structure plans for the project, then the retaining wall plans will be inserted in the roadway plans as W-series sheets.

If a retaining wall is eliminated during the design of the project, a note should be added to the plans to clarify why the wall numbers are no longer in sequence. The note should be added to the plan sheet that depicts the next wall in the series. For example, if Retaining Wall #2 was eliminated, a note should be added to the plan sheet that contains Retaining Wall #3. The note should state that "RETAINING WALL #? HAS BEEN ELIMINATED." No note is needed if the retaining wall that was eliminated is the only wall on the project or where the wall numbering sequence is not affected.

TEMPORARY SHORING 6-7C

Temporary shoring is typically required to maintain traffic, but in rare cases may be used to protect wetlands, buildings, structures or for the removal of existing structures. Please reference the “Temporary Shoring” memorandum dated January 17, 2007 for additional information regarding unit responsibilities.

If temporary shoring is required for the maintenance of traffic, the Roadway Design Unit will show the temporary shoring on the roadway plans (plan view without stations) and reference the traffic control plans. If the temporary shoring is required at more than one location, the quantity for each location will be shown on the traffic control plans.

If the Roadway Design Unit is requesting the temporary shoring (rare occurrence), the temporary shoring location (stations and offsets), typical section(s) and notes will be shown in the roadway plans. If the temporary shoring is required at more than one location, the quantity for each location will be shown on the roadway plans.

If temporary shoring is required, the Geotechnical Engineering Unit may provide standard shoring details for insertion into the final plans. The number of detail sheets will be dependent on the notes referenced in the Temporary Shoring Recommendations from the Geotechnical Engineering Unit. The standard shoring details should be placed in the roadway plans as 2-series sheet(s).

GUIDELINES FOR USE OF PRESTRESSED
CORED SLAB BRIDGE SPANS 6-8

Pre-stressed cored slab span bridges provide an excellent and economical structure under the right conditions, but they are not the most feasible structure for many sites.
The following guidelines should be used in determining the conditions where pre-stressed concrete cored slab spans should be considered for use in a bridge.

GUIDELINES FOR USE OF PRESTRESSED
CORED SLAB BRIDGE SPANS (continued) 6-8

Cored Slab Bridges Guidelines

These guidelines are general in nature. The Hydraulics Unit and Structure Management Unit should be contacted before making final determination, as in some situations; pre-stressed girders are more economical. This is particularly true for stream-crossing structures.

Grade:	Less Than 3%	For 90° skew
	0%	For other than 90° skew
Alignment:	Tangent Only	
Skew:	60° thru 120°	
Loading:	HS-20	

Spans	Cored Slab Unit	Superstructure Depth
34′ to 42′	36″ x 18″	20″ *
41′ to 49′	36″ x 21″	23″ *

*Depths shown are from top of wearing surface to bottom of the unit at the gutter line. The pavement depths across the bridge width will vary due to the pavement cross slope.

There are occasions when use of cored slabs may prove feasible even when the listed limiting conditions are exceeded.

Close coordination will be required between the Roadway Design Unit, Structure Management Unit, and the Hydraulics Unit when evaluating the use of cored slabs.

The structure recommendation, on a cored slab bridge, will show the minimum clear distance as required by The Bridge Policy.

CLEARANCES UNDER STRUCTURES 6-9

Bridge widths and lateral clearances under structures shall be based upon the traffic volumes, recommendations received from the Project Development and Environmental Analysis Branch, and criteria contained in The Bridge Policy. Any provisions for future widening other than those contained in the Environmental Planning Document shall require approval by the State Design Engineer.

GUIDELINES FOR THE INTERFACE OF ROADWAY
PLANS AND STRUCTURE PLANS BENEATH BRIDGES 6-10

A. End Bent Fill Area Beneath Bridges:

The Roadway Design Project Engineer and the Structure Management Project Engineer must coordinate with each other to determine the proper treatment underneath the structure. Following are the six basic situations that are encountered in design of the end bent fill area beneath bridges:

1) Bridge Pier with Concrete Barrier
2) Guardrail with Bridge Pier Eliminated
3) Earth Slope with Bridge Pier Eliminated
4) Curb and Gutter Approach
5) Existing Shoulder and Ditch Under Bridge (without provision for future pavement widening)
6) Existing Shoulder and Ditch Under Bridge (with provision for future pavement widening)

1. Bridge Pier With Concrete Barrier or Guardrail:

The Structure Management Unit will determine whether the outside bridges pier will be used or eliminated. If the pier is used, a concrete barrier will be used when the face of the bridge pier is 20′ or less from the edge of travel lane. The face of the barrier will be variable, usually from 6′ to 18′ from the edge of the travel lane. The end bent slope break point will be 1′-6″ behind the face of the barrier. Structure Design will locate the pier a minimum of 1′-11″ behind the face of the barrier. The resulting 6″ space between the back of the barrier and face of pier will allow room for the 4″ slope protection and the toe wall. This space will allow water to drain from the slope protection paving behind the concrete barrier. The shoulder will be paved from the edge of travel lane to the concrete barrier.

Guardrail will be used in lieu of a concrete barrier if the face of pier is greater than 16′ from the edge of the main travel lane but within the clear recovery area. The end bent slope break point is in the same position as the concrete barrier. The end bent slope paving and the toe wall will be the same, except for absence of the concrete barrier. Shoulder paving will extend from the edge of travel lane to the slope protection paving.

2. Guardrail With Bridge Pier Eliminated:

If Structure Management determines there will be no bridge pier and the approach roadway is in a fill, then Roadway Design must determine if a false cut on the roadway approach will be used. On interstates, freeways, and expressways, a false cut is recommended on the approach. On locals and collectors, a false cut is recommended only if suitable waste material is available. The Roadway Design Project Engineer must coordinate this decision with the Structure Management Project Engineer. (If a false cut is used, see No. 3.) If there is no false cut, the end bent slope break point is in the same position as with the concrete barrier (see No. 1). The end bent slope paving and the toe wall will be the same as with No. 1, except for absence of the bridge pier and barrier. Shoulder paving will extend from the edge of travel lane to the slope protection paving.

3. Earth Slope With Bridge Pier Eliminated:

This will be used when there is no outside bridge pier and a natural or false cut can be graded. The Roadway Design Project Engineer must coordinate this information with the Structure Management Project Engineer. With a natural or false cut the projected end bent slope break point is in the same position as with the concrete barrier (see No. 1). The end bent fill slope will be rounded with a 6′ vertical curve. The 6″ slope protection is a Roadway pay item and extends 4′-6″ to either side of the projected end bent slope break point. The end bent area beyond the 4′-6″ distance is 4″ slope protection and is a Structure pay item. The shoulder area between the edge of the travel lane and the beginning of the 6″ slope protection will be paved.

4. Curb and Gutter Under Bridge:

When a curb and gutter section is carried beneath a bridge, the end bent slope break point will vary 6′ to 12′ from the edge of travel lane. If outside bridge piers are used, the face of pier will be a minimum of 5″ behind the end bent slope break point.

5. Existing Shoulder and Ditch Under Bridge
(Without provision for future pavement widening):

This method is to be used in cases where a bridge is built over an existing road with no changes proposed in the pavement, shoulder, or ditch of the road beneath the bridge, and no provisions are being made for the bridge to accommodate future widening of the existing road beneath. The end bent slope break point will be variable 7′-6″ to 13′-6″ from the edge of travel lane in accordance with the Bridge Policy (see 6-1 in this Chapter). The end bent fill toe is located by projecting a shoulder slope from the edge of existing pavement. If an outside pier is used, it will be located a minimum 5″ behind the toe of end bent fill. If the pier in this location is at least 2′-0″ behind the existing ditch, the ditch should drain satisfactorily. If the pier in this location is less than 2′-0″ behind the existing ditch and would interfere with flow of water in the ditch, the designer should consider doing one of the following:

1. Slightly grade the shoulder and ditch section to allow drainage to flow past the pier.
2. Eliminate the existing ditch, grade to the shoulder section and install concrete barrier or guardrail and a drainage system for the bridge end bent area.
3. Coordinate with Structure Design on greater pier offset, if cost effective.

6. Existing Shoulder and Ditch Under Bridge
A. With provision for future pavement widening:

This method is to be used in cases where a bridge is built over an existing road with minor pavement widening and/or shoulder and ditch grading proposed initially, and provisions are to be made for additional pavement widening in the future.

All bridge widths and clearances shall be based upon the traffic volumes, design speed and bridge recommendations received from the Project Development and Environmental Analysis Branch. Any provisions for future widening other than those noted in the Environmental Planning Document shall require approval of the State Design Engineer. The end bent slope break point will be variable 7′-6″ to 13′-6″ from the edge of future travel lane in accordance with the Bridge Policy (see 6-1 of this Chapter).

The end bent slope break point is located by projecting a "future" shoulder slope from the edge of existing or proposed pavement. If an outside pier is used, it will be located a minimum 5″ behind the toe of end bent fill. If the pier in this location is at least 2′-0″ behind the existing or proposed ditch, the ditch should drain satisfactorily.

If the pier in this location is less than 2′-0″ behind the existing or proposed ditch and would interfere with flow of water in the ditch, the designer should consider doing one of the following:

1. Slightly regrade the proposed shoulder and ditch section to allow drainage to flow past the pier.
2. Eliminate the ditch, grade to the "future" shoulder section and install a drainage system for the bridge end bent area.
3. Coordinate with Structure Design on greater pier offset, if cost effective.

B. Slope of Roadway Shoulder in the End Bent Area:

The shoulder slope rates and rollover to be used directly under bridges are illustrated on 6-10, Figure 1. This Figure is to be used as a guide in cases where the roadway through a bridge is superelevated. Shoulder slope treatment is shown for both the high-side and low-side for superelevation rates of .00 to .10. The left chart on Figure 1 will be applied in cases of (1) no paved shoulder, (2) 4′ paved shoulder, and (3) 10′ paved shoulder. The right chart on Figure 1 applies to 2′ paved shoulders.

This shoulder treatment under bridges agrees with Roadway Standard Drawings, Std. No’s. 560.01 and 560.02 (Standard Method of Shoulder Construction - High Side of Superelevated Curve) with the following exception: The 6′-0″ vertical curve will not be used on the high side of superelevation directly opposite the bridge end bent fill. The shoulder slope is constant between the edge of pavement/paved shoulder and the end bent fill slope protection paving. A 100′ transition in shoulder slope will be required approaching and leaving the bridge area in cases where the typical roadway shoulder has the vertical curve on the high side of superelevation.

C. Paved Shoulder Transitions Through Bridges:
Guidelines for paved shoulder widths and transitions under bridges are as follows:

1. Roadway Standard Drawings, Std. No. 610.01 shows paved shoulders treatment for the situation where there is an outside pier and concrete barrier. In this case, full width shoulder shall be paved from edge of travel lane to concrete barrier. Full width paved shoulder will taper to typical paved shoulder section as shown in the plan view. In situations where the concrete barrier section will extend beyond the end of slope protection paving, begin the paved shoulder taper at the end of concrete barrier. The elevation view shows construction details for expansion joint material between slope protection paving, pier, and concrete barrier.

2. Roadway Standard Drawings, Std. No. 610.02 shows paved shoulder treatment for the situation where there is no outside pier, and guardrail is used at the base of end bent fill slope. In this case, full width shoulder shall be paved from edge of travel lane to the base of end bent fill slope. Full width paved shoulder will taper to typical paved shoulder section, as shown in the plan view.

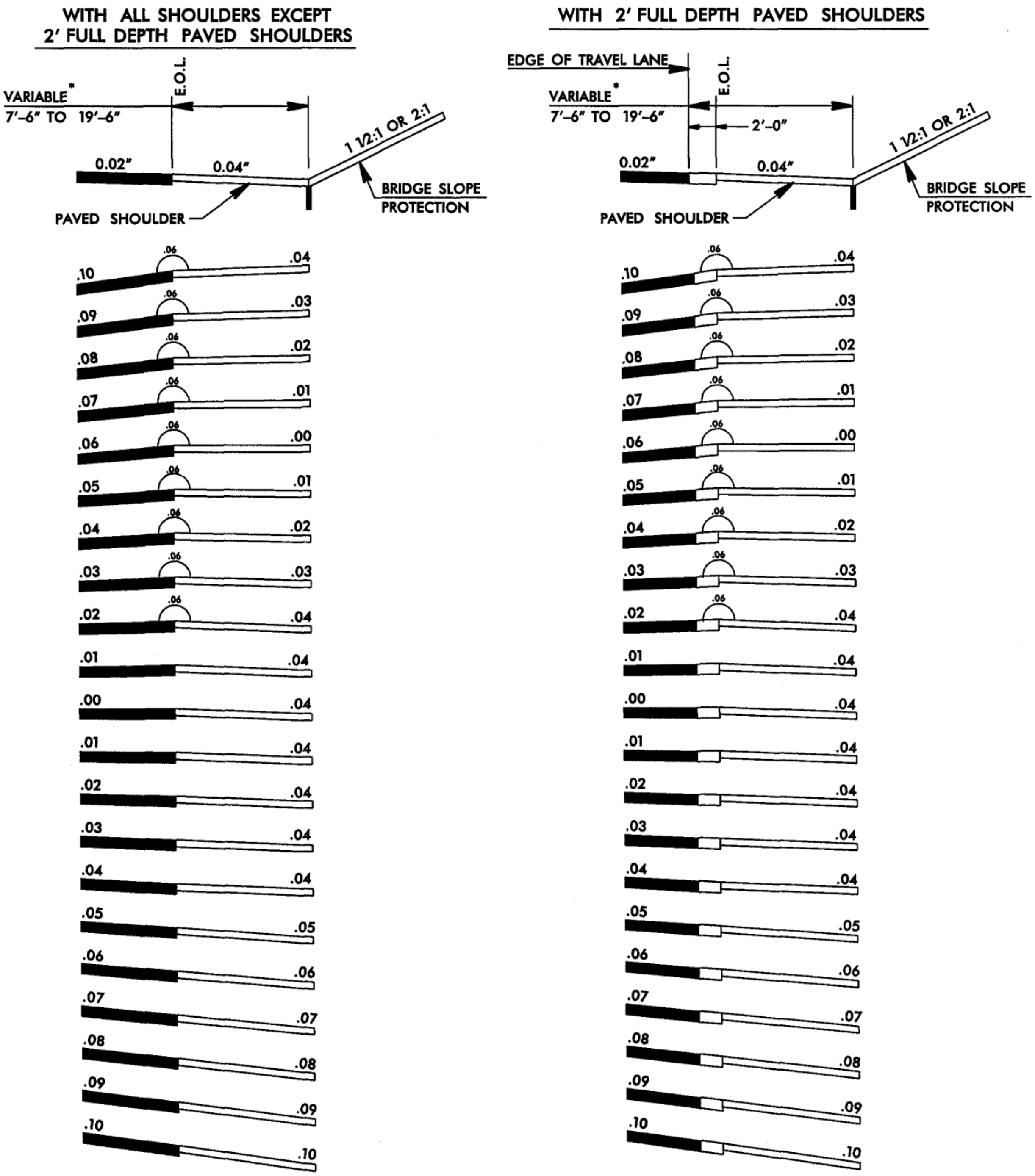
3. Roadway Standard Drawings, Std. No. 610.03, shows paved shoulder treatment for the situation where there is no outside pier, and a natural cut or earth slope false cut is graded to protect the end bent fill area. In this case, full width shoulder shall be paved from edge of travel lane to the toe of 6″ concrete slope protection paving. Full width paved shoulder will taper to typical paved shoulder section, as shown in the plan view. The elevation view shows placement of 6″ concrete slope protection paving (Roadway item) and 4″ concrete slope protection paving (Bridge item). Vertical curve offset charts are included for 1 1/2:1 and 2:1 end bent fill slopes.

D. Slope Protection Paving Under Bridges:
See 6-6D of this Chapter.

E. Guardrail Treatment Under Bridges
See Chapter 3 of this Manual.

FIGURE 1 **6 – 10**
F – 1

STANDARD METHOD OF SHOULDER CONSTRUCTION UNDER BRIDGES



NOTES:
1. ROLL-OVER ALGEBRAIC DIFFERENCE IN RATE OF CROSS SLOPE NOT TO EXCEED 0.06 AS SHOWN.
2. TRANSITION FROM ABOVE SLOPE UNDER BRIDGE TO ROADWAY TYPICAL SECTION IN 100' FROM EDGE OF BRIDGE SLOPE PROTECTION.

* SEE BRIDGE PLANS

GUIDELINES FOR TRANSITION ZONE APPROACHING
THE END BENT FILL AREA BENEATH BRIDGES 6-11

A. Interstates, Freeways, Expressways, and Interchanges:

If the approach roadway is in a natural cut, use Roadway Standard Drawings, Std. No. 225.09 for the transition from the normal shoulder and ditch section to the bridge end bent area. If the roadway is in a fill and a false cut is provided, use Roadway Standard Drawings, Std. No. 225.07 for this transition. With outside bridge piers, a false cut is recommended only on projects where suitable waste material is available. If the outside pier is eliminated, a false cut is recommended in most all cases. The transition beyond the bridge should range from 100′ to 300′ depending on field conditions. If the approach roadway is in a fill and no false cut is provided, use Roadway Standard Drawing, Std. No. 225.09 for both approach and trailing sides.

B. Locals and Collectors:

Use Roadway Standard Drawings, Std. No. 225.09 for both cut and fill approaches. False cuts on the approach roadway are usually not recommended. The same transition length can be made immediately beyond the bridge.

A. Bridge Deck Drainage:

See 6-6B in this Chapter.

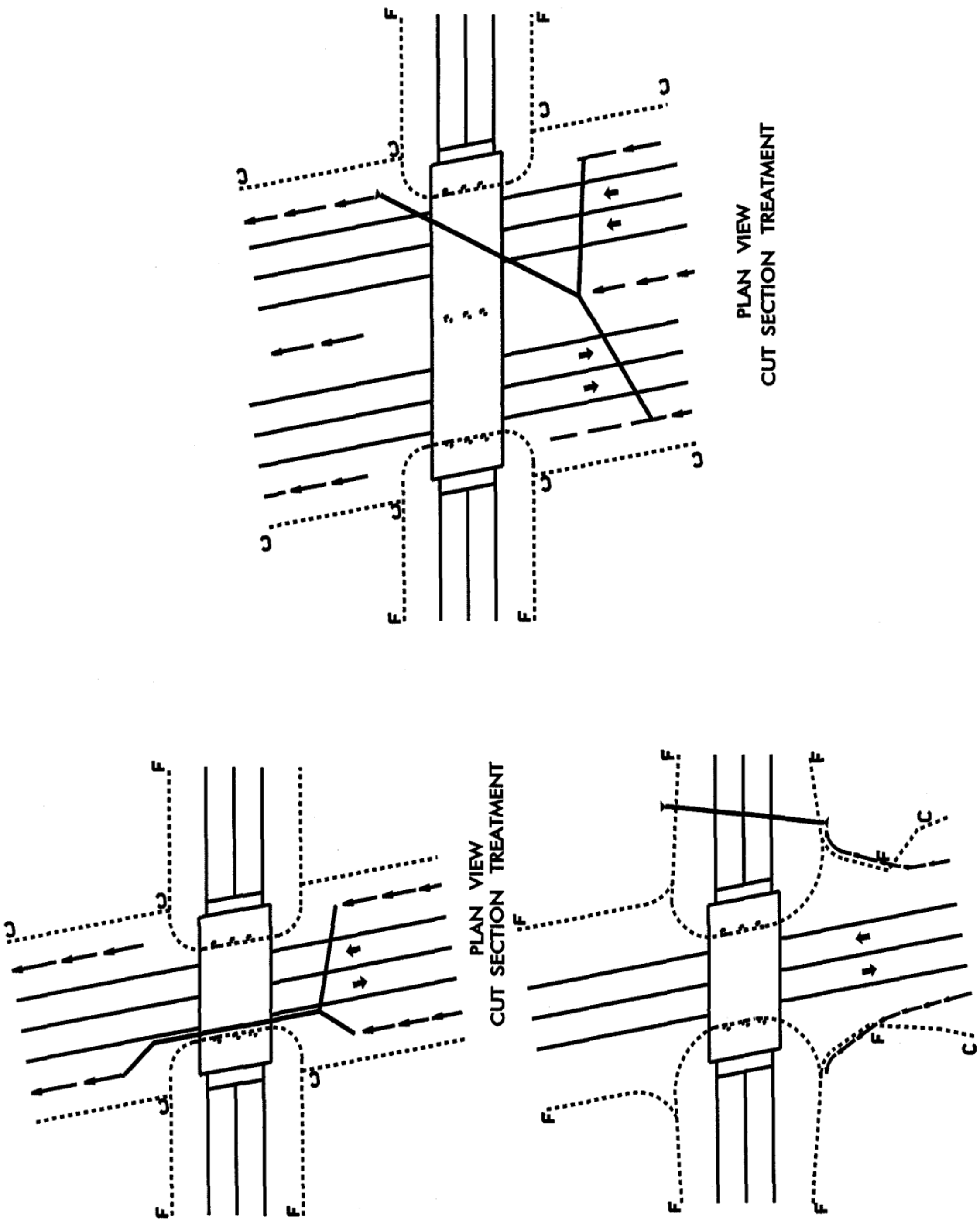
B. Draining the Shoulder and Ditch Transition Areas Beneath Bridges:

Drainage flow patterns in bridge areas will be determined by numerous factors including grades, method of grading (cut or fill), single or dual lane roadway, method of end bent fill area treatment, etc. Each bridge should be analyzed individually and the drainage system designed to fit the situation. Roadway Design and the Hydraulics Units should coordinate the design to assure proper drainage.

C. Drainage of End Bent Fill Slope:

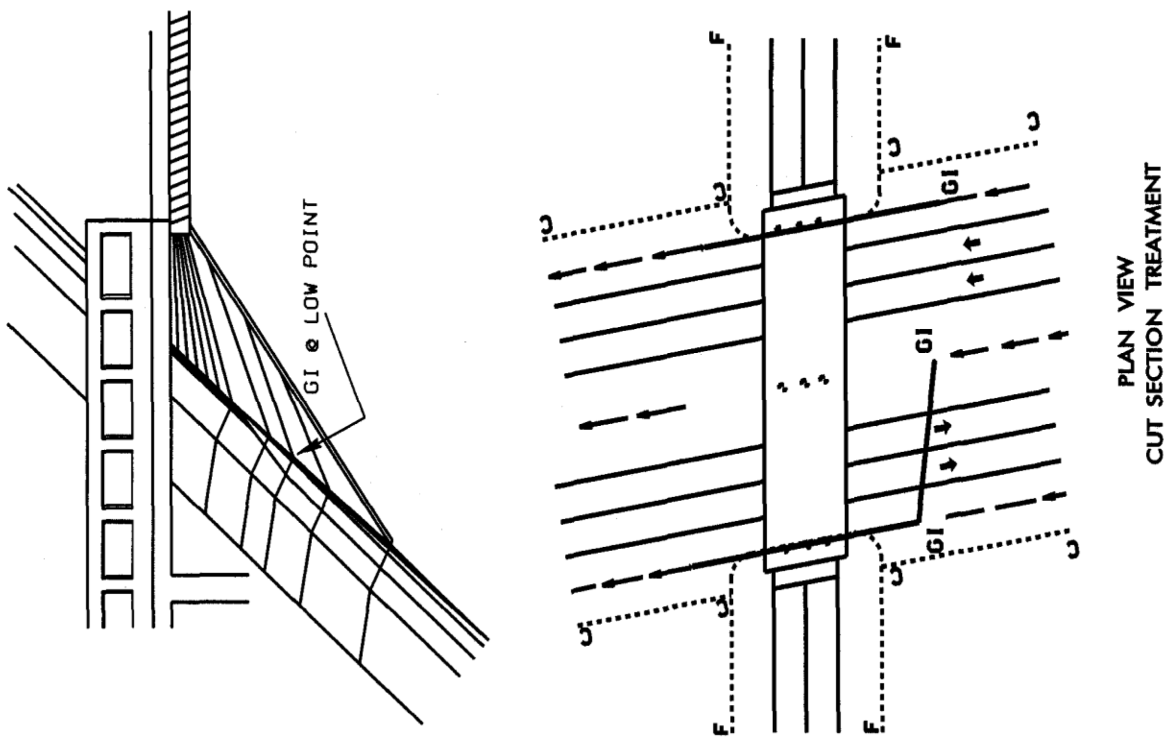
Consideration must be given to handling rainwater runoff from end bent slope protection paving in cases where the concrete barrier will be used at the toe (See Std. Drawing 610.01). Normally, there should be only a small amount of water in this area, except with some combinations of divided roadway sections and large bridge skew angles. The face of bridge pier is to be no closer than 6″ from the back of concrete barrier to allow this water to flow from behind the barrier. In some cases, special shoulder paving may be required to prevent erosion at the point where concentrated water runs from behind the concrete barrier onto the shoulder.

FIGURE 1 **6 – 12 / F – 1**



GUIDE FOR DRAINING BRIDGE SEPARATIONS

FIGURE 2



GUIDE FOR DRAINING BRIDGE SEPARATIONS

Reasonable and prudent effort should be made to develop alignment that will avoid horizontal curvature on bridges. Bridges that do occur on horizontal curves should be widened, as required by pavement widening criteria, and the bridge rail should be offset an additional distance as necessary to provide adequate stopping sight distance. These offset distances are a function of the design speed and radius of curve and are derived from A Policy on Geometric Designs of Highways and Streets (2011), Table 3-26b and Figure 3-22b. In specific examples on some local and collector system roads with sharp curvature, the extra bridge rail offset for horizontal stopping sight distance can be very large when compared with normal (tangent) offset specified by the Bridge Policy. To avoid excessive bridge cost, engineering judgement should be used in determining the bridge width on some low volume roads where existing conditions elsewhere on the road do not seem to warrant the expense of an extra wide bridge rail offset.

The existing horizontal and vertical alignment on the approaching roadway should control the design speed of the structure. In many cases, a lower design speed, commensurate with the adjacent roadway, will reduce the need for structure widening.

Included below is a procedure entitled, "Method for Determining Bridge Widths on Curves", which in some cases will allow stopping sight distance to be based upon a reduced speed. This procedure requires discussion of additional widening with the State Roadway Design Engineer when structure recommendations are submitted and should result in uniform application of widening criteria within the Unit, in cases where judgment is a primary factor in determining bridge rail offsets.

It is emphasized that design speed and widening requirements in these cases must be discussed with the State Roadway Design Engineer for concurrence that this procedure can be used to derive the bridge width. This is simply a procedure to allow uniform evaluation of horizontal sight distance requirements for bridges that are "spot" improvements on existing roads.

A. Method for Determining Bridge Width on Curves:

Bridges should be widened as required by horizontal curves and bridge rail should be offset for adequate stopping sight distance.

B. Curve Widening:

The travel lane width on bridges and the approach travel lane widths should be widened as required by the pavement widening chart shown in A Policy on Geometric Design of Highways and Streets (2011), Table 3-28B.

C. Bridge Rail Offset:

The bridge rail should be offset to provide for adequate stopping sight distance. The required sight distance should be determined as listed below and the bridge rail offset increased if required:

1. Interstate and Arterial System:

Use bridge rail offset that will provide the stopping sight distance required by the design speed of the project.

2. Local and Collector System:

Use bridge rail offset that will provide the stopping sight distance required by the design speed of the project as indicated in Chapter 1-1B of this manual.

NOTES:

1. See 6-13, Figures 1, 2 and 3 for the procedure to be used in determining bridge width on curves.

2. The design speed and additional widening required should be discussed with the Assistant State Roadway Design Engineer when structure recommendations are submitted.

3. On Interstates, Freeways, and Arterials, the desirable sight distance should be used whenever possible.

4. Maximum bridge rail offset should not exceed 12′.

5. Design speeds below the speed recommended in the environmental planning document, or rail offsets that do not meet the design speed stopping sight distance, will require an approved design exception.

PROCEDURE FOR DETERMINING BRIDGE WIDTH ON CURVES FOR INTERSTATES AND ARTERIALS

PROJECT NO.:___________ TIP:____________ COUNTY:__________

LOCATION:______________ R = _____________ Dc = _____________

Design Year ADT = _________ DHV = _____________

Width of Pavement (Tangent). . . . .= _________

Pavement Curve Widening required
*** (Table 3-26b) . . . .= _________**

Proposed Pavement Width. . . . .= _________

Width from Bridge Policy plus (+) pavement
curve widening . . . .= __________________

Offset to Bridge Railing to Provide Min. Stopping Sight Distance:

Design Speed = ________ mph
Design stop.sight dist. = _______ (design speed * Figure 3-22b)
Min.stop.sight dist. = _________ (design speed * Figure 3-22b)

Design Lateral distance required = ________ (* Figure 3-22b)
Min. Lateral distance required = ________ (*Figure 3-22b)

Lateral distance = _____	**Lateral distance =______**
(min. stop. sight dist.)	**(des. stop. sight dist.)**
Minus 1/2 lane width = _____	**Minus 1/2 lane width = ______**
Offset from e.p. to	**Offset from e.p. to**
bridge rail = _____	**bridge rail =______**

Prop.Bridge Width (min. stop. sight dist.) = ___________________

Prop.Bridge Width (des. stop. sight dist.) = ___________________

Note: Discuss results with Assist. State Roadway Design Engineer if additional bridge width is required.

Computed by: ______________________________ Date: __________

Checked by: ________________________________ Date: __________

Approved by: ______________________________ Date: _________
Assist.State Rdwy. Des. Eng.

- **Exhibits are located in A Policy on Geometric Design of Highways and Streets (2011).**

PROCEDURE FOR DETERMINING BRIDGE WIDTH ON CURVES FOR COLLECTOR ROADS

PROJECT NO.:___________ TIP:____________ COUNTY:__________

LOCATION:______________ R = _____________ Dc = _____________

Design Year ADT = _________ DHV = _____________

Width of Pavement (Tangent). . . . .= _________

Pavement Curve Widening required
(* Exhibit 3-51) . . . .= _________

Proposed Pavement Width. . . . .= _________

Width from Bridge Policy plus (+) pavement
curve widening . . . .= __________________

Offset to Bridge Railing to Provide Min. Stopping Sight Distance:

Design Speed = ________mph (From Planning Report)
Min. design speed = ________ mph (Collector Road Chapter 1-1B)

Design speed stop. sight dist. = ________ (*Figure 3-22b)
Min. design speed stop. sight dist. = ________ (*Figure 3-22b)

Lateral dist. req'd. = ____(design speed, * Figure 3-22b)
Lateral dist.req'd.=____(min. design speed, * Figure 3-22b)
Lateral distance = _____ Lateral distance =______
(min. des. speed) (design speed)
Minus 1/2 lane width = _____ Minus 1/2 lane width =______
Offset from e.p. to Offset from e.p. to
bridge rail = _____ bridge rail =______

Prop. Bridge Width (min. des. speed) =__________________________
____
Prop. Bridge Width (design speed) =_____________________________
____
____
Note: Discuss results with Assist. State Roadway Design Engineer
if additional bridge width is required.
Computed by: ______________________________ Date: __________

Checked by: _______________________________ Date: __________

Approved by: ______________________________ Date: __________
Assist. State Rdwy. Des. Eng.

*** Exhibits are located in A Policy on Geometric Design of Highways and Streets (2011).**

PROCEDURE FOR DETERMINING BRIDGE WIDTH ON CURVES FOR LOCAL ROADS

PROJECT NO.:___________ TIP:____________ COUNTY:__________

LOCATION:______________ Dc = ___________ R = _____________

Design Year ADT = _________ DHV = _____________

Width of Pavement (Tangent). . . . .= _________

Pavement Curve Widening required
(* Exhibit 3-51) . . . .= _________

Proposed Pavement Width. . . . .= _________

Width from Bridge Policy plus (+) pavement
curve widening . . . .= __________________

Offset to Handrail to Provide Min. Stopping Sight Distance:

Design Speed = ________mph (From Planning Report)
Min. design speed = ________mph (Local Roads Chapter 1-1B)

Design speed stop. sight dist. = ________ (*Figure 3-22b)
Min.design speed stop. sight dist. = ________ (*Figure 3-22b)

Lateral dist. req'd. = ____ (design speed, * Figure 3-22b)
Lateral dist. req'd.=____(min.design speed, * Figure 3-22b)

Lateral distance = _____ Lateral distance =______
(min. des. speed) (design speed)
Minus 1/2 lane width = _____ Minus 1/2 lane width =______
Offset from e.p. to Offset from e.p. to
bridge rail = _____ bridge rail =______

Prop. Bridge Width (min. des. speed) =__________________________
____
Prop. Bridge Width (design speed) =_____________________________
____
____

Note: Discuss results with Assist. State Roadway Design Engineer
if additional bridge width is required.

Computed by: ______________________________ Date: __________

Checked by: _______________________________ Date: __________

Approved by: ______________________________ Date: __________

Assist. State Rdwy. Des. Eng.

*** Exhibits are located in A Policy on Geometric Design of Highways and Streets (2011).**

CHECKLIST FOR COORDINATION OF ROADWAY AND STRUCTURE PLANS 6-14

(1) Checklist:

In order to eliminate discrepancies between the Roadway and Structure Plans on projects, a final check will be performed by an employee from Roadway Design and an employee from Structure Design after final plans have been checked and just before final plans are printed. See 6-14, F-1 for an example of the Checklist for Coordination of Roadway and Structure Plans that the two employees will check, sign and place in the project file.

(2) Slope Transitions:

A note shall be added to the Roadway Typical Sections denoting the beginning and ending stations for the slope transitions at each structure. The note shall include a cross reference to cross-sections and appropriate roadway standards. Example of note is as follows:

See cross-sections and Std. Nos. 225.07, 225.08 and 225.09 or for slope transitions under bridges at the following locations:

Line -L- Sta. 307+00.000 Rt. to Sta. 313+00.000 Rt.
Line -L- Sta. 311+00.000 Lt. to Sta. 317+00.000 Lt.

Whenever side slopes cannot be transitioned to slope under bridge in accordance with the Roadway Standard Drawings; details or cross-sections shall be included in the plans showing the slope transition.

FINAL CHECKLIST FOR COORDINATION OF
ROADWAY AND STRUCTURE PLANS

PROJECT NO. ______________________________ COUNTY _________________
I.D. No. ___________________

__1. Beginning and ending stations shown on Roadway Plans for bridge agree with Structure Plans.

__2. Pay items on Structure Plans agree with the pay items on the Roadway Plans (Example – If rip-rap is required, do not show the rip-rap on Structure Plans and dumped stone on Roadway Plans).

__3. Guardrail attachments on structure and roadway plans are attached at the same points and located on the same corners.

__4. Bridge widths on Roadway Plans (if shown) agree with widths on Structure Plans.

__5. Shoulder to shoulder widths beneath the bridge on a grade separation shown on the Structure Plans agree with widths shown on the typical sections in the Roadway Plans.

__6. Drainage Structures shown on the structure plans agree with Drainage Structures shown on Roadway Plans.

__7. Note shown stating that existing pavement shall be scarified in area of end-bent piles.

__8. Pay Items and Roadway Standard Drawings or details are included in the Roadway Plans for reinforced bridge approach fills or Subregional Tier bridge approach fills.

__9. Vertical and Horizontal Alignment on Roadway Plans agree with that shown on Structure Plans.

Checked By_________________________Date________

Checked By_________________________Date________

DIVISION OF HIGHWAYS
NCDOT
SUB REGIONAL TIER DESIGN GUIDELINES FOR BRIDGE PROJECTS

FEBRUARY 2008

Approved William F Rosser
State Highway Administrator

Approved John F Sullivan
Federal Highway Administration

REV. DATE 03/10/08
REV. N0. 6

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SUB REGIONAL TIER DESIGN GUIDELINES FOR BRIDGE PROJECTS

CONTENTS PAGE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SUB REGIONAL TIER DESIGN GUIDELINES FOR BRIDGE PROJECTS

PURPOSE

The Sub Regional Tier Design Guidelines for Bridge Projects establishes the controlling design elements for new and reconstructed bridges on the North Carolina Highway System designated as minor collectors, local and/or secondary roads. Engineering judgment must be applied during project development, while considering the site-specific conditions, to achieve desirable levels of service and assure safety of the traveling public. Each bridge project shall provide a safe and economical design, while maintaining or improving the operating conditions at the site.

If a bridge project is designed to the standards set forth in these guidelines, no formal design exception approval is required.

If a bridge project is designed to the standards set forth in these guidelines and does not match the current planning document, a memorandum to the project file shall be written to acknowledge that the Sub Regional Tier Guidelines for Bridge Projects was used. No formal design exception approval is required.

Formal design exception approval is required when standards set forth in these guidelines are not met. Project files shall fully justify and document the need for a design exception to the standards. Any anticipated design exception required for a project shall be listed in the environmental document.

BACKGROUND

These guidelines establish broad limits by presenting minimum values for design and allowing engineering judgment to be applied to achieve desirable levels of traffic service and safety appropriate to the social, economical and environmental controls applicable to the specific project. The North Carolina bridge inventory is aging at a rate, which exceeds the current bridge replacement program. In an effort to minimize the amount of approach work and to maximize the limited funds available for the bridge program, representatives from the Bridge Maintenance Unit, Construction, Operations, Planning, and Highway Design Branch Units evaluated the Department’s bridge replacement program and established bridge replacement design criteria that maintains current operating conditions without compromising safety. These guidelines direct planners and designers to minimize changes in the vertical grade, structure length and width, approach roadway limits and right of way for each site.

PROCEDURE

The Project Development and Environmental Analysis Branch (PDEA) will prepare a planning document that includes appropriate consideration of the safety, social, economic and environmental impacts. On-site field reviews and scoping meetings must be held during the planning and design process. At a minimum, representatives from PDEA, Highway Design and the Division should be in attendance at these meetings.

PLANNING

PDEA's Bridge Project Development Unit will coordinate with Highway Design, Division and Traffic Engineering staff to provide, in the environmental document, decisions reached regarding applicable design criteria such as bridge approach travel speed, design speed, bridge width and lane and shoulder widths. These decisions will be based on traffic forecast and crash and severity rates when compared to the statewide average (provided by the Traffic Engineering and Safety Systems Branch) and whether the location is identified by North Carolina's Highway Safety Improvement Program.

The Bridge Project Development Unit will also coordinate with the Division and the Bridge Maintenance Unit on the possibility of removal of redundant bridges and options for rehabilitation instead of replacement where appropriate. Consideration shall be given to the use of accelerated construction techniques.

ROADWAY DESIGN (GEOMETRIC DESIGN CRITERIA)

The following geometric design criteria will be used based on the traffic forecast and whenever the crash and severity rates are below the statewide average (provided by the Traffic Engineering and Safety Systems Branch). Also, the project site shall not be at a location identified by North Carolina's Highway Safety Improvement Program.

Design Speed: The design speed shall be established after considering the topography, anticipated operating speed, the adjacent land use and the functional classification of the highway. The design speed selected for the project shall be identified and recorded in the environmental document. Once the design speed is selected, all of the pertinent highway features should be related to this speed to obtain a balanced design. All references to speed in this document are the design speed unless otherwise noted.

Lane and Shoulder Widths: R-R-R Guide, Table 2, Page 14.

Bridge Width:
20 year Design Volume Less than 4000 vehicle/day
Design speed of 45 mph and under: Bridge Deck Width (Minimum) = 24 feet
Design speed above 45 mph: Bridge Deck Width (Minimum) = 26 feet

20 year Design Volume Over 4000 vehicle/day
For all design speeds: Bridge Deck Width (Minimum) = 28 feet*
(* For current ADT over 3000 vehicle/day: use 30 feet)

In no case shall the bridge width be less than that of the approach roadway width (including paved shoulders).

Horizontal Clearance: Bridge Policy, Page 26. (Horizontal Clearances for Local System)

Vertical Clearance: Bridge Policy, Page 9. (Vertical Clearances)

Horizontal Alignment: An existing horizontal curve may be retained as is without further evaluation if the existing curve design, assuming correct superelevation is provided, corresponds to a speed that is within 10 mph of the design speed.

Vertical Alignment: An existing vertical curve may be retained if the curve's design speed is within 20 mph of the project's design speed and the design volumes are less than 1500 vehicles/day.

An existing vertical curve may be retained if the curve's design speed is within 10 mph of the project's design speed.

Stopping Sight Distance: Minimum stopping sight distance should be provided for the horizontal and vertical curve conditions as stated above (Horizontal and Vertical Alignment). Values are shown in Exhibit 5-2, page 381
. [AASHTO, A Policy on Geometric Design of Highways and Streets (2004)].

Cross Slope: Pavement cross slope should be adequate to provide proper drainage. Normally, cross slopes range from 1.5 to 2 percent for asphalt pavements.

Superelevation: It is desirable to superelevate curves in accordance with AASHTO Guidelines. The curve should be signed and marked for the appropriate speed in accordance with the provisions of the "Manual On Uniform Traffic Control Devices For Streets And Highways" (MUTCD) if minimum superelevation rates can not be achieved.

Grades: The existing roadway grade may be retained. An appropriate minimum grade is typically 0.3%.

Guardrail: Transition guardrails to bridge rails should be provided on all four corners of an undivided two-way, two-lane bridge.

Design speed of 45 mph and under: The minimum length of guardrail required at the bridge approach is 50 feet (including the guardrail anchor units). This design utilizes a Test Level 2 (TL-2) Guardrail Anchor Unit Type 350.

Design speed above 45 mph: The minimum length of guardrail required at the bridge approach is 75 feet (including the guardrail anchor units). This design utilizes a Test Level 3 (TL-3) Guardrail Anchor Unit Type 350.

Engineering judgment must be applied during all stages of project development to achieve desirable levels of traffic service and safety, while considering site-specific conditions. At a minimum, current operating conditions shall be maintained and safety improved at documented and potentially hazardous locations.

For very low-volume local roads the <u>Guidelines for Geometric Design for Very Low-Volume Local Roads (ADT 400 vehicles and less), AASHTO 2001</u> may be used in lieu of the Sub Regional Tier Design Guidelines for Bridges. “A very low-volume local road is a road that is functionally classified as a local road and has a design average daily traffic volume of 400 vehicles per day or less.”

HYDRAULIC DESIGN

<u>FEMA</u>: Identify project site locations that require FEMA Detailed Study or Limited Detail Study and design for compliance.

<u>Non FEMA</u>: Consult with the Division Office to establish Level of Service needs if the existing roadway is overtopped by the 25-year frequency storm or an event with a lower return period.

The minimum return period for design shall maintain the existing level of service.

The maximum return period for design is the 25-year frequency storm.

Where design frequency is less than the 25-year storm, the engineer will assess the property upstream and downstream of the highway rights of way for impacts to private property.

<u>Hydraulics</u>: The recommended structure type shall be considered in the following priority order: a) Pipe Culvert (circular or arch pipe), b) Box Culvert, c) Bottomless Culvert Structure founded in non-scourable rock (concrete or metal), d) Bridge.

<u>Deck Drainage</u>: There shall be no direct discharge of deck runoff into open waters with classification of WS-I or Outstanding Resource Water.

There shall be no direct discharge into open waters within one half (0.5) mile of Critical Area of WSII, WSIII, and WSIV.

There shall be no direct discharge in all other water classifications where storm water runoff gutter spread is not at risk for safety of the traveling public.

Gutter Spread: Avoid spread into travel lane for a 4 inches/hour rainfall intensity. Investigate steeper gutter slope, increase deck cross slope, eliminate super elevation, coordinate rail and deck drain details with Structure Design Engineer, etc. to reduce gutter spread when necessary.

Bridge Scour: The Hydraulics Engineer shall analyze scour for the 100-year or overtopping flood. Cone of influence for total scour to be shown as 1.4H: 1V on the bridge profile drawing.

Debris Assessment: Identify debris transport potential at the site. Where debris transport potential is low, the use of battered piles may be appropriate and should be noted under "Additional Information" on the Bridge Survey Report.

General Comments: Consider span arrangements that accommodate the use of cored slabs or box beams to facilitate top down construction, even if an interior bent is in the water.

GEOTECHNICAL DESIGN

AASHTO Load and Resistance Factor Design (LRFD) Specifications: Use higher resistance factors when subsurface conditions are appropriate. Use Importance Factor, η=0.95, for load factor.

Scour: Design to allow approach fill wash outs rather than constructing abutment walls, with foundations to remain standing. Scour Critical Elevations will be required at these end bents.

Utilize designed scour countermeasures in lieu of more costly foundation solutions.

Reinforced Approach Fills: Use reinforced bridge approach fills in all coastal plain areas. In all other areas, utilize alternate standard detail to ensure backfill material is retained in areas of end bent excavation.

Interior Bents: Use drilled-in piles with a Pile Driving Analyzer (PDA) in lieu of drilled pier foundations.

STRUCTURE DESIGN

AASHTO Load and Resistance Factor Design (LRFD) Specifications: Use Importance Factor, η=0.95, for load factor. Use empirical deck design method for cast in place decks of girder bridges.

Bridge Rail: Utilize Standard Flat Face rail to facilitate deck drain functionality and minimize bridge width. (Show plan details for an epoxy protective coating for exterior cored slab or box beam surfaces adjacent to deck drains.)

Use Standard 1-Bar Metal Rail or approved precast New Jersey shaped barrier rail as appropriate for posted or design speed of 45 mph or less.

For designated bicycle routes or on roadways where the need to accommodate bicycle safety has been identified in the environmental planning document, use of a 42" rail height is acceptable; however, the Standard 2-Bar Metal Rail (54” rail height) shall be utilized for bridges spanning waterways of 100 feet or more in width.

Design Lanes: Use the actual number of travel lanes on the structure for design of superstructure and substructure elements, in lieu of the number of lanes that can be accommodated by the clear roadway.

Approach Slabs: Detail 12 foot long approach slabs, with ends parallel to the skew.

Overlays: Except for low water bridges, show plan details for an asphalt overlay on cored slab and box beam superstructures.

Substructure: Limit cap, column and drilled shaft sizes to those required for load carrying capacity, while maintaining constructability.