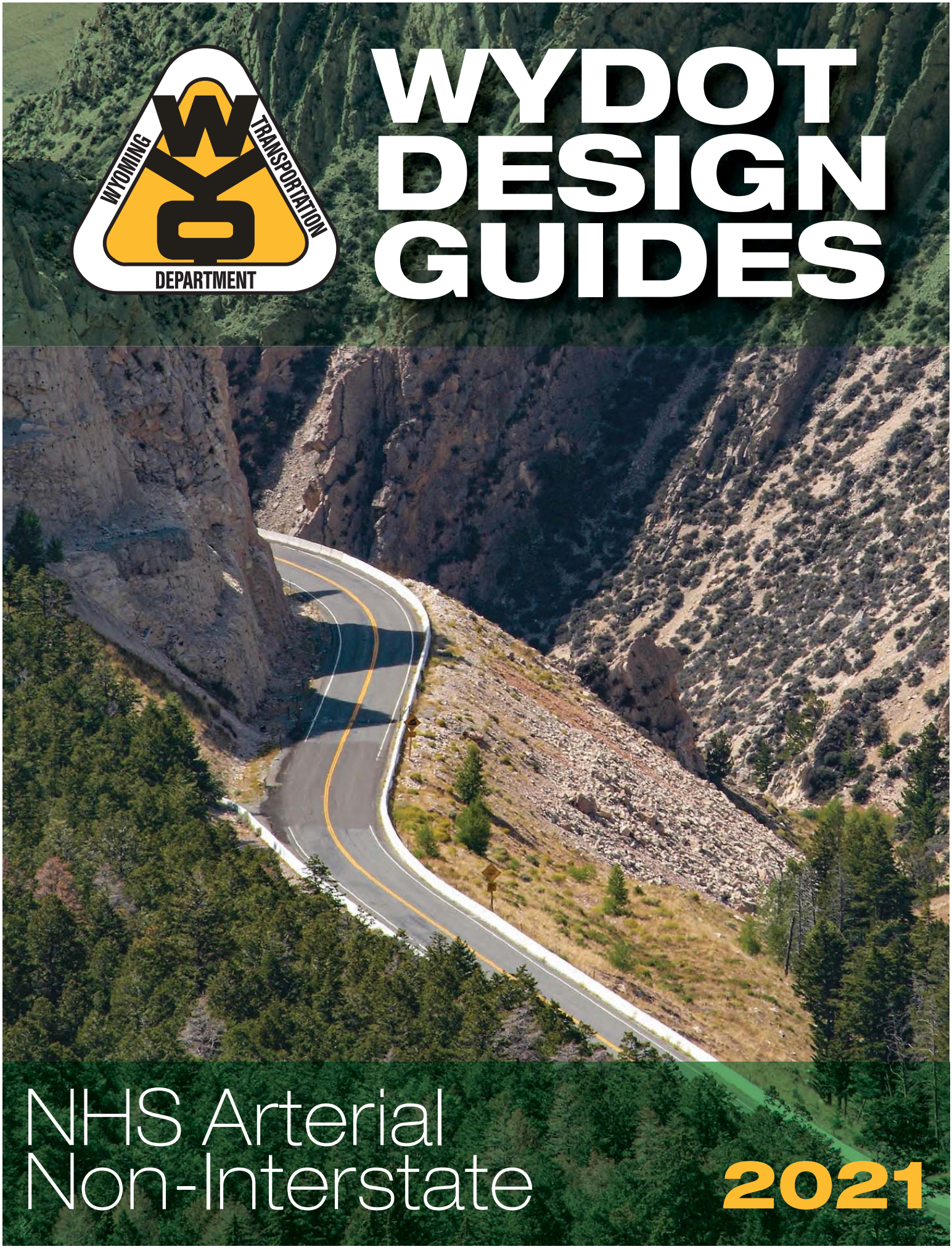
WYOMING TRANSPORTATION DEPARTMENT
WYDOT DESIGN GUIDES
NHS Arterial
Non-Interstate
2021

Table of Contents

GUIDE FOR NATIONAL HIGHWAY SYSTEM (NHS) HIGHWAYS (NHS ARTERIALS, Non-Interstate)

PRESERVATION – REHABILITATION – RECONSTRUCTION

INTRODUCTION

This Guide is directed to developing transportation projects on the Wyoming NHS Arterial Highway System, non-Interstate, functionally classified as Principal Arterials. The Guide outlines project development criteria and procedures, within three project types – Preservation, Rehabilitation, and Reconstruction – to address major Program areas. These Program areas are: Highway Pavements, Highway and Roadside Geometrics, Highway Structures, Highway and Roadside Safety, Highway Capacity, Highway Intersections, and Highway Corridor Evaluations.

PROJECT AND PROGRAM DIRECTION

Developing each transportation project, from early scoping through design and construction, must recognize that the Department continues to operate with increasing transportation needs, higher construction costs, and limited funding. As a result, project scopes and designs should be developed with an understanding of those objectives that best meet the Department's goals to take care of all physical aspects of the State Transportation System and to exercise good stewardship of resources.

Every project scope and design must be specifically directed to the highway corridor proposed for improvement, rather than applying historical standards or practices based on the highway system. Preservation projects should first review the highway corridor to identify existing deficiencies in pavements, bridge structures, safety, capacity, and highway operations including interchanges and intersections; Rehabilitation and Reconstruction projects should evaluate the highway corridor to identify existing deficiencies in pavements, bridge structures, safety, capacity, and highway operations including interchanges and intersections. Early consideration of the existing physical condition of the highway/roadside, and the safety, operational, and maintenance history of the corridor should be used to establish a needs-based justification for any proposed improvement, included in the project scope. Project scopes would then guide development of cost-effective designs.

To further support the above goals and objectives directed to narrowly defined project scopes and cost-effective designs, the criteria and procedures presented in this Guide are developed as recommended practice. The criteria and procedures may be modified, as needed, to meet an individual project or location-specific situation. As a result, the use of words such as 'may or should' versus 'shall, will, or must' is intended to support presentation of the criteria, and is not intended to present a permissive condition versus a required condition.

GENERAL DEFINITIONS

1. Functional Classification: Classification of the system of public highways by the character of service they provide. The National Highway System, non-Interstate, is functionally classified as Principal Arterial as this System provides for a high level of mobility and access control.
2. Controlling Design Criteria: Controlling design criteria are Design Speed (DS), Lane Width, Shoulder Width, Horizontal Curve Radius, Cross Slope, Superelevation Rate, Maximum Grades, Stopping Sight Distance, Structure Vertical Clearance, and Bridge Structure Capacity (loading). Design values for each of the Controlling Design Criteria are developed by the American Association of State Highway and Transportation Officials (AASHTO).

   A definition of Controlling Design Criteria often includes addressing Design Exceptions. Design Exceptions are used, for Reconstruction projects, where it is not reasonable to achieve full compliance with AASHTO minimum design values for any of the controlling design criteria. The process for evaluating, justifying, and documenting Design Exceptions is presented in the WYDOT *Road Design Manual*.
3. Highway Design, Highway and Roadside Safety, and Bridge Structure Design Criteria and Values: The criteria and values current with development of this Guide are listed as References. All References used in this Guide are to the most current adopted editions.
4. Highway Capacity Analysis: This analysis, applicable to Reconstruction projects and to those Rehabilitation projects with bridge replacement, will be completed for a 20-year design life using procedures from the Transportation Research Board (TRB) *Highway Capacity Manual*, or an adopted State analysis method. A Level-of-Service (LOS) D has been selected as the appropriate LOS to warrant capacity improvements for NHS Arterial rural and urban mainline sections.
5. Project Scope and Funding: Project scopes will be determined at an early planning stage using established management systems for Pavements, Bridges, and Safety. Early project scoping will develop the project purpose, project type, project limits, and location-specific major elements.

   Projects meeting the criteria presented in this Guide are eligible for State and Federal funding categories (NHPP, STP, HSIP, TAP, State Construction, State Safety).

6. Preservation Project Type: Preservation of the highway corridor to allow for the construction of a) a range of pavement design strategies that extend the service life or serviceability of the roadway pavement structure as identified in the Pavement Management System, b) bridge structure preservation or maintenance strategies identified in the Bridge Management System, and c) selected location-specific roadway and roadside safety improvements supported by the Safety Management System and including location-specific roadway geometric improvements. This project type may also address corridor needs for (a) operational improvements including auxiliary lanes and intersections improvements, (b) roadway traffic control device upgrades including signs, signals, and markings and (c) areas of isolated reconstruction or rehabilitation to meet identified highway needs.
7. Rehabilitation Project Type: Rehabilitation of existing highways to allow for the construction of selected improvements including (a) pavement design strategies identified in the Pavement Management System, (b) highway geometric upgrades, (c) bridge structure replacement or rehabilitation strategies identified in the Bridge Management System, (d) roadway and roadside safety improvements supported by the Safety Management System, (e) operational improvements including auxiliary lanes, modifications to existing interchanges and intersections, and upgrades to roadway traffic control devices including signs, signals, and markings. This project type could include isolated areas of reconstruction to meet identified highway needs.
8. Reconstruction Project Type: New construction or reconstruction of existing highways to provide for (a) the full range of pavement design strategies identified in the Pavement Management System, (b) highway geometric criteria upgrades, (c) bridge structure replacement or rehabilitation strategies identified in the Bridge Management System, (d) a full range of roadway and roadside safety improvements supported by the Safety Management System, (e) added capacity for design year traffic including additional travel lanes and auxiliary lanes, new intersections and modifications to existing intersections, and (f) roadway traffic control devices.

APPLICATION CRITERIA – NHS ARTERIAL PRESERVATION PROJECTS

Project Direction

These application criteria, as stated in the Introduction, are directed to each Preservation project scope and design. Each project should first review the highway corridor (defined as the project limits) to identify existing deficiencies in pavements, bridge structures, safety, capacity, and highway operations including interchanges and intersections. Early consideration of the existing physical condition of the highway/roadside, and the safety, operational, and maintenance history of the corridor should be used to establish a needs-based justification for any proposed improvement, included in the project scope. Project scopes would then guide development of cost-effective designs.

Highway Pavements

NHS Arterial Preservation projects provide for a range of pavement design strategies to extend the service life of existing plant-mix asphalt pavements and Portland cement concrete pavements. Strategies for plant-mix asphalt pavements include, but are not limited to, surface preparations (mill, level, full-depth reclamation, other), overlays, wearing surfaces, chip seals, micro-surfacing, and seal coats. Strategies for Portland cement concrete pavements include, but are not limited to, isolated slab replacement, dowel bar retrofit, grind and texture, and joint seals. Preservation projects will construct these strategies or other pavement treatment types as identified in the Pavement Management System and further outlined in the Pavement Condition and Project Candidates manual developed and administered through the Materials Program. This project type could include isolated areas of reconstruction or rehabilitation to meet identified pavement structure needs.

Highway and Roadside Geometrics

NHS Arterial Preservation projects are not intended to improve mainline NHS Arterial geometric design or roadside elements; these would typically be evaluated as part of a Rehabilitation or Reconstruction type project. Auxiliary lanes, including acceleration/deceleration lanes, can be constructed with a Preservation project, when justified.

Highway Structures

NHS Arterial Preservation projects will provide for the preservation or maintenance of existing bridge structures, consistent with improvements identified in the Bridge Management System.

Highway and Roadside Safety

Project planning for NHS Arterial Preservation will require a highway safety screening to determine the safety improvements/countermeasures recommended on each project. By entering the project limits into the Safety Management System (SMS) administered by the Highway Safety Program, a Highway Safety (HWS) Segment Report is generated. The HWS Segment Report will show the Safety Index (SI) rating for the project limits.

The use of the SMS to obtain an SI rating constitutes a highway safety screening and supports the Department's effort to reduce the frequency and severity of highway crashes, and directs attention and funding to 1) those highway sections that have a history of more severe or frequent crashes and 2) those highway sections where construction of safety improvements/countermeasures have the potential to significantly reduce the crash frequency and/or severity.

Highway sections with an SI Rating of 1 or 2 do not have a history of frequent or severe crashes. Although safety improvements/countermeasures may be constructed on these highway sections, the highway safety screening does not require any additional safety work to be added to preservation projects.

Highway sections with an SI Rating of 3 or 4 show a history of frequent or severe crashes and requires the project planning team to evaluate the need to add safety improvements/countermeasures to the project. This evaluation will reveal the potential to reduce the frequency or severity of specific crash types/locations and is the joint responsibility of Highway Safety, Planning, Traffic, District, and Highway Development.

The safety evaluation will consist of adding multiple safety treatments to the road sections within the SMS prior to the recon or kick-off meeting. At the recon or kick-off meeting, the design team will review all of the treatments suggested, review the benefit to cost ratios, and determine what safety treatments should be added to the project. Proposed safety improvements will be available for inclusion in the project scope.

Preservation projects do not require additional safety improvements to be added to the project. If no safety improvements are recommended for the project after the design team evaluation has been completed, a note will be placed in the project file by the lead designer stating why safety improvements were not added to the project.

Safety improvements, if selected for inclusion in the project scope, will meet applicable geometric and safety design criteria and design values as presented in this Guide for NHS Arterial Rehabilitation Projects, WYDOT *Road Design Manual*, AASHTO *Roadside Design Guide* (RDG), AASHTO *Manual for Assessing Safety Hardware* (MASH), NCHRP *Report 350 Recommended Procedures for the Safety Performance of Highway Features*, and FHWA *Manual on Uniform Traffic Control Devices* (MUTCD).

Highway Capacity

NHS Arterial Preservation projects are not intended to provide for additional travel lanes; future year NHS Arterial capacity needs would typically be evaluated as part of a Reconstruction type project. Auxiliary lanes, including truck climbing lanes, and acceleration/ deceleration lanes can be constructed with a Preservation project, when justified.

Highway Intersections and Interchanges

Intersections within the limits of a NHS Arterial Preservation project can be modified, as needed, to construct auxiliary lanes, including turn lanes.

NHS Arterial Preservation projects are not intended to improve interchange ramp or crossroad geometric design or roadside elements; these would typically be evaluated as part of a Rehabilitation or Reconstruction type project, or an Interstate project.

Highway Corridor Reviews and Evaluations

NHS Arterial Preservation projects should review all physical aspects of the highway corridor to identify existing deficiencies and/or other highway and roadside elements that may require continued maintenance, and address WYDOT direction for Americans with Disabilities Act (ADA) requirements from the WYDOT *Road Design Manual*. For this NHS project type, the highway corridor to be reviewed is the project limits.

This project type may include an operational evaluation of all roadside hardware, including bridge curb and rail, guardrail barriers and terminals, bridge rail to guardrail connections, sign support breakaway hardware, sign legend and retroreflection, and highway and interchange lighting. These installations may be upgraded, if needed, to meet design standards according to the AASHTO *Manual for Assessing Safety Hardware* (MASH), NCHRP *Report 350 Recommended Procedures for the Safety Performance of Highway Features*, FHWA *Manual on Uniform Traffic Control Devices* (MUTCD), and WYDOT *Operating Policy 25-1 Traffic Control and Roadway Lighting Devices.* Roadside safety hardware upgrades need to be reviewed per the Department's MASH implementation plan.

All Preservation project designs should avoid right-of-way acquisitions and/or construction easements; these projects should also avoid or minimize environmental impacts and resultant cost of mitigation.

The Design Phase should evaluate alternative contracting including, but not limited to, Lane Rental, and Incentive/Disincentive provisions.

APPLICATION CRITERIA – NHS ARTERIAL REHABILITATION PROJECTS

Project Direction

These application criteria, as stated in the Introduction, are directed to each Rehabilitation project scope and design. Each project should first evaluate the highway corridor (defined as the project limits for roadside elements and both the project limits and adjacent sections for highway (roadway) geometric elements) to identify existing deficiencies in pavements, bridge structures, safety, capacity, and highway operations including interchanges and intersections. Early consideration of the existing physical condition of the highway/roadside, and the safety, operational, and maintenance history of the corridor should be used to establish a needs-based justification for any proposed improvement, included in the project scope. Project scopes would then guide development of cost-effective designs.

Highway Pavements

NHS Arterial Rehabilitation projects provide for a broad range of pavement design strategies. Strategies for plant-mix asphalt pavements include, but are not limited to, removal and replacement, widening, surface preparations (mill, level, full-depth reclamation, other), overlays and seal coats. Strategies for Portland cement concrete pavements include, but are not limited to, crack and seat, grind (level), overlay and seal coats. Rehabilitation projects will construct these strategies or other pavement treatment types as identified in the Pavement Management System and further outlined in the Pavement Condition and Project Candidates manual developed and administered through the Materials Program. This project type could include isolated areas of reconstruction to meet identified pavement structure needs.

Rural multi-lane NHS Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The right lane and shoulder will be designed to a full-depth pavement structure for 14 feet (12 feet of outside travel lane plus 2 feet of right shoulder). The remaining right shoulder width will be evaluated for a reduced-depth pavement structure. The full width of the left lane (or all other travel lanes) will be designed to a full-depth pavement structure, and the full left shoulder will be evaluated for a reduced-depth pavement structure. Auxiliary lanes, including passing, climbing, and continuous acceleration/deceleration lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Rural two-lane and urban NHS Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The travel lanes will be designed to a full-depth pavement structure for the full width. Shoulders will be evaluated for a reduced-depth pavement structure for the inside 2 feet, with the remainder of the shoulder width extending the plant mix or constructed with a consolidated and drain-able material. Auxiliary lanes, including passing, climbing, and continuous acceleration/ deceleration lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Highway and Roadside Geometrics

Project planning for NHS Arterial Rehabilitation projects will include an evaluation of existing highway elements against design values for Controlling Design Criteria and selected non-controlling design criteria that are below Tolerable Controls. Tolerable Controls are generally defined as the design values for highway elements in effect at the time of original construction of the NHS Arterial highway section proposed for improvement, or the design values for existing highways elements if the highway section has been improved since original construction. The evaluation will be used to select the highway elements that will be improved and included in the Rehabilitation project scope.

Table 1 presents the minimum design values for Tolerable Controls for the Controlling Design Criteria relating to highway design. Design values for Tolerable Controls for the Controlling Design Criteria relating to bridge structures are presented in Table 2 located in a following section, Highway Structures. These minimum design values are applicable to mainline NHS Arterial sections and are not intended to control the design of auxiliary lanes.

The design values presented in this Guide apply to the State Highway System and do not apply to NHS Arterials under Local Government jurisdiction.

For NHS Arterial Rehabilitation projects, highway and bridge structure designs for proposed improvements will be based on the minimum design values for Tolerable Controls as presented in this Guide. The use of higher values, up to the AASHTO minimum design values from Table 3, are available for use when justified due to higher traffic volumes, higher truck traffic volumes, identified safety concerns including higher frequency or more severe crash types, or other identified highway needs.

Table 1. NHS Arterial - Rehabilitation Project Type: Controlling Design Criteria and Tolerable Controls (Design Values)

Controlling Design Criteria	Rural Design Values 70 MPH Posted Speed	Rural Design Values 65 MPH or less Posted Speed	Urban Design Values	Footnote
Design Speed (DS)	60 MPH	55 MPH	Existing Posted Speed	1
Lane Width	11 Feet	11 Feet	11 Feet	2
Shoulder Width Two-lane Multi-lane Divided	 Existing Existing	 Existing Existing	 Existing Existing	3, 4
Horizontal Curve Radius	60 MPH DS	55 MPH DS	DS	
Cross Slope	1.5%	1.5 %	1.5 %	
Superelevation Rate	Superelevation Tables e_{max} = 8%	Superelevation Tables e_{max} = 8%	Superelevation Tables e_{max} = 8%	5
Maximum Grade	Existing	Existing	Existing	
Stopping Sight Distance	570 Feet	495 Feet	DS	

Footnote 1 – The Rural Design Value for DS can be reduced based on terrain type.

Footnote 2 – Retain existing lane widths if >11 feet and the DS > 45 MPH.

Footnote 3 – On rural sections, wider shoulder widths and/or paved widths may be selected in consideration of WYDOT *Operating Policy 7-4, Bicycle Accommodation and Multiple-Use Transportation Facilities.* On urban sections, the shoulder widths may be increased to provide for parking lanes, bicycle lanes, and/or turn lanes. Selected shoulder widths include the gutter pan width, measured to face of curb.

Footnote 4 – For those highway sections where the existing shoulder widths exceed the design values presented in Table 3, the shoulder widths may be reduced to meet the design values in Table 3.

Footnote 5 – Superelevation Table e_{max} = 6% may be used in mountainous terrain; Superelevation Table e_{max} = 4% may be used in low-speed urban areas. In low-speed urban areas, superelevation may be adjusted/evaluated as described in the Road Design Manual.

The referenced AASHTO and WYDOT manuals identify minimum design values for non-controlling design criteria. Selected criteria and design values are presented in Table 1a for non-controlling design criteria relating to highway and roadside geometric design.

Table 1a. NHS Arterial - Rehabilitation Project Type:
Non-Controlling Design Criteria and Design Values

Non-Controlling Design Criteria	Rural Design Values	Urban Design Values	Footnote
Fore Slope Rate	1V:4H to 1V:6H including Surfacing Taper	Existing	1
Clear Zone Width	See Road Design Manual	Lateral Offset @ 1.5 Feet (From Curb Face)	
Slope Rate –beyond Clear Zone	See Road Design Manual	Existing	1
Median Width	Existing or Selected Design Value	Existing or Selected Design Value	1
Sag Vertical Curve – Headlight Sight Distance	570 Feet, 60 MPH DS 495 Feet, 55 MPH DS	DS	2
Lateral Offset to Obstruction	Paved Shoulder Width	1.5 Feet (From Curb Face)	

Footnote 1 – Selection of slope rates and median widths should avoid right-of-way acquisitions and/or construction easements; should also consider avoidance or minimization of environmental impacts and resultant cost of mitigation.

Footnote 2 - Sag vertical curves are normally designed to not restrict the distance of roadway illuminated by vehicle headlights, which would reduce stopping sight distance at night.

Highway Structures

Project planning for NHS Arterial Rehabilitation projects will evaluate existing bridge structure elements against design values for Controlling Design Criteria. This evaluation will assist in selecting those bridge structure elements, related to controlling design criteria that are below Tolerable Controls, which will be improved as part of the Rehabilitation project scope. Tolerable Controls are generally defined as the design values for bridge structure elements in effect at the time of original construction of the NHS Arterial bridge structure proposed for improvement, or the design values for existing bridge structure elements if the bridge structure has been improved since original construction.

NHS Arterial Rehabilitation projects will also evaluate bridge structures to determine elements in an advanced state of deterioration. Work needed to extend the functional life of the structure, including structure replacement, widening, or reconstruction of any element, may be addressed with a Rehabilitation project. Any bridge structure replaced or proposed for rehabilitation of major elements will be evaluated for structure type, length, and width requirements, with a highway capacity analysis based on a selected 20-year design life. The location of abutments and piers will consider design values for Lateral Offset to Obstructions, which may vary by highway system crossed (Interstate, NHS Arterial, Non-NHS State Highway, Public Highway).

Table 2 presents the minimum design values for Tolerable Controls for the Controlling Design Criteria relating to bridge structure design for a rehabilitated structure and a new structure. These minimum design values are applicable to mainline NHS Arterial bridge structures and are not intended to control the design of structures serving auxiliary lanes.

For NHS Arterial Rehabilitation projects, bridge structure designs for rehabilitation of an existing structure will be based on the minimum design values for Tolerable Controls as presented in this Guide. The use of higher values, up to AASHTO minimum design values, are available for use when justified due to higher traffic volumes, higher truck traffic volumes, identified safety concerns including higher frequency or more severe crash types, or other identified highway needs.

For NHS Arterial Rehabilitation projects, bridge structure design for replacement of an existing structure will be based on the minimum AASHTO design values identified in both Table 2, Table 3, and Table 4. Long structures, defined as length in excess of 200 feet, may have a lesser roadway width to accommodate the traveled way plus 4 feet offsets (left and right side) to curb barrier or rail.

Table 2. NHS Arterial - Rehabilitation Project Type: Structure Controlling Design Criteria and Tolerable Controls (Design Values)

Controlling Design Criteria	Rural and Urban Design Values REHABILITATE BRIDGE	Rural and Urban Design Values REPLACE BRIDGE	Footnote
Vertical Clearance – Highway Structures			1, 2
Structure over Interstate Highway	15 Feet	16 Feet	
Structure over NHS Arterial	14 Feet	16 Feet	
Structure over Non-NHS Arterial	14 Feet	16 Feet	
Structure over Non-NHS Collector	Existing	14 Feet	
Structure over Non-NHS Local	Existing	14 Feet	
Vertical Clearance – Sign Structures			
All Highway Systems	Existing	19 Feet	
Structural Capacity	HS-20, Inventory Rating ≥ 0.8	HL-93	

Footnote 1 – Vertical Clearance design values are minimums, and may be < existing clearances. Rehabilitation projects will maintain existing clearances. Raising structures or reconstructing mainline grades to meet a minimum design value would typically be addressed as a Reconstruction project type.

Footnote 2 - For replaced (new) Highway Structures, consider an additional 0.5 Feet of Vertical Clearance to allow for future pavement surfacing.

Highway and Roadside Safety

Project planning for NHS Arterial Rehabilitation will require a highway safety screening to determine the safety improvements/countermeasures recommended on each project. By entering the project limits into the Safety Management System (SMS) administered by the Highway Safety Program, a Highway Safety (HWS) Segment Report is generated. The HWS Segment Report will show the Safety Index (SI) rating for the project limits.

The use of the SMS to obtain an SI rating constitutes a highway safety screening and supports the Department's effort to reduce the frequency and severity of highway crashes, and directs attention and funding to 1) those highway sections that have a history of more severe or frequent crashes and 2) those highway sections where construction of safety improvements/countermeasures have the potential to significantly reduce the crash frequency and/or severity.

Highway sections with an SI Rating of 1 or 2 do not have a history of frequent or severe crashes. Although safety improvements/countermeasures may be constructed on these highway sections, the highway safety screening does not require any additional safety work to be added to rehabilitation projects.

Highway sections with an SI Rating of 3 or 4 show a history of frequent or severe crashes and requires the project planning team to evaluate the need to add safety improvements/countermeasures to the project. This evaluation will reveal the potential to reduce the frequency or severity of specific crash types/locations and is the joint responsibility of Highway Safety, Planning, Traffic, District, and Highway Development.

The safety evaluation will consist of adding multiple safety treatments to the road sections within the SMS prior to the recon or kick-off meeting. At the recon or kick-off meeting, the design team will review all of the treatments suggested, review the benefit to cost ratios, and determine what safety treatments should be added to the project. Proposed safety improvements will be available for inclusion in the project scope.

Rehabilitation projects do not require additional safety improvements to be added to the project. If no safety improvements are recommended for the project after the design team evaluation has been completed, a note will be placed in the project file by the lead designer stating why safety improvements were not added to the project.

Safety improvements, if selected for inclusion in the project scope, will meet applicable geometric and safety design criteria and design values as presented in this Guide for NHS Arterial Rehabilitation Projects, WYDOT *Road Design Manual*, AASHTO *Roadside Design Guide* (RDG), AASHTO *Manual for Assessing Safety Hardware* (MASH), NCHRP *Report 350 Recommended Procedures for the Safety Performance of Highway Features*, and FHWA *Manual on Uniform Traffic Control Devices* (MUTCD).

Highway Capacity

NHS Arterial Rehabilitation projects are not intended to provide for additional Arterial travel lanes. Future year NHS Arterial capacity needs would typically be evaluated as part of a Reconstruction type project. Auxiliary lanes, including truck climbing lanes, acceleration/ deceleration lanes, and turn lanes can be constructed with a Rehabilitation project, when justified.

Highway Intersections and Interchanges

NHS Arterial Rehabilitation projects will evaluate the geometric design, capacity, and safety needs for major intersections, including the intersecting road; improvements can be included in the project scope. Capacity improvements to the intersection may be delayed, if not justified within the first ten years of the design life selected for the highway capacity analysis.

A NHS Arterial Rehabilitation project can also include the evaluation of geometric design, capacity and safety needs for interchange ramp connections to the Interstate system. Improvements needed to correct identified deficiencies or meet future-year projected travel demands can be included in the project scope, or delayed and programmed with a future Interstate project type. Design criteria and values are presented in the WYDOT *Road Design Manual* and supplemented by AASHTO *A Policy on Geometric Design of Highways and Streets*.

Highway Corridor Evaluations

NHS Arterial Rehabilitation projects should evaluate all physical aspects of the highway corridor to identify existing deficiencies and/or other highway and roadside elements that may require continued maintenance, and address WYDOT direction for Americans with Disabilities Act (ADA) requirements from the WYDOT *Road Design Manual*. For this NHS project type, the highway corridor to be evaluated is the project limits for roadside elements and both the project limits and adjacent sections for highway (roadway) geometric elements.

This project type will include an operational evaluation of all roadside hardware, including bridge curb and rail, guardrail barriers and terminals, bridge rail to guardrail connections, sign support breakaway hardware, sign legend and retroreflection, and highway and interchange lighting. These installations may be upgraded, if needed, to meet design standards according to the AASHTO *Manual for Assessing Safety Hardware* (MASH), NCHRP *Report 350 Recommended Procedures for the Safety Performance of Highway Features*, FHWA *Manual on Uniform Traffic Control Devices* (MUTCD), and WYDOT *Operating Policy 25-1 Traffic Control and Roadway Lighting Devices*. Roadside safety hardware upgrades need to be reviewed per the Department's MASH implementation plan.

NHS Arterial Rehabilitation projects may require a hydraulic analysis. The scope of the hydraulic analysis and resultant design work will vary depending on project improvements being undertaken.

All Rehabilitation project designs should be evaluated to avoid right-of-way acquisitions and/or construction easements; this evaluation should also consider avoidance or minimization of environmental impacts and resultant cost of mitigation.

Project planning for NHS Urban Arterial Rehabilitation projects should include a corridor review of adopted State or Local Government plans, such as Transportation Alternatives Program (TAP) or bicycle and pedestrian plans, and determine if any identified improvements should be included in the project scope.

Cost reduction evaluations should be considered during the Design Phase, including Life Cycle Costing, Value Engineering, and Constructability Reviews. The Design Phase should evaluate alternative contracting including, but not limited to, Cost plus Time, Lane Rental, and Incentive /Disincentive provisions.

APPLICATION CRITERIA – NHS ARTERIAL RECONSTRUCTION PROJECTS

Project Direction

These application criteria, as stated in the Introduction, are directed to each Reconstruction project scope and design. Each project should first evaluate the highway corridor (defined as the project limits for roadside elements and the project limits, adjacent sections, and WYDOT Long Range Transportation/Corridor Plans for highway (roadway) geometric elements) to identify existing deficiencies in pavements, bridge structures, safety, capacity, and highway operations including interchanges and intersections. Early consideration of the existing physical condition of the highway/roadside, and the safety, operational, and maintenance history of the corridor should be used to establish a needs-based justification for any proposed improvement, included in the project scope. Project scopes would then guide development of cost-effective designs.

Highway Pavements

NHS Arterial new construction or reconstruction projects provide for the full range of pavement design strategies for the new construction or the removal and replacement of existing plant-mix asphalt pavements and Portland cement concrete pavements. These designs will provide for a minimum 20-year structure design life.

Rural multi-lane NHS Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The right lane and shoulder will be designed to a full-depth pavement structure for 14 feet (12 feet of outside travel lane plus 2 feet of right shoulder). The remaining right shoulder width will be evaluated for a reduced-depth pavement structure. The full width of the left lane (or all other travel lanes) will be designed to a full-depth pavement structure, and the full left shoulder will be evaluated for a reduced-depth pavement structure.

Auxiliary lanes, including passing, climbing, turning, and acceleration/deceleration lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Rural two-lane and urban NHS Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The travel lanes will be designed to a full-depth pavement structure for the full width. Shoulders will be evaluated for a reduced-depth pavement structure for the inside 2 feet, with the remainder of the shoulder width extending the plant mix or constructed with a consolidated and drain-able material. Auxiliary lanes, including passing, climbing, turning, parking, and bicycle lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Highway and Roadside Geometrics

NHS Arterial reconstruction projects will be designed to meet minimum design values for Controlling Design Criteria and best practice for non-controlling geometric and safety elements.

The design values presented in this Guide apply to the State Highway System and do not apply to NHS Arterials under Local Government jurisdiction.

Design values are presented in AASHTO *A Policy on Geometric Design of Highways and Streets*, WYDOT *Road Design Manual, and* AASHTO *Roadside Design Guide* (RDG); design values for rural multi-lane NHS Arterials are presented in WYDOT *Operating Policy 7-5, Standards for Non-Interstate Multilane Highways*. AASHTO identifies both minimum and desirable design values for Controlling Design Criteria; this Guide will present minimum values in Table 3 for the eight Controlling Design Criteria relating to highway design. AASHTO minimum design values for the two Controlling Design Criteria relating to bridge structures are presented in Table 4 located in a following section, Highway Structures. These minimum design values are applicable to mainline NHS Arterial sections and are not intended to control the design of auxiliary lanes.

Highway designs will be based on the minimum design values presented in this Guide. Design values (from referenced AASHTO and WYDOT manuals), above the minimums presented in this Guide, are available when justified due to higher traffic volumes, higher truck traffic volumes, identified safety concerns including higher frequency or more severe crash types, or other identified highway needs.

Table 3. NHS Arterial - Reconstruction Project Type:
Controlling Design Criteria and Design Values

Controlling Design Criteria	Rural Design Values 70 MPH Posted Speed	Rural Design Values 65 MPH Posted Speed	Urban Design Values	Footnote
Design Speed (DS)	70 MPH	65 MPH	30 MPH	1, 2, 3
Lane Width	12 Feet	12 Feet	11 Feet	4
Shoulder Width				5
2-Lane Or Undivided	Outside Shldr	Outside Shldr	Right & Left Shldr	
Vehicles/Day < 400	4 Feet	4 Feet	Gutter Pan	
Vehicles/Day 400-2000	6 Feet	6 Feet	Gutter Pan	
Vehicles/Day > 2000	8 Feet	8 Feet	Gutter Pan	
Multi-Lane Divided				
Outside Shoulder	8 Feet	8 Feet	Gutter Pan	
Inside Shoulder	4 Feet	4 Feet	Gutter Pan	
Horizontal Curve Radius	70 MPH DS	65 MPH DS	30 MPH DS	
Cross Slope	2.0%	2.0%	2.0%	
Superelevation Rate	Superelevation Tables e_{max} = 8%	Superelevation Tables e_{max} = 8%	Superelevation Tables e_{max} = 8%	6
Maximum Grade				
Flat Terrain	3%	3%	7%	
Rolling Terrain	4%	4%	9%	
Mountainous Terrain	5%	5%	11%	
Stopping Sight Distance	730 Feet	645 Feet	200 Feet	

Footnote 1 – The Urban Design Values are presented for a curb and gutter section; if a ditch section is constructed, use Rural Design Values for 65 MPH posted speed.

Footnote 2 – The selected Design Speed must meet the posted speed. Design Speed should be selected with respect to anticipated operating speeds, adjacent land use, and terrain type. For Rural sections, the design speed can be reduced to a minimum 40 MPH.

Footnote 3 – On urban curb and gutter sections, a mountable (sloping) curb type design should be used when the Design Speed is > 45 MPH.

Footnote 4 – For Rural Design Values, AASHTO allows the use of 11 feet travel lanes for those arterials with volumes below 400 vehicles/day, or a combination of lower design speeds, ≤ 50 MPH, and lower design volumes, ≤ 2000 vehicles/day.

Footnote 5 – On rural sections, wider shoulder widths and/or paved widths may be selected in consideration of WYDOT *Operating Policy 7-4, Bicycle Accommodation and Multiple-Use Transportation Facilities.* On urban sections, the shoulder width may be increased to provide for parking lanes, bicycle lanes, and/or turn lanes. Selected shoulder widths include the gutter pan width, measured to face of curb.

Footnote 6 – The Superelevation Table e_{max} = 6% may be used in mountainous terrain; the Superelevation Table e_{max} = 4% may be used in low-speed urban areas. In low-speed urban areas, superelevation may be adjusted/eliminated as described in the Road Design Manual.

The referenced AASHTO and WYDOT manuals also identify minimum design values for non-controlling design criteria. Selected criteria and design values are presented in Table 1a for non-controlling design criteria relating to highway and roadside geometric design.

Table 3a. NHS Arterial - Reconstruction Project Type:
Non-Controlling Design Criteria and Design Values

Non-Controlling Design Criteria	Rural Design Values	Urban Design Values	Footnote
Fore Slope Rate	1V:4H to 1V:6H, including Surfacing Taper	Existing	1
Clear Zone Width	See Road Design Manual	4 Feet (From Curb Face)	
Slope Rate – beyond Clear Zone	See Road Design Manual	Existing	1
Median Width	Widths from Operating Policy 7-5	Selected Value	1
Sag Vertical Curve – Headlight Sight Distance	730 Feet, 70 MPH DS 645 Feet, 65 MPH DS	200 Feet	2
Lateral Offset to Obstruction	See Roadside Design Guide	1.5 Feet (From Curb Face)	

Footnote 1 – Selection of slope rates and median widths should avoid right-of-way acquisitions and/or construction easements; should also consider avoidance or minimization of environmental impacts and resultant cost of mitigation.

Footnote 2 - Sag vertical curves are normally designed to not restrict the distance of roadway illuminated by vehicle headlights, which would reduce stopping sight distance at night.

Highway Structures

NHS Arterial Reconstruction projects will provide for the construction of new bridge structures, or the reconstruction or rehabilitation of existing bridge structures, consistent with improvements identified in the Bridge Management System. These projects will be designed to meet minimum design values for Controlling Design Criteria. Design values are presented in the AASHTO *A Policy on Geometric Design of Highways and Streets*, AASHTO *LRFD Bridge Design Specifications,* AASHTO *Standard Specifications for Highway Bridges,* and the WYDOT *Bridge Design Manual*.

Bridge structure designs will be based on the minimum design values presented in this Guide, see Table 3 and Table 4. Design values, above the minimums presented in this Guide, are available (from referenced AASHTO and WYDOT manuals) when justified due to higher traffic volumes, higher truck traffic volumes, identified safety concerns including higher frequency or more severe crash types, or other identified highway needs. Long structures, defined as length in excess of 200 feet, may have a lesser roadway width to accommodate the traveled way plus 4 feet outside offsets to curb barrier or rail.

Table 4. NHS Arterial - Reconstruction Project Type:
Structure Controlling Design Criteria and Design Values

Controlling Design Criteria	Rural and Urban Design Values	Footnote
Vertical Clearance		1, 2
Structure over Interstate	16 Feet	
Structure over NHS Arterial	16 Feet	
Structure over Non-NHS Arterial	16 Feet	
Structure over Non-NHS Collector	14 Feet	
Structure over Non-NHS Local	14 Feet	
Vertical Clearance – Sign Structures All Highway Systems	19 Feet	
Structure Capacity	HL 93	

Footnote 1 - For new Highway Structures, consider an additional 0.5 Feet of Vertical Clearance to allow for future pavement surfacing.

Footnote 2 - Bridge replacement to meet Vertical Clearance is not required; a Design Exception will be processed justifying the action to leave the bridge in-place. The determination to replace an existing bridge overpass to meet vertical clearance will also include a functional and structural evaluation of the bridge.

Any new, reconstructed, or rehabilitated bridge structure will be evaluated for structure type, including the location of abutments and piers and length and width requirements. This evaluation will address future capacity needs of the NHS Arterial corridor, using a highway capacity analysis based on a 20-year design life, and will address all Controlling Design Criteria design values.

Highway and Roadside Safety

Project planning for NHS Arterial Reconstruction will require a highway safety screening to determine the safety improvements/countermeasures recommended on each project. By entering the project limits into the Safety Management System (SMS) administered by the Highway Safety Program, a Highway Safety (HWS) Segment Report is generated. The HWS Segment Report will show the Safety Index (SI) rating for the project limits.

The use of the SMS to obtain an SI rating constitutes a highway safety screening and supports the Department's effort to reduce the frequency and severity of highway crashes, and directs attention and funding to 1) those highway sections that have a history of more severe or frequent crashes and 2) those highway sections where construction of safety improvements/countermeasures have the potential to significantly reduce the crash frequency and/or severity.

Highway sections with an SI Rating of 1 or 2 do not have a history of frequent or severe crashes. Although safety improvements/countermeasures may be constructed on these highway sections, the highway safety screening does not require any additional safety work to be added to rehabilitation projects.

Highway sections with an SI Rating of 3 or 4 show a history of frequent or severe crashes and requires the project planning team to evaluate the project and determine the best areas to add safety improvements/countermeasures to the project to reduce the frequency or severity of specific crash types/locations. This evaluation is the joint responsibility of Highway Safety, Planning, Traffic, District, and Highway Development.

The safety evaluation will consist of adding multiple safety treatments to the road sections within the SMS prior to the recon or kick-off meeting. At the recon or kick-off meeting, the design team will review all of the treatments suggested, review the benefit to cost ratios, and determine what safety treatments will be added to the project. Proposed safety improvements will be available for inclusion in the project scope.

Safety improvements selected for inclusion in the project scope will meet applicable geometric and safety design criteria and design values as presented in this Guide for NHS Arterial Reconstruction Projects, WYDOT *Road Design Manual*, AASHTO *Roadside Design Guide* (RDG), AASHTO *Manual for Assessing Safety Hardware* (MASH), NCHRP *Report 350 Recommended Procedures for the Safety Performance of Highway Features*, and FHWA *Manual on Uniform Traffic Control Devices* (MUTCD).

Highway Capacity

NHS Arterial Reconstruction projects, including new construction, will provide for additional continuous travel lanes needed to meet a future-year projected travel demand. Auxiliary lanes, including truck climbing lanes and continuous acceleration/deceleration lanes, will be constructed when justified.

Capacity improvements to add additional travel lanes may be delayed if not justified within the first ten years of the 20-year design life.

Highway Intersections and Interchanges

NHS Arterial Reconstruction projects will evaluate the geometric design, capacity, and safety needs for major intersections, including the intersecting road. All improvements will be included in the project scope. Capacity improvements to the intersection may be delayed, if not justified within the first ten years of the 20-year design life.

A NHS Arterial Reconstruction project can also include the evaluation of geometric design, capacity and safety needs for interchange ramp connections to the Interstate system. Improvements needed to correct identified deficiencies or meet future-year projected travel demands can be included in the project scope, or delayed and programmed with a future Interstate project type. Design criteria and values are presented in the WYDOT *Road Design Manual* and supplemented by AASHTO *A Policy on Geometric Design of Highways and Streets*.

Highway Corridor Evaluations

NHS Arterial Reconstruction projects should evaluate all physical aspects of the highway corridor to identify existing deficiencies and/or other highway and roadside elements that may require continued maintenance. For this NHS project type, the highway corridor to be evaluated is the project limits for roadside elements and the project limits, adjacent sections, and WYDOT Long Range Transportation/Corridor Plans for highway (roadway) geometric elements.

This project type will include an operational evaluation of all roadside hardware, including bridge curb and rail, guardrail barriers and terminals, bridge rail to guardrail connections, sign support breakaway hardware, sign legend and retroreflection, and highway and interchange lighting. These installations will be upgraded, if needed, to meet design standards according to the AASHTO *Manual for Assessing Safety Hardware* (MASH), NCHRP *Report 350 Recommended Procedures for the Safety Performance of Highway Features,* FHWA *Manual on Uniform Traffic Control Devices* (MUTCD), and WYDOT *Operating Policy 25-1 Traffic Control and Roadway Lighting Devices.* Roadside safety hardware upgrades need to be reviewed per the Department's MASH implementation plan.

NHS Arterial Reconstruction projects will typically require a hydraulic analysis. The scope of hydraulic analysis and resultant design work will vary depending on project improvements being undertaken.

All Reconstruction project designs should be evaluated to avoid right-of-way acquisitions and/or construction easements; this evaluation should also consider avoidance or minimization of environmental impacts and resultant cost of mitigation.

Project planning for NHS Urban Arterial Reconstruction projects should include a corridor review of adopted State or Local Government plans, such as Transportation Alternatives Program (TAP) or bicycle and pedestrian plans, and determine if any identified improvements should be included in the project scope.

Cost reduction evaluations should be considered during the Design Phase, including Life Cycle Costing, Value Engineering, and Constructability Reviews. The Design Phase should evaluate alternative contracting including, but not limited to, Cost plus Time, Lane Rental, and Incentive /Disincentive provisions.

REFERENCES

The References presented in this Guide are intended to refer to the most current and adopted editions.

Transportation Research Board (TRB):

- *Highway Capacity Manual*

American Association of State Highway and Transportation Officials (AASHTO):

- *A Policy on Geometric Design of Highways and Streets*
- *LRFD Bridge Design Specifications*
- *Standard Specifications for Highway Bridges*
- *Roadside Design Guide* (RDG)
- *Roadway Lighting Design Guide*
- *Manual for Assessing Safety Hardware* (MASH)

Wyoming Department of Transportation (WYDOT):

- *Operating Policy*
  - *7-4, Bicycle Accommodation and Multiple-Use Transportation Facilities*
  - *7-5, Standards for Non-Interstate Multilane Highways*
  - *25-1 Traffic Control and Roadway Lighting Devices*
- *Traffic Studies Manual*
- *Road Design Manual*
- *Bridge Design Manual*
- *Hydraulics Manual*
- *Long Range Transportation Plan – Corridor Visions*

National Cooperative Highway Research Program (NCHRP):

- *Report 350 Recommended Procedures for the Safety Performance of Highway Features*

Federal Highway Administration (FHWA):

- *Manual on Uniform Traffic Control Devices* (MUTCD)