ROADSIDE CULTURALRESOURCES PRESERVATION: A GUIDE TO ASSESSING THE EFFECTS OF ROADSIDE SAFETY IMPLEMENTATION ON THE BLUE RIDGE PARKWAY

BACKGROUND

A draft document titled "Roadside Safety Implementation and Assessment of Adverse Effects Screening Methodology" was originally prepared by the National Park Service (NPS) Blue Ridge Parkway (BLRI) resource planning staff for the purpose of assessing the addition of roadside safety features and their impact on the historic integrity of the BLRI. The NPS/BLRI contracted with The Jaeger Company (TJC), a landscape architectural and planning firm, to perform a peer review of the draft methodology to determine the applicability of merging visual resource assessment methods with historic integrity as well as determining if the criterion would be suitable and defensible for application.

The NPS/BLRI and TJC conducted a series of meetings with the Federal Highway Administration (FHWA), State Historic Preservation Offices (SHPO) of North Carolina and Virginia, Advisory Council on Historic Preservation and National Park Service staff to reach an agreed upon process for evaluating the need for additional safety features on the BLRI and the affects these features would have on historic resources. Input from the meetings, along with field testing of the methodology on Section 1-N of the Parkway (Milepost 121.4 to Milepost 136.0), provided further refinement of the preliminary methodology. Based upon the inter-agency team consultation the process is now called "Roadside Barrier Warranting and Assessment of Adverse Effects Screening Methodology"

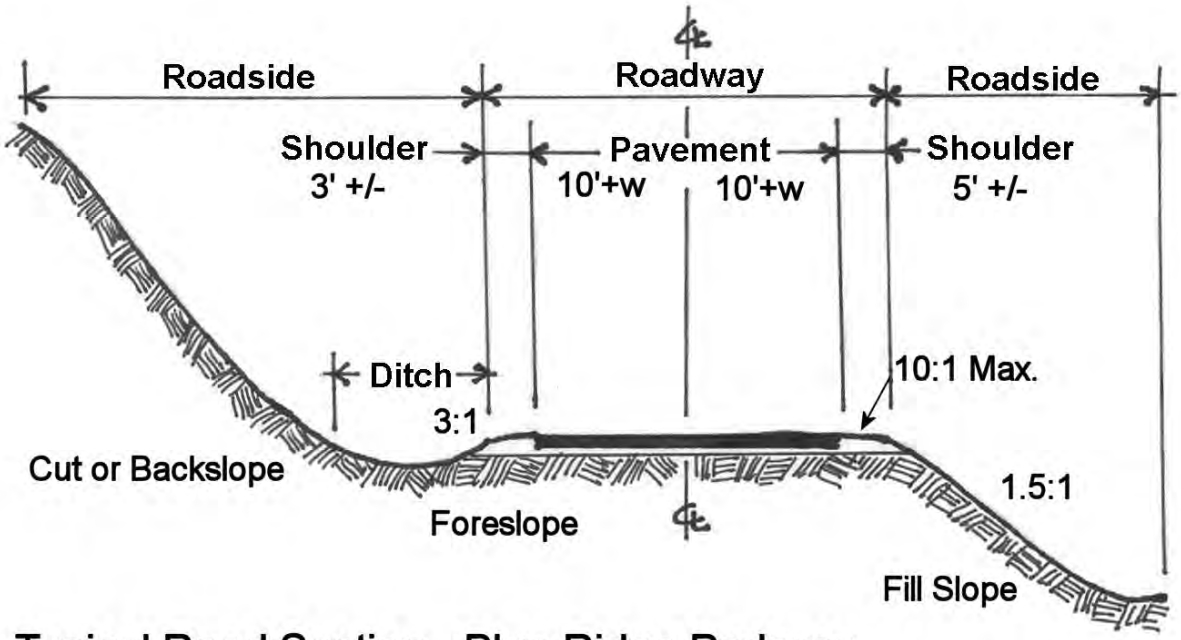
The purpose of this warranting and screening process would be for evaluating warranted road barrier changes along the Parkway motor road and the potential cultural, natural and visual resources impact of that change. The screening process also would be used in accomplishing the overall Section 106 process for an undertaking by National Park Service (NPS) staff in performing project scoping and effect determinations for construction activities proposed within the limits of the Parkway's historic designed landscape. A primary goal of this process is to preserve the significance and integrity of the Parkway while considering the effect of implementing warranted roadside barriers or other safety guideline requirements.

The process includes a method for making a qualitative adverse affect determination by assessing the addition of proposed roadside safety features. This method would become a component of an integrated project scoping document for 3-R, 4-R and line item

construction road projects. The intent is to develop an agreed upon systematic approach in which a warrant determination and possible treatments are made on a project by project basis. Additionally, the method provides a means of documenting the process by which a decision is made.

BLUE RIDGE PARKWAY TYPICAL ROAD SECTION

Construction of the first section of Blue Ridge Parkway began in September 1935. Over 300 miles of Parkway was designed and constructed by 1945. Then by 1966 all but 8 miles of Parkway had been constructed. All this is to say, that the Parkway is primarily a product of the design philosophy and safety guidelines of the late 1930's, 40's and early 50's. The road section below illustrates the typical road prism—travel lane and shoulder widths and foreslope and fill slope ratios found along much of the Parkway. These typical section standards that were used are very different than what would be done if the Parkway was being designed and constructed today.



Typical Road Section - Blue Ridge Parkway

Even though 460 miles of the Parkway was built, a section at a time, over 31 years with some changes in design standards, there still is "sameness" to the nature of the road prism from one section to another. What a driver expects on a road is greatly influenced

by what they experience on the previous section of road. A consistency of experience on the Blue Ridge Parkway is provided by:

- Posted speed limit of 45 mph or lower,
- Travel lane widths of 10 feet plus widening,
- Horizontal alignment comprised of spiral curves with minimum radii of 716 feet or 8° curve,
- Vertical alignment with 10% maximum grades,
- Narrow road shoulders that only average 3' to 5' +or-,
- 3:1 foreslopes and 1.5:1 for fill slopes,
- Fixed objects (bridge wing walls, guardwalls, tunnel portals) within the 8 foot clear zone,
- Steep unprotected open roadside embankments for vistas,
- Overlook parking areas, and
- Undulating roadside vegetation edges.

All of the above bring a consistency to the Parkway driving experience and a driver's perceived need to exercise a higher level of caution than a primary or interstate highway requires.

ADAPTING CURRENT ROADSIDE BARRIER WARRANTING TO THE BLUE RIDGE PARKWAY

All of the above listed existing typical Parkway road section conditions make it necessary to adapt the barrier warranting process when applied on the Blue Ridge Parkway. This is most applicable in two areas of the warranting process, 1. determining the required clear zone and 2. identifying and addressing potential hazards.

Clear zones distances from the edge of the through roadway are determined by design speed, design ADT and backslope and foreslope/fill slope ratios (AASHTO Roadside Design Guide, Table 3.2). Using Table 3.2 given the steep 3:1 foreslopes and 1.5:1 for fill slopes found along the Parkway, clear zones of 20' or more are required. This is problematic because of the Parkway's narrow road shoulders that only average 3' to 5' +or- in many of the situations where roadside fixed objects are potential hazards. In these situations three things would occur, 1. roadside barriers would have to be extended further in distance to where the shoulder widens enough to terminate the

barrier with the required clear zone offsets and tapers, 2. the required clear zone offset just would not be met or 3. shoulders would need to be substantially widened to accommodate the required clear zone offset distances that would adversely affect the Parkway's historic designed landscape. Beside the physical constraints of the Parkway's typical road section, the concept of driver expectancy was factored into the NPS/BLRI and FHWA/EFLHD agreeing on using 8' to 10" as the required clear zone for the Blue Ridge Parkway.

With a clear zone requirement for the Blue Ridge Parkway of 8' to 10' being utilized, fixed objects and roadside features that may be hazards within that clear zone will be evaluated through a two step process described in SECTION I. That section outlines the processes for roadside barrier warranting and assessment methodology for determining the level of adverse effects when roadside safety features are proposed within the typical Parkway road section. SECTION 2 provides guidelines for assessing the historic resources associated with the Blue Ridge Parkway's typical road section.

SECTION I - ROADSIDE SAFETY AND EFFECT SCREENING PROCESS

Before a new roadside barrier safety feature would be considered for installation along the Blue Ridge Parkway motor road, a three step warranting, screening and decision making process shall be implemented:

- Step 1: Roadside Barrier Warranting
  During the scoping for a 3R project it will be determined if placement of a safety feature is warranted. If a roadside barrier is warranted and proposed then Step 2 shall be implemented.

- Step 2: Historic Integrity and Affects Screening
  Evaluate the existing roadside conditions to determine the level of effect the addition of a roadside safety feature would have on the Parkway's historic resources.

- Step 3: Project Implementation
  The findings from Steps 1 and 2 will be evaluated to determine if warranted barriers will be included in the project. This will include both the NPS and EFLHD staff involved in the scoping for FLHP projects. The final determination on actions to be taken, including any mitigative measures, will be a joint collaboration between the NPS and EFLHD; but ultimately, the final decision on the action to be taken is the responsibility of the NPS.

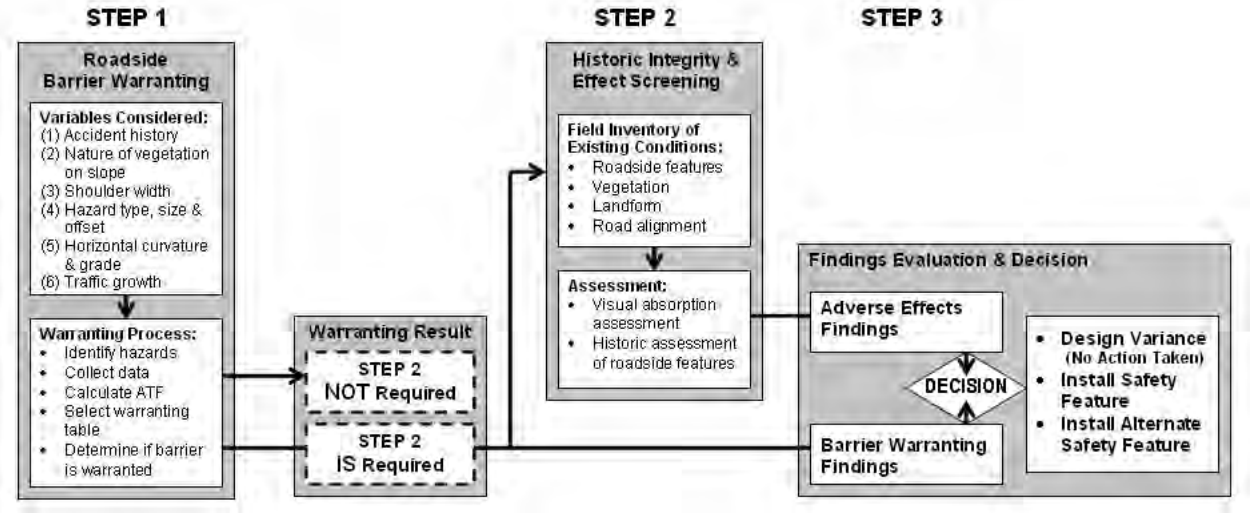


Figure 1: Flow Chart

Step 1: Roadside Barrier Warranting

The Blue Ridge Parkway is classified as low speed (posted speed limits of 45 mph or lower) and a low volume (ADT below 2,000) roadway. Based upon that classification barrier warranting will be performed by the NPS and FHWA throughout the limits of each project area as a part of project scoping to evaluate and determine the locations where roadside safety barriers are warranted utilizing the FLH Barrier Guide for Low Volume and Low Speed Roads, Appendix A, Roadside Barrier Warrants. The warranting process described in that manual utilizes the "Adjusted Traffic Factor" (ATF) formula that considers the following variables, (4) through (6). ATF is calculated by modifying the initial average daily traffic (ADT) with adjustments for traffic growth, horizontal curvature and grade.

Variables (1), (2) and (3) described below are important to consider in the warranting process for the Blue Ridge Parkway in addition to the variables included in the ATF formula. The first three variables--crash history, presence of fill slope vegetation and driver expectancy on the Parkway are important to consider in exercising professional judgment in determining the degree to which a barrier is warranted.

(1) Crash History (roadway-related): Does the accident data indicate that the conditions described in any of the variables 4-6 contribute to EITHER one injury/fatality crash in the location within the barrier limits, OR two or more total crash incidents (which would include property damage only) within the barrier limits? Does the accident data indicate that if the warranted safety feature had been in place the accident would have been prevented or the severity reduced? If NO, then step 2 may not need to be performed unless when applying the "Adjusted Traffic Factor" (ATF) process if a benefit/cost ratio of 4.0 or greater results, then guardrail is clearly warranted and step 2 must be performed.

(2) Natural Vegetation on a Fill Slope: Can the vegetation (treeline, shrubs that lie along the slope below the hinge point) contain an errant vehicle? If NO, then a barrier may be warranted and Step 2 must be performed.

(3) Available Shoulder Width: Does the available shoulder width meet the driver expectancy of the Parkway and/or the 8 to 10 foot clear zone recovery width that allows an errant vehicle to safely correct? If NO, then Step 2 must be performed.

(4) Hazard type, size and offset: Fixed objects and roadside features that may be hazards within the clearzone are defined by type, size (length and width) and offset from edge of pavement.

(5) Unusual Roadway Geometric Conditions: Does the roadway geometry (horizontal curvature--outside/inside of curve or downgrade at this location meet the driver expectancy of the Parkway or Park Road Standards definition of points of unusual danger (outside of curve and downgrade)?

(6) Traffic Growth: The projected percent of increase in ADT determines the annual growth factor.

If there is not a history of crashes in the specific location and the ATF process determines that a barrier is not warranted or is on the low side of possibly warranted then Step 2 is not needed and proposing a barrier should not be undertaken. If there is a history of crashes at the site and the ATF results in a barrier being clearly warranted Step 2 must be completed.

Calculation of the ATF used in the warranting tables is determined by the following formula--ATF = AADT x TG x HC x DG.

Where: AADT is Annual Average Daily Traffic and that number is found in Appendix One, NPS Traffic Monitoring Program, Coverage Count and Data, November 2006

TG is Traffic Growth and this factor value is found in Appendix B, Calculation of the Adjusted Traffic Factor, Table A.1.

HC is Horizontal Curve and this factor value is found in Appendix B, Table A.2.

DG is Down Grade and this factor value is found in Appendix B, Table A.3.

See Appendix Two for additional information about the calculation of the ATF, application of the warranting tables and example application cases.

Step 2: Historic Integrity and Effects Screening:

Screening should be performed to determine the presence of sensitive cultural or environmental resource conditions. This process involves an inventory of roadway alignment, landform and vegetation to assess the ability of the landscape to visually absorb the proposed safety feature; and a historic resource assessment to help determine the impact a proposed safety feature would have on the resources. Part 2 provides more detail on this process.

Project Implementation: If a need for a safety feature is demonstrated and the Historic Integrity and Affects Screening process reveals that there is a minimal adverse effect, then additional guardrail and/or barrier end treatment upgrades may be installed as soon as funding is available. This installation must be carefully designed according to Parkway guidelines/criteria and sited to minimize resource impact. SECTION 2 provides more information on safety mitigation.

THRESHOLDS OF CHANGE

The degree to which an undertaking would affect a cultural landscape character area is dependent upon the proposed new safety feature's visual compatibility with, and contrast to, the qualities of the landscape area's other physical features and how it would change the historic fabric and composition of the cultural landscape character area. Therefore, the degree or severity of change caused by the undertaking on a cultural landscape character area and its associated historic features and fabric would be determined by the change to the historic fabric and the landscape character area's ability to visually absorb the introduction of a new physical feature.

Historic Fabric

In this context the aspects of historic integrity including Materials, Workmanship and Feeling/Aesthetics are more focused on the historic fabric of the bridge, tunnel, and guardwall features or roadside areas where a safety improvement is proposed.

- Materials are the physical elements such as concrete and masonry that were used independently or together on bridge structures. Tunnels have masonry portals or

natural rock faces. Guardwalls are all masonry. Turf stabilized shoulders are a standard along the entire length of the Parkway motor road. Roadside ditch waterways are either turf (unpaved) or paved with bituminous asphalt or stone masonry.

- Workmanship of the early sections of Parkway exhibits a unique design style for bridges where no two were alike. These early bridges are primarily masonry structures. Later bridges have concrete parapet and wing walls and some structures have stone veneer abutments. Most tunnels have masonry portals, but some have not been modified and have the natural rock face. Guardwalls are all masonry but there are various pattern styles and native and non-native stone combined in a particular configuration or pattern.

- Feeling/Aesthetics is the historic sense of the past period of time that is experienced along most all of the sections of Parkway. That historic sense is created by the type and location of contributing historic resources from the Parkway's period of significance as defined by the National Historic Landmark status.

Visual Absorption and Awareness of Roadside

Before the cultural landscape character area's visual absorption can be determined it needs to be understood in terms of two aspects of determining historic integrity including Setting and Design and Spatial Organization.

- Setting is the physical environment of the cultural landscape, the surroundings and the way in which the focal feature to be modified is positioned or sited.

- Design and Spatial Organization encompasses the physical location of a roadside feature in relationship to landform (cut and fill slopes) on the approach side of the feature, presence of vegetation, and curvature of the roadway (both horizontally and vertically).

Setting, Design and Spatial Organization are used to describe the visual character and complexity of a cultural landscape character area and they directly relate to being able to describe a landscape's visual absorption capability.

The ability of various cultural landscape character areas to visually absorb changes is a function of where the viewer is located relative to the introduced feature, the viewer's sightline, and the degree of visual complexity of the landscape that is the backdrop for the feature.

Viewer Sightlines - Experiencing the Parkway for most visitors primarily occurs along the roadway from automobiles, motorcycles, recreation vehicles or bicycles. The view from a vehicle is first limited or controlled by where a person is sitting and then by the configuration and size of windows from which they view the oncoming and passing roadside landscape. In addition, other determinants of what a driver and passengers in a vehicle can see include the width, length and direction of their view.

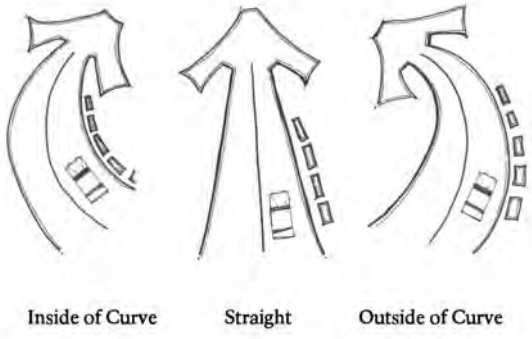


Figure 2: Horizontal Road Alignment

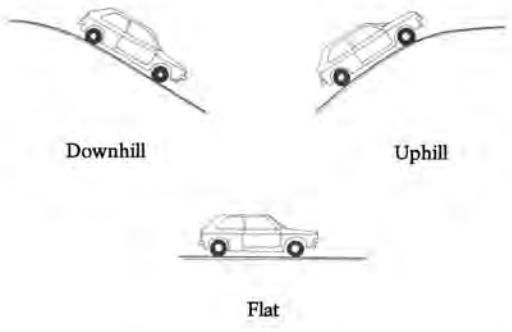


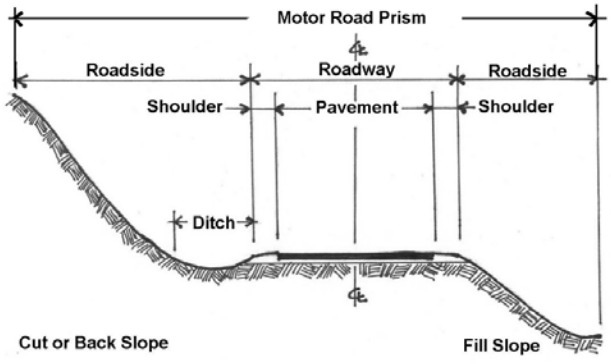
Figure 3: Vertical Road Alignment

Vertical and horizontal alignments of the roadway play a major role in directing a visitor's view. The relationship between roadside features and the curvature of the roadway is one aspect of evaluating the degree to which something placed along the roadside will visually dominate the view or attract attention. On tangent or straight sections of roadway the sightline direction is straight ahead and parallel to the roadside where a safety improvement would be installed. A section where the vehicle is on the inside of the curve the sightline is directed away from the roadside where a safety improvement would be installed. An outside curve section of roadway directs the view towards the safety improvement. So the tangent and inside curve horizontal alignments tend to deemphasize the roadside directly adjacent to the travel lane and focus the viewer beyond and away from roadside details.

Vertical alignments of a roadway also affect how roadsides are viewed, but less than the horizontal alignment does. Views of roadsides from roadways with little vertical curvature tend to emphasize roadside features because the viewer's sightline is parallel to the road surface both near the vehicle and for some distance down the road. Vertical curvature where the alignment is ascending or descending tends to direct views farther down the road. Likewise, views are more focused on roadside features when the feature is on an ascending or descending grade.

The degree of curvature for both horizontal and vertical alignments affects how much sightlines are directed towards or away from roadside objects. For both horizontal and vertical alignments shorter radii tend to either increase the level that views are directed away from or towards roadside features. For longer radii curves views of roadside features do not differ much, they are almost equally visible whether located on the inside or outside of horizontal curves or on ascending or descending vertical curves.

Landscape Visual Complexity - A landscape area's visual complexity is defined by physical and visual attributes of landform. In this situation the concept of landscape visual complexity is being applied, not to distant views, but rather to views of the immediate roadside as seen from a vehicle moving along the Parkway roadway. For the purpose of this analysis, only landform is applied. Landform is described as roadside cut or back slopes and fill slopes located within the roadway prism. A cut or back slope roadside landform typically provides a top of slope elevation that is well above the top of elevation of the proposed safety feature, thus the safety feature should more easily blend in with the landscape. The contrast of the safety feature with the surrounding landscape is minimized because of the presence of the landform backdrop. However, a safety feature placed in the fill slope landform roadside situation is highlighted against the horizon because there is an

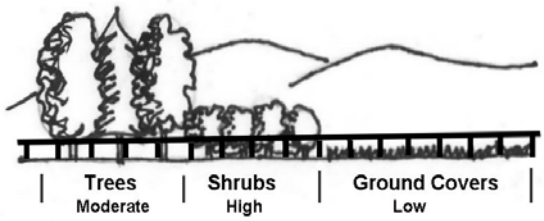


Typical Road Section Landform of the Motor Road Prism

Figure 4: Road Prism

absence of the landform backdrop and therefore less ability to absorb a new roadside feature.

The degree to which a safety feature is visually absorbed is also dependent upon the type of vegetation present on the slope or along or near the top of a fill slope. Typically along the Parkway roadside there are combinations of trees, shrubs and ground covers. An illustrative example of the visual absorption capability of vegetation types is shown in figure 5. In this example a section of guardrail passes in front of trees, shrubs and ground cover illustrating the absorption capability of each vegetation type. Trees and shrubs by virtue of their height have a greater capacity to extend above a safety feature eliminating the situation where the safety feature is highlighted against the horizon. Ground cover has minimal capacity to absorb the addition of a safety feature along the roadside in a fill slope landform situation as shown in the graphic below. The roadsides that exhibit the most visual absorptive qualities are those in which there is a cut/back slope covered with a mix of trees, shrubs and ground covers. Given the backdrop landform and the density of vegetation, these landscape areas would most effectively absorb new roadside features. Safety features such as wooden guardrails with natural materials would have a low to moderately low contrast with the surrounding landscape in this type of setting. Roadsides comprised of fill slopes with low vegetation would have the least landscape visual complexity and therefore the least ability to absorb the introduction of a new roadside safety feature.



Visual Absorption Capability by Vegetation Type

Figure 5: Vegetation Absorption

HISTORIC INTEGRITY AND EFFECT SCREENING

Inventory: Field inventory is the first step in the Historic Integrity and Affects Screening process and is used to determine the level of intensity that the impact of a proposed safety improvement would have on the existing conditions of the Parkway. The example Field Inventory Form will guide in the process of inventorying the information needed to assess proposed project areas for impacts.

Information and Supplies Needed to Perform Field Inventory:

- Scaled PLUM for project area showing location of proposed safety feature
- Field Inventory Form to record vegetation and landform
- Visual Absorption Assessment Worksheet: form to record and value road alignment, vegetation character and landform data
- Supplies: Red pen, engineers scale, camera, and a measuring wheel

All data collected during field work will be recorded on the Field Inventory Form shown below. Instructions for completing the form follow on page 12.

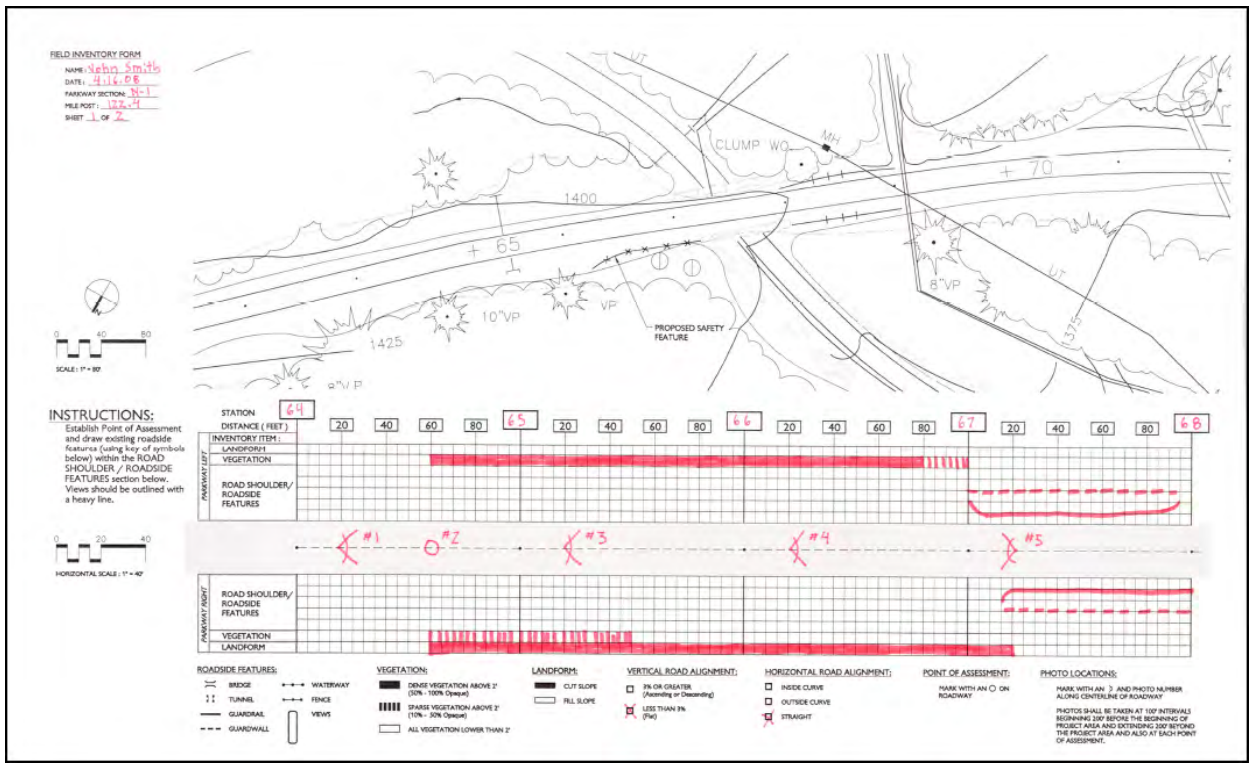


Figure 6: Sample Field Inventory Form-Southbound Approach

Above are example photographs showing the driver's view of roadside and bridge approaches being evaluated on the inventory from.

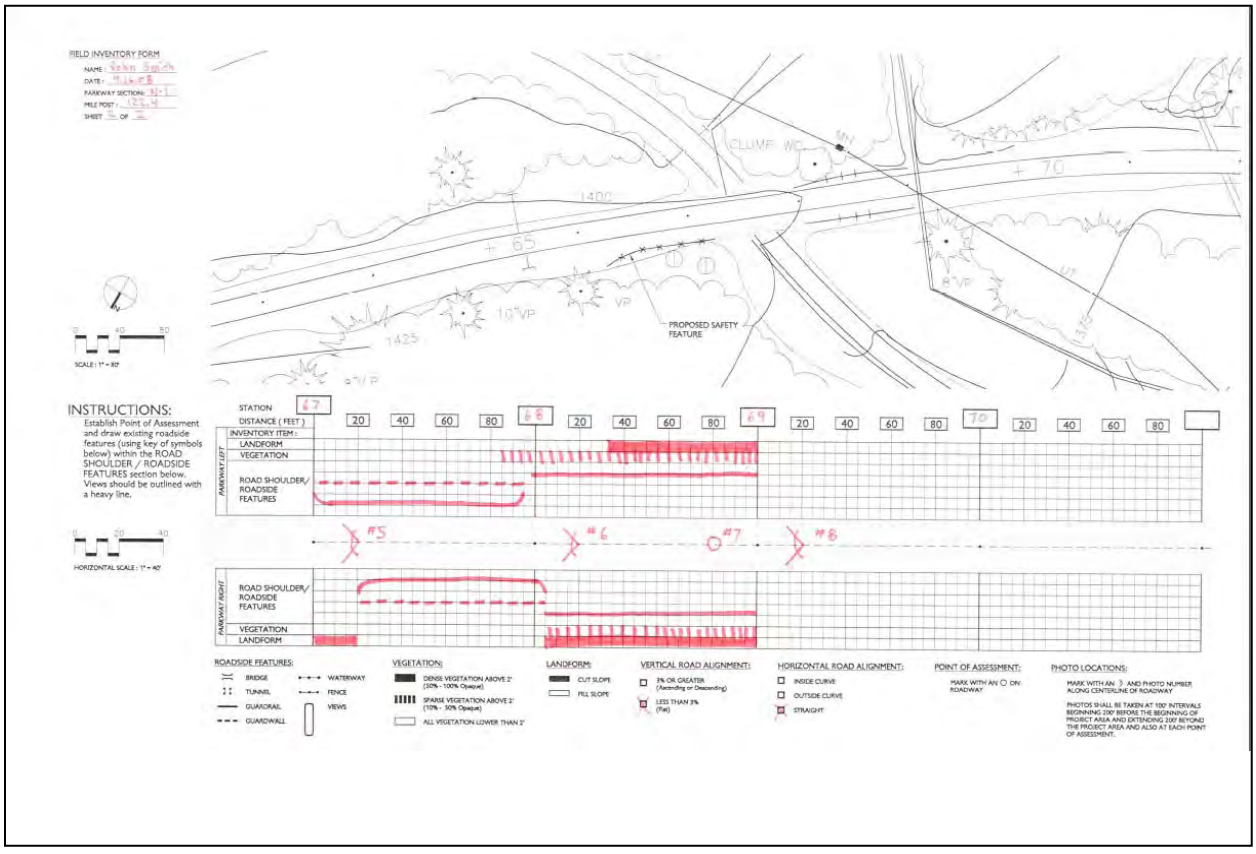


Figure 7: Sample Field Inventory Form-Northbound Approach

Field Inventory Form Instructions:

1. Before you begin: In the top left corner of the field form, record the name of person performing the field work, the date of the inventory, the parkway section in which the proposed project occurs, the closest milepost north of the project area. Many project areas will stretch across several inventory sheets; therefore it is critical to number each sheet of the project area. One hundred feet of overlap between each sheet of the project set is needed for clarity.

2. Determine the Points of Assessment: Each project will be evaluated from both the northbound and southbound drivers' perspective. One point of assessment will be located 150' north of the northern end of the proposed safety feature. The second point will be located 150' south of the southern end of the proposed project. These are the points from which the proposed safety feature will be evaluated.

3. Draw existing roadside features where they occur along the roadway within the Road Shoulder/Roadside Features row of the field form: Symbols for each roadside feature type to be inventoried are found in a Roadside Features legend at the bottom left side of the form.

4. Record roadside vegetation character: Within the Vegetation row of the field form, use a symbol from the Vegetation Legend at the bottom of the field form to record the vegetative character along each side of the roadway. Only the vegetation character which occurs within the first 25' of the road shoulder should be inventoried.

5. Record the landform type that exists on each side of the roadway: Within the Landform row of the field form, use a symbol from the Landform Legend at the bottom of the field form to record the landform type found immediately along each side of the roadway. Only the landform types should be determined by evaluating the first 25' of the road shoulder.

6. Record vertical and horizontal road alignment: Within the appropriate column at the bottom of the form, check the road alignment condition which describes the overall road alignment within the project area. From the point of assessment, what is the general character of the horizontal and vertical road alignment?

7. Photograph the project area: Photos should be taken at 100' intervals beginning 200' from each end of the proposed safety structure. Photos should be taken using a digital camera, with each photo saved to produce a 300dpi, 8x10 .jpeg image. Each photo should be oriented with the center line and taken from the center line of the roadway. The photo location and photo number shall be recorded along the center line of the road on the field form.

Visual Absorption Assessment: Information gathered during field inventory will be used to assess the ability of landscape within the project area to visually absorb the introduction of a new safety feature. It is most desirable to complete the assessment while conducting the field inventory work, but the visual absorption assessment may also be completed remotely using the field inventory form and photos as the basis for decision making. The VISIDATA computerized data base is another source that contains still and video photographic documentation of roadside conditions that may also be used remotely for the visual absorption assessment. The Sample Completed Absorption Assessment Worksheet (Figure 8) will be helpful in completing an assessment of other project areas.

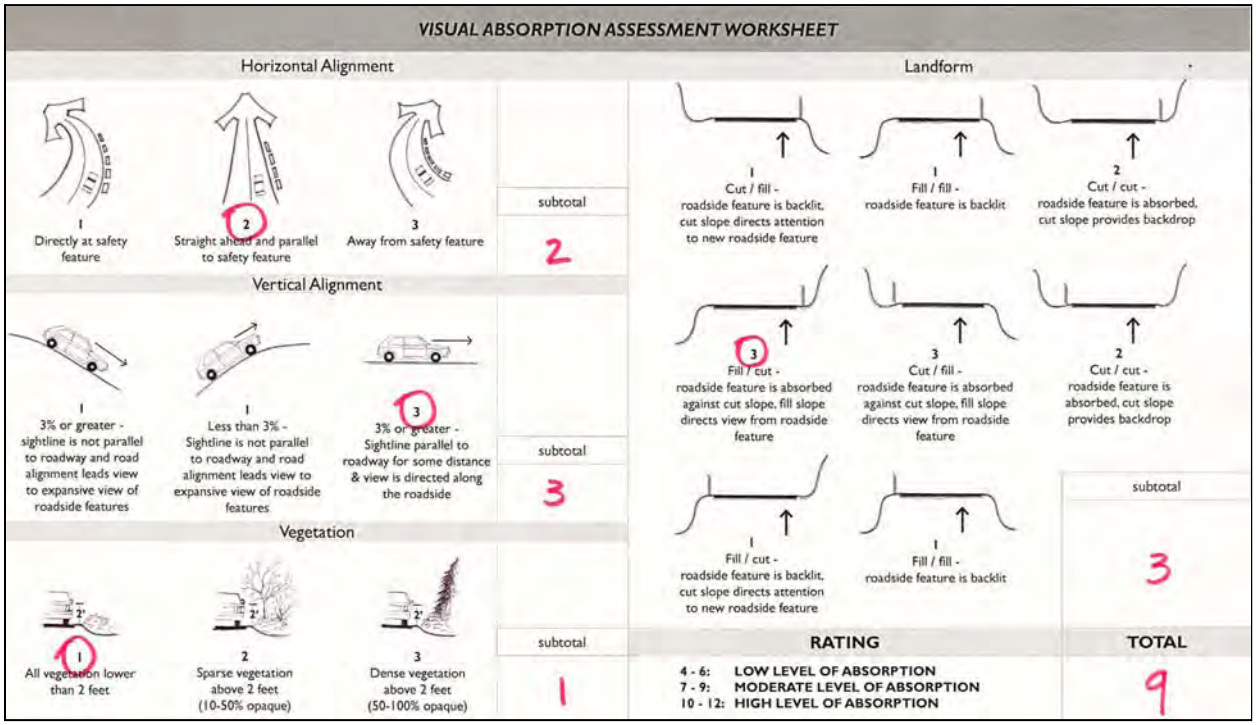


Figure 8: Sample Completed Absorption Assessment Worksheet

Using the information recorded on the field inventory form assess the general condition of the project area by filling out the Visual Absorption Assessment Worksheet. Two assessments should be provided for each project area, one from the assessment point north of the project and one from the southern assessment point.

1. Assessing horizontal alignment: Consult the field inventory form for your project area to obtain the horizontal alignment of the project area. Enter the value associated with the horizontal alignment in the totals column on the right side of the assessment worksheet.

2. Assessing vertical alignment: Consult the field inventory form for your project area to obtain the vertical alignment of the project area. Enter the value associated with the vertical alignment in the totals column on the right side of the assessment worksheet.

3. Record the assessment rating for vegetation: From the established assessment points determine the vegetative character of the vegetation which serves as the backdrop for the new safety feature. Record the value associated with the vegetation character in the totals column on the right side of the assessment worksheet.

4. Record the assessment rating for the landform: From the established assessment points determine the type of landform which serves as the backdrop for the new safety feature. Record the value associated with the landform type in the totals column on the right side of the assessment worksheet.

5. Total the values for each assessment category for both assessment points.

6. Proposed safety features will be assessed from both a north and south bound direction. The assessment which finds the greatest visual impact to the Parkway will be used to assess the overall impact of the proposed project. (The lower of the two visual absorption assessment scores will be used as the visual absorption rating for the proposed project).

Historic Assessment of Roadside Features: For purposes of assessing potential impacts to historic resources, the thresholds of change for the intensity of an impact is evaluated in terms of alteration of the historic fabric of the Parkway. Based on the Historic Resource Study for the Parkway contributing historic resources are very likely to occur within any proposed 3-R project area. These resources include elements of the Parkway such as bridges, road shoulder and views. As part of Step 2 in the Screening Process, the historic resources of a project area must be evaluated to determine the historic integrity of the resources. This assessment and determination must take the form of a Cultural Landscape Report (CLR) and must be conducted by a NPS approved professional using the period of significance identified in the Parkway's Historic Resource Study. SECTION 2 gives more specific direction for completing the historic resource assessment.

Effect Findings

The following effect would be determined based on the historic integrity of the resources and the landscapes ability to visually absorb a new feature:

Negligible: No action taken

Minor: Impact – alteration of a resource which possesses low historic integrity where safety improvement could be made without diminishing the overall historic integrity of the project area due to the ability of the landscape to visually absorb the safety feature. *For the purposes of Section 106, the determination of effect would be no adverse effect.*

Moderate: Impact – alteration of a resource which possesses high or moderate historic integrity where implementation of a safety improvement would diminish the overall integrity of the resource(s) of the project area would be deemed a Moderate Adverse Effect despite the ability of the landscape to visually absorb the safety feature. Similarly, alteration of a resource which possesses low historic integrity to provide a safety upgrade which occurs in an area with low or moderate landscape absorption would be a Moderate Adverse Effect. *For the purposes of Section 106, the determination of effect would be adverse effect.* A Memorandum of Agreement (MOA) or Programmatic Agreement (PA) is executed among the NPS and applicable state and/or

tribal historic preservation officers and, if necessary, the Advisory Council on Historic Preservation (ACHP) in accordance with 36 CFR 800.6. Measures identified in the MOA or PA to minimize or mitigate adverse impacts reduces the impact intensity under National Environmental Policy Act (NEPA) from major to moderate.

Major: Impact - alteration of a resource which possesses high or moderate historic integrity to provide a safety upgrade which occurs in an area with moderate or low landscape absorption would be a Major Adverse Effect. Proposed alterations to resource(s) which result in impairment of that resource are considered a Major Adverse Effect. *For the purposes of Section 106, the determination of effect would be adverse effect.* Measures to minimize or mitigate adverse impacts cannot be agreed upon and the NPS and applicable state and/or tribal historic preservation officer and/or the ACHP are unable to execute a MOA or PA in accordance with 36 CFR 800.6.

The table below summarizes the above information by illustrating when possibly warranted barriers would have major to minor adverse effects considering the effects findings by combining the findings of the historic resource assessment for the project area and the assessment of the project areas ability to absorb a new feature.

Table 1: Adverse Effect Considerations for "Possibly Warranted" Barriers

Consideration	Barrier would be a major adverse effect if:	Barrier would be a moderate adverse effect if:	Barrier would be a minor adverse effect if:
Level of integrity of landscape features & spatial organization	High to moderate historic integrity of resources	Moderate to low historic integrity of resources	Low historic integrity of resources
Alteration of historic fabric—materials, workmanship or feeling/aesthetics	Major to moderate alteration of historic fabric	Moderate to minor alteration of historic fabric	Minor to no alteration of historic fabric
Visual absorption capability of landscape setting	Landscape has low absorption capability	Landscape has low to moderate absorption capability	Landscape has moderate to high absorption capability

Impact mitigation	Barrier would not be installed—*safety variance utilized and low impact mitigation treatment may be installed*	Barrier may be installed—*if so measures identified in MOA or PA to minimize or mitigate adverse impacts would be implemented*	Barrier would be installed— *addition is deemed visually compatible with landscape*

Step 3: Findings Evaluation & Decision:

This is the decision making step where the Step 1 warranting data for the roadway, traffic, potential hazard, crash history, other issues and the warranting considerations found in Table A.4 are weighed against the Step 2 level of adverse effect that the barrier undertaking would have given characteristics of the historic designed parkway landscape. Table 1: Adverse Effect Considerations for "Possibly Warranted" Barriers from Step 2 would be used in conjunction with Table A.4 Barrier Warrant Considerations for "Possibly Warranted" Conditions from Step 1 to focus the findings evaluation and discussions between NPS and EFLHD staff.

SECTION 2 – HISTORIC RESOURCE ASSESSMENT

The Roadside Safety and Effect Screening Process discussed in Section 1 must be implemented with a full understanding of the Blue Ridge Parkway's designed landscape features that have been individually assessed and classified as contributing or noncontributing to the national significance of the Blue Ridge Parkway.

In his December 2005 Blue Ridge Parkway, Virginia and North Carolina Historic Resource Study, Ian Firth evaluated the Blue Ridge Parkway's eligibility for designation as a National Historic Landmark. This work was commissioned by the Blue Ridge Parkway in accordance with U.S. Department of the Interior's criteria for nominating a property as a National Historic Landmark. As part of the nomination process the period of national significance for the property was determined. (This is the period of time in which the Parkway attained its national significance). Firth makes the case that the period of national significance for the Blue Ridge Parkway is 1933 when the Parkway project was initiated until 1987 when the Parkway was completed. Within this timeframe he identifies two stories; the first 22 years of design and construction of a new national road type (1933- 1955) and the story of completing the roadway (1956-1987). This document refers to the period between 1933 and 1955 as the Design and Early Construction Era and the period between 1956 and 1987 as the Road Completion Era.

A designed landscape feature is considered to be a contributing resource to the property if it was present during the period of national significance, relates to the significance of the property, and possesses a high degree of historical integrity. A designed landscape feature is determined to be a noncontributing resource if it did not exist during the period of national significance, does not relate to the documented national significance of the property, or due to alterations, disturbances, additions, or other changes, it no longer possesses a high degree of historical integrity. In his Historic Resource Study for the Parkway, Firth defined all resources related to the Design and Early Construction Era as potentially contributing. Additionally, only the resources directly related to the completion of the road and its scenic corridor are potentially contributing in the Road Completion Era. These items include the road prism and all associated structures there in, as well as, all overlooks, parking areas and interchanges and their associated structures. Firth states that "the road prism includes all constructed landforms from top of cut to toe of fill; and the overlooks and parking areas include all constructed landforms within and around each area." Structures such as tunnels, waterways, culvert

and guardrails are some of the potential contributing resources that are likely to be encountered within Parkway project areas.

While the Historic Resource Study for the Parkway has thoroughly established its great national importance, defined its period of national significance and listed the types of potential contributing resources that are present, not all of the individual resources have been inventoried and assessed. The NPS has begun the process of developing the List of Classified Structures for the Parkway to determine which designed landscape features qualify as contributing or noncontributing.

Because this work has not been completed for the entire Parkway, it is critical that the resources of the Blue Ridge Parkway be assessed before any project which could potentially change the Parkway is approved. Projects which involve work other than repair, in-kind replacement of failing resources or general maintenance must document and assess all resources in the vicinity of the project area to insure that resource integrity is maintained.

For the purposes of historic resource assessment on the Blue Ridge Parkway, there are some special considerations that are vital to consider when evaluating a roadside safety project proposal:

- A clear understanding of the proposed roadway safety project scope and project area description.

- Developing the historical overview and context for the project area should be informed by the existing Historic Resource Study for the Parkway.

- Parkway Land Use Maps (PLUMs) shall serve as historical base maps/period plans.

- All resources indicated on the PLUMs will be considered in the evaluation of historic resources.

- An accurate site map to represent existing conditions should be produced by updating the PLUMs to include any additional existing features or missing original features.

- Updating the PLUMs is an ongoing effort that should be completed prior to assessing the resources on a project.

- The preferred treatment for the indentified section of parkway that best preserves and balances integrity, historical significance and current needs/use will be.

- The original design goals for the Parkway and the Secretary of the Interiors Standards for Historic Preservation should be reflected in treatment recommendations.

- The effects of proposed safety improvements on historic resources should be addressed in project scoping treatment recommendations, however it should be noted that the treatment recommendations may cause significant alteration to the initially proposed project scope.

- Changes necessary to address safety issues along the Parkway should not alter or remove contributing resources, but rather take the form of distinct but visually compatible and unifying additions to the original fabric.

- The Organic Act of 1916 protects against the "impairment" of resources. Impairment of Parkway resources must be avoided.

Once the determination is made for which designed landscape features qualify as contributing or noncontributing the following should be considered if a safety feature is warranted:

- Creative mitigation options should be considered that uphold the design philosophy of the Parkway.

- The safety feature should not be disguised as an original part of the structure in terms of materials, style of construction, color, texture, etc. but should be visually compatible with the structure.

- Materials should be evaluated as to their ability to fit into the surrounding landscape and designed so that the feature is visually absorbed by the landform or vegetation.

- A design variance may be used when the accident data does not indicate a contributing site problem and the other screening evaluation criteria possibly warrant a safety feature.

- A "mock up" section should be constructed to test and approve prior to full construction whenever a new type or style of safety feature is to be installed, an unusual site condition exists, or when its visual absorption capability needs to be evaluated.

- Designers should participate during construction.

- Design alternatives should be considered on a case by case basis considering the conditions of that particular site "one size does not fit all" therefore there should be no standard solution.

- Safety mitigation requires abstract thinking in terms of assessing the value in the scenic landscape.

LIST OF PREPARERS

A technical advisory group comprised of individuals from the National Park Service, Federal Highway Administration and State Historic Preservation Offices of North Carolina and Virginia were invited to provide review and critique of this document. A series of meetings were held with this group to present research findings, conduct field testing of the methodology and to aid the design consultant in refining the processes associated with the final Guidebook.

This group included:

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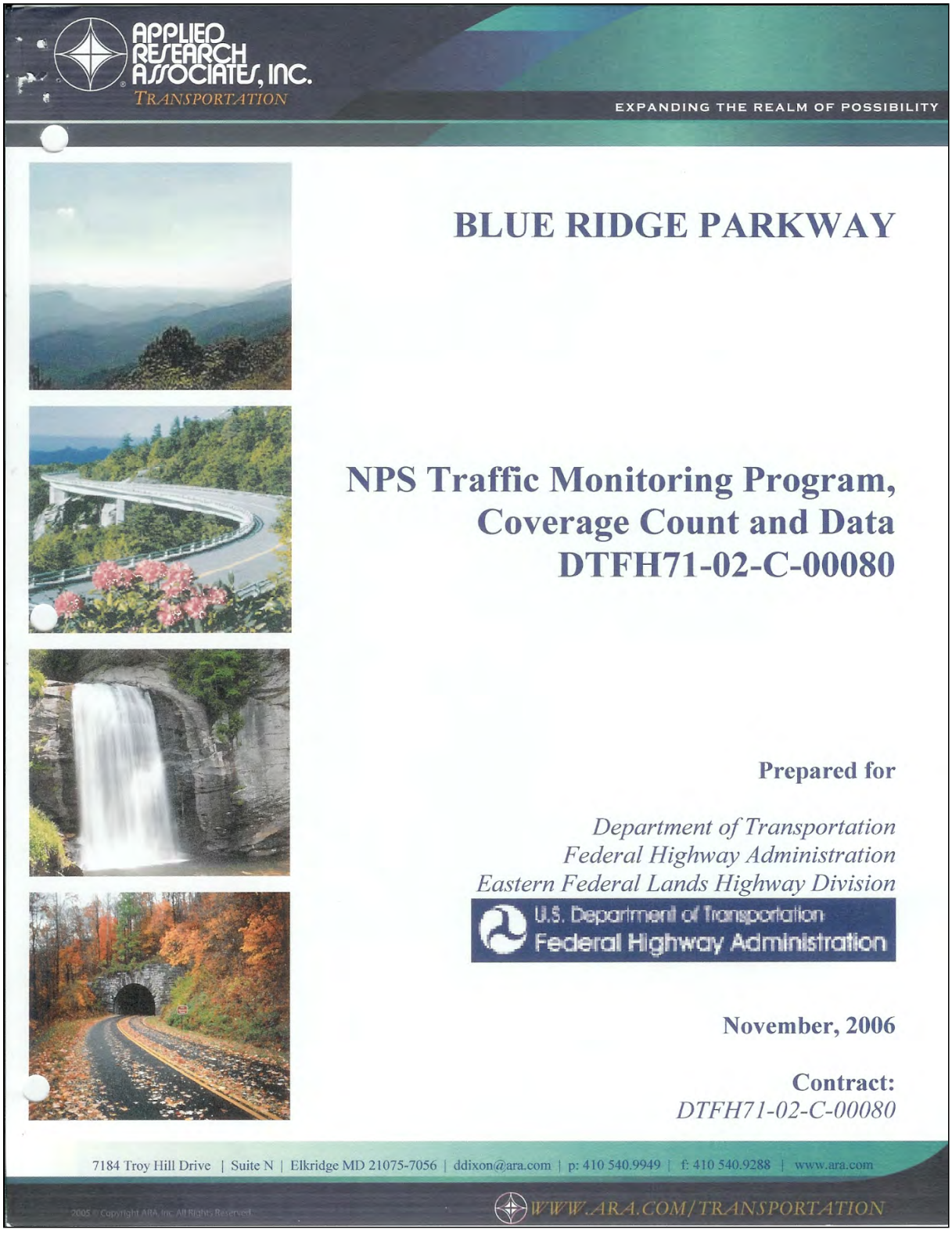
APPENDIX ONE: NPS Traffic Monitoring Program, Coverage Count and Data, Blue Ridge Parkway, November 2006



This report contains the results of the traffic data study conducted as a part of the National Park Service (NPS) Traffic Monitoring Program designed to provide system coverage traffic data. In addition to the results obtained during current traffic data collection effort, the report includes summary results and traffic statistics from the similar efforts done in 1988,1991, and 1994. The reader should note that although the information presented in this report and in the traffic database has been thoroughly reviewed, the statistics used to develop the report, as all statistics, are subject to accuracy limits. Therefore, while this report is intended to provide a representation of actual situations, it is not presented, nor should it be interpreted, as absolute facts.

The NPS/FHWA Traffic Monitoring Program is part of an ongoing program managed jointly by the NPS and the Federal Highway Administration (FHW A) to monitor traffic on national park roads and provide information in support of traffic safety, transportation planning, visitor-use planning, roadway maintenance, bridge and pavement management, and traffic operations programs.

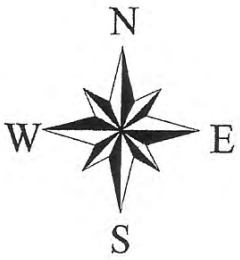
In 1984, the Branch of Transportation of the NPS Denver Service Center began installing a system of permanent traffic counting equipment. By 1989, equipment had been installed at all 59 park units planned for in the program. In subsequent years, a number of parks have been withdrawn from the program based on evaluations of their traffic data and the need to make more effective use of the staffing available to conduct the program. The parks remaining in the program today represent those with the highest traffic and include parks with notable traffic safety concerns.

The traffic data collection program at each park unit consists of four types:

1. Continuous volume counts at limited permanent locations.
2. Short-term volume counts covering a large number of locations.
3. Short-term manual vehicle classification counts at strategic locations.
4. Short-term manual vehicle occupancy counts at strategic locations.

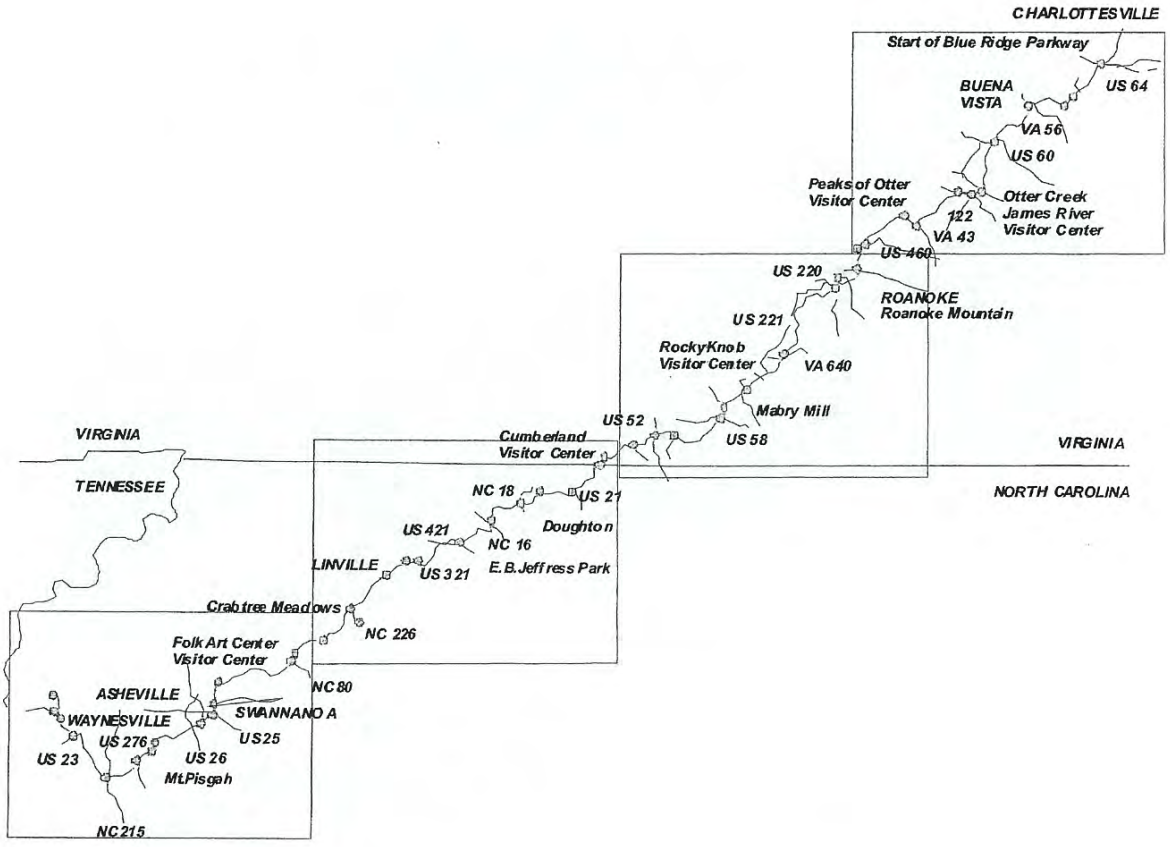
The following Blue Ridge Parkway segment portion maps and traffic trend tables are excerpted from the NPS Traffic Monitoring Program, Coverage Count and Data, Blue Ridge Parkway, November 2006. They provide average annual daily traffic counts for 1991, 1994 and 2006 as well as a more detailed traffic summary for 2006. These data will be used during FLHP project scoping for the warranting process unless more current data are available.

National Park Service
2004 Traffic Data Report Addendum

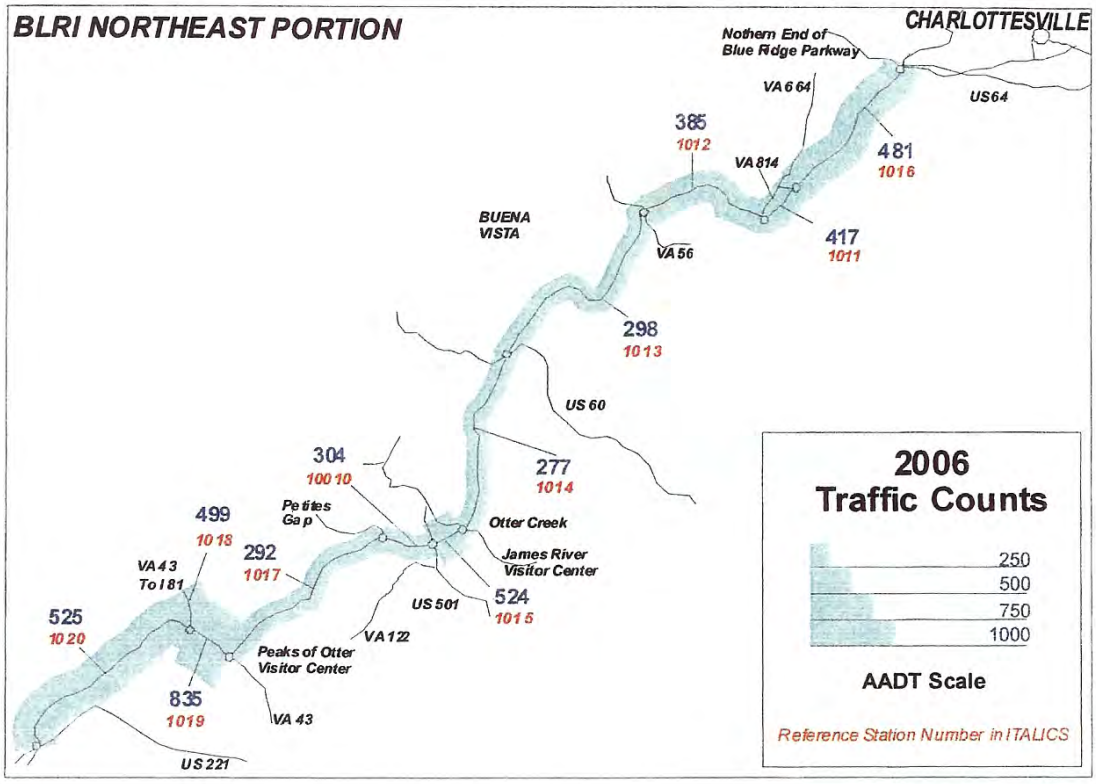


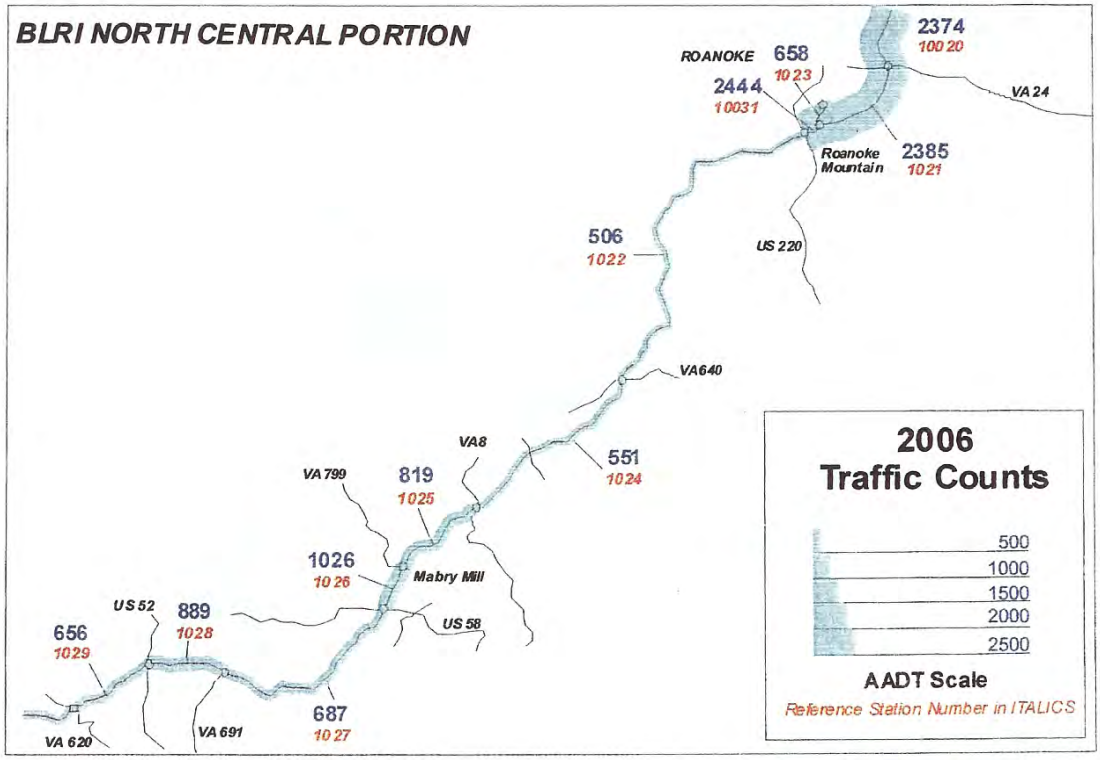
Blue Ridge Parkway

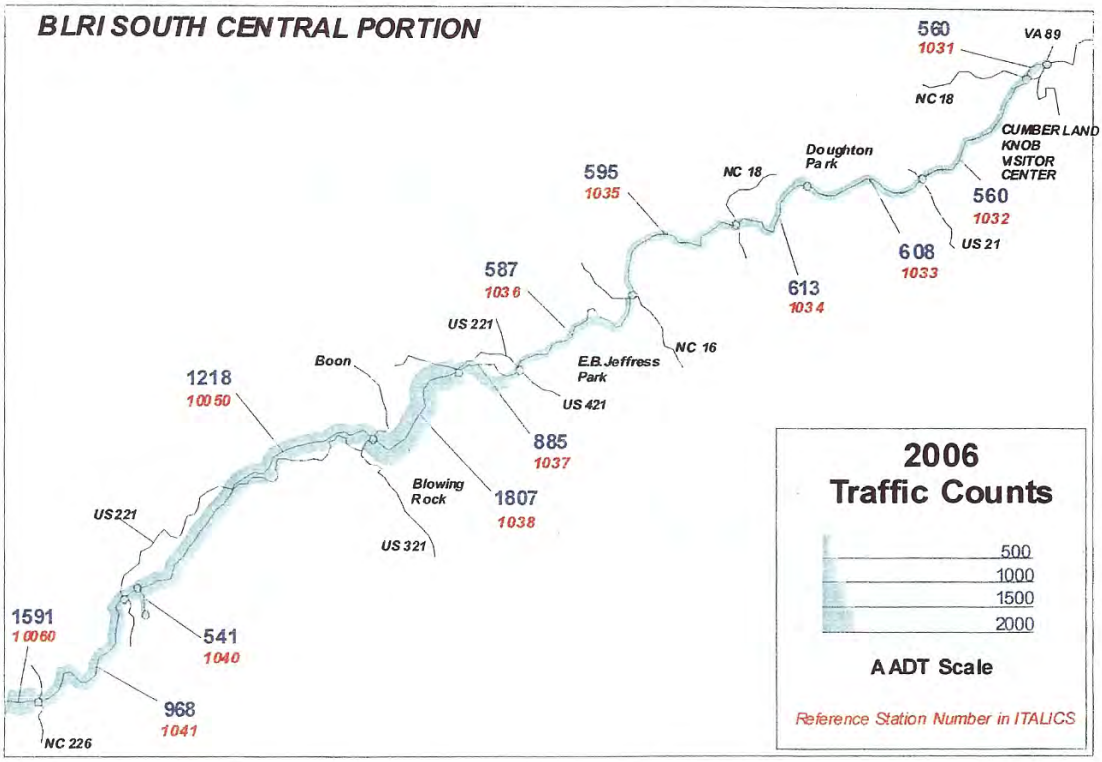
North Carolina and Virginia
U.S. Department of Interior
NATIONAL PARK SERVICE

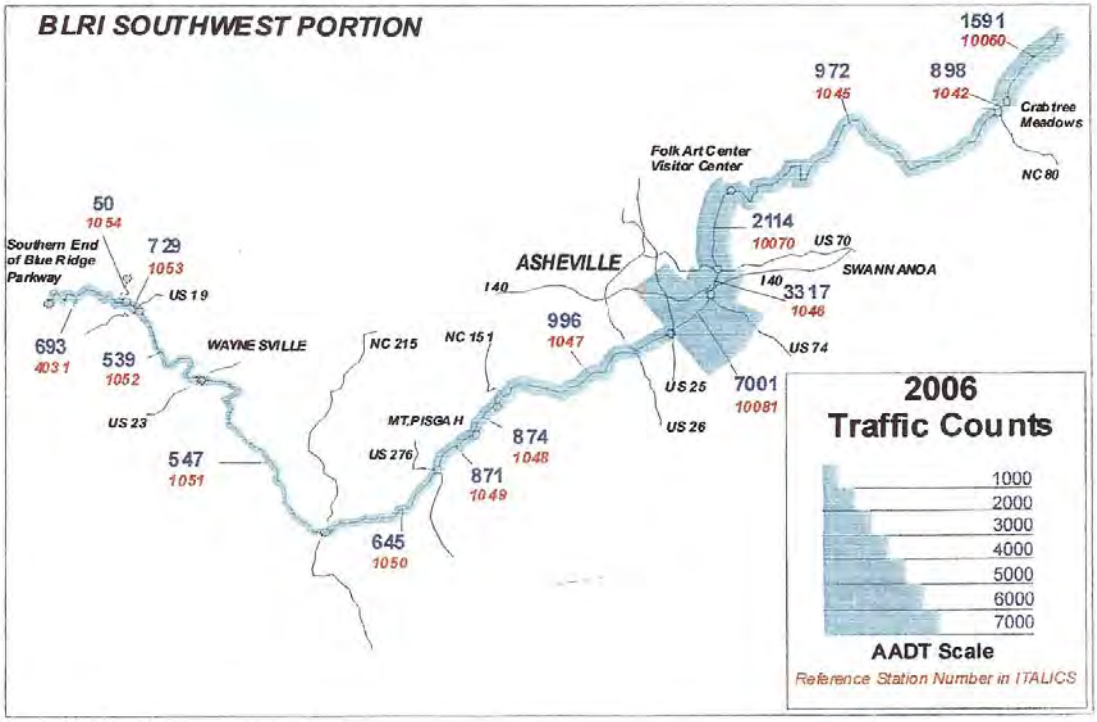


PARKWAY SEGMENT PORTION LOCATION MAP


BLRI NORTHEAST PORTION
CHARLOTTESVILLE
Nothern End of Blue Ridge Parkway
VA 664
US64
385
1012
481
1016
VA 814
BUENA VISTA
VA 56
417
1011
298
1013
US 60
304
10010
277
1014
Petites Gap
499
1018
Otter Creek
James River Visitor Center
292
1017
VA 43 To I 81
US 501
524
1015
525
1020
VA 122
Peaks of Otter Visitor Center
835
1019
VA 43
US 221
2006 Traffic Counts
250
500
750
1000
AADT Scale
Reference Station Number in ITALICS


BLRI NORTH CENTRAL PORTION
2374
10020
ROANOKE
658
1023
2444
10031
VA 24
Roanoke Mountain
2385
1021
506
1022
US 220
VA640
VA8
551
1024
VA 799
819
1025
1026
1026
Mabry Mill
US 58
US 52
889
1028
656
1029
687
1027
VA 691
VA 620
2006 Traffic Counts
500
1000
1500
2000
2500
AADT Scale
Reference Station Number in ITALICS


BLRI SOUTH CENTRAL PORTION
560
1031
VA 89
NC 18
CUMBERLAND KNOB VISITOR CENTER
Doughton Park
NC 18
595
1035
560
1032
US 21
608
1033
613
1034
587
1036
US 221
NC 16
E.B. Jeffress Park
US 421
Boon
1218
10050
885
1037
Blowing Rock
1807
1038
US 321
US 221
1591
10060
541
1040
968
1041
NC 226
2006
Traffic Counts
500
1000
1500
2000
AADT Scale
Reference Station Number in ITALICS


BLRI SOUTHWEST PORTION
1591
10060
972
1045
898
1042
Crabtree Meadows
NC 80
Folk Art Center Visitor Center
50
1054
729
1053
Southern End of Blue Ridge Parkway
US 19
2114
10070
US 70
ASHEVILLE
SWANNANOA
I 40
I 40
3317
1046
996
1047
US 74
693
4031
539
1052
WAYNESVILLE
NC 215
NC 151
US 25
7001
10081
US 23
MT. PISGAH
US 26
874
1048
547
1051
US 276
871
1049
645
1050
2006
Traffic Counts
1000
2000
3000
4000
5000
6000
7000
AADT Scale
Reference Station Number in ITALICS

National Park Service Traffic Count Program

BLUE RIDGE PARKWAY **TRAFFIC TRENDS SUMMARY**

Rt. No.	Roadway Segment	Sta. ID.	Length	AADT 1988	AADT 1991	AADT 1994	AADT 2006	VMT(1000's) 1988	VMT(1000's) 1991	VMT(1000's) 1994	VMT(1000's) 2006
1	B.R.Parkway - Interstate Rt 64 to Va. Hwy. 664	1016	13.64	1000	477	759	481	4979	2375	3779	2395
1	B.R.Parkway - Va. Hwy. 664 to Va. Hwy. 814	1011	4.96	1000	448	504	417	1810	811	912	755
1	B.R.Parkway - Va. Hwy. 814 to Va. Hwy. 56	1012	8.51	1000	414	410	385	3106	1286	1274	1196
1	B.R.Parkway - Va. Hwy. 56 to U.S. Hwy. 60	1013	18.39	1000	445	448	298	6712	2987	3007	2000
1	B.R.Parkway - U.S. Hwy. 60 to Otter Creek	1014	15.48	1000	386	318	277	5650	2181	1797	1565
1	B.R.Parkway - Otter Creek to U.S. Hwy. 501	1015	3.03	1000	749	980	524	1106	828	1084	580
1	B.R.Parkway - U.S. Hwy. 501 to Petites Gap	10010	7.02	1000	333	354	304	2562	853	907	779
1	B.R.Parkway - Petites Gap to No. Jct. Va. Hwy. 43	1017	14.83	1000	658	566	292	5413	3562	3064	1581
1	B.R.Parkway - No. Jct. Va. Hwy. 43 to So. Jct. Va. Hwy. 43	1019	4.97	1000	738	698	835	1814	1339	1266	1515
1	B.R.Parkway - So. Jct. Va. Hwy. 43 to U.S. Hwy. 221/460	1020	15.1	1000	638	519	525	5512	3516	2860	2894
1	B.R.Parkway - U.S. Hwy. 221/460 to Va.Hwy.24	10020	6.23	1000	1840	1624	2374	2274	4184	3693	5398
1	B.R.Parkway - Va.Hwy.24 to Mill Mountain Road	1021	8.09	1000	1643	2056	2385	2953	4852	6071	7043
1	B.R.Parkway - Mill Mountain Road to U.S.Hwy.220	10031	0.9	1000	1935	2148	2444	329	636	706	803
1	B.R.Parkway - U.S.Hwy.220 to Va.Hwy.640	1022	29.24	1000	1041	903	506	10673	11110	9637	5400
1	B.R.Parkway - Va.Hwy.640 to Va. Hwy.8.	1024	14.66	1000	576	467	551	5351	3082	2499	2948
1	B.R.Parkway - Va.Hwy. 8 to Va. Hwy.799.	1025	9.07	1000	524	1125	819	3311	1735	3724	2711
1	B.R.Parkway - Va.Hwy. 799 to U.S. Hwy.58	1026	3.4	1000	643	1307	1026	1241	798	1622	1273
1	B.R.Parkway - U.S.Hwy 58 to V.A. Hwy.691	1027	15.58	1000	594	460	687	5687	3378	2616	3907
1	B.R.Parkway - V.A. Hwy.691 to U.S.Hwy 52	1028	6.21	1000	842	1700	889	2267	1909	3853	2015
1	B.R.Parkway - U.S.Hwy 52 to V.A. Hwy. 89	1029	16.47	1000	753	1052	656	6012	4527	6324	3944
1	B.R.Parkway - V.A. Hwy. 89 to No. Jct. N.C. Hwy 18.	1031	1.39	1000	673	725	560	507	341	368	284
1	B.R.Parkway - No. Jct. N.C. Hwy 18. to U.S.Hwy.21	1032	12.37	1000	544	797	560	4515	2456	3598	2528
1	B.R.Parkway - U.S.Hwy.21 to Doughton Park	1033	11.47	1000	627	453	608	4187	2625	1897	2545
1	B.R.Parkway - Doughton Park to So. Jct. N.C. Hwy. 18	1034	6.95	1000	500	870	613	2537	1268	2207	1555
1	B.R.Parkway - So. Jct. N.C. Hwy. 18 to N.C. Hwy. 16	1035	13.21	1000	489	721	595	4822	2358	3476	2869
1	B.R.Parkway - N.C. Hwy. 16 to U.S.Hwy 421	1036	15.21	1000	457	819	587	5552	2537	4547	3259
1	B.R.Parkway - U.S.Hwy 421 to U.S.Hwy. 221/421 Conn.	1037	4.21	1000	554	1638	885	1537	851	2517	1360
1	B.R.Parkway - U.S.Hwy. 221/421 Conn. to U.S.Hwy 321	1038	10.97	1000	890	1403	1807	4004	3564	5618	7235
1	B.R. Parkway - U.S.Hwy 321 to U.S.Hwy 221	10050*	25.79	1000	1278	1358	1218	9413	12030	12783	11465
1	B.R. Parkway - U.S.Hwy 221 to N.C.Hwy 226	1041	13.37	1000	765	953	968	4880	3733	4651	4724
1	B.R. Parkway - N.C.Hwy 226 to Crabtree Meadows	10060	8.61	1000	1282	1363	1591	3143	4029	4283	5000
1	B.R. Parkway - Crabtree Meadows to N.C. Hwy. 80	1042	4.65	1000	599	661	898	1697	1017	1122	1524
1	B.R. Parkway - N.C. Hwy. 80 to Folk Art Center	1045	37.86	1000	866	1208	972	13819	11967	16693	13432
1	B.R. Parkway - Folk Art Center to U.S.Hwy.70	10070	0.58	1000	1497	1661	2114	212	317	352	448
1	B.R. Parkway - U.S.Hwy.70 to U.S.Hwy.74	1046	1.61	1000	2945	2313	3317	588	1731	1359	1949
1	B.R. Parkway - U.S.Hwy.74 to U.S.Hwy.25	10081	3.92	1000	4955	5681	7001	1431	7090	8128	10017
1	B.R. Parkway - U.S.Hwy.25 to N.C.Hwy.151	1047	18.88	1000	625	1157	996	6891	4307	7973	6864
1	B.R. Parkway - N.C.Hwy.151 to Mt.Pisgah.	1048	1.05	1000	681	1238	874	383	261	474	335
1	B.R. Parkway - Mt.Pisgah. to U.S. Hwy. 276	1049	3.12	1000	815	1250	871	1139	928	1424	992
1	B.R. Parkway - U.S. Hwy. 276 to N.C.Hwy.215	1050	11.54	1000	552	587	645	4212	2325	2473	2717
1	B.R. Parkway - N.C.Hwy.215 to U.S.Hwy.23	1051	19.76	1000	567	603	547	7212	4089	4349	3945
1	B.R. Parkway - U.S.Hwy.23 to U.S.Hwy.19	1052	12.8	1000	513	545	539	4672	2397	2546	2518
1	B.R. Parkway - U.S.Hwy.19 to Balsam Mountain Road.	1053	2.33	1000	712	757	729	850	606	644	620
1	B.R. Parkway - Balsam Mountain Road to U.S Hwy.441.	4031	11.72	1000	647	725	693	4278	2768	3101	2965
100	Balsam Mountain Road - B.R Parkway to Overlook	1054	8.86	1000	204	216	50	3234	660	699	162
138	Mill Mountain Road - B.R Parkway to Park Boundary	1023	2.32	1000	587	725	658	847	497	614	557
151	Va.Hwy.43 - B.R.Parkway to Park Boundary	1018	1.08	1000	728	793	499	394	287	313	197
212	Linville Falls Road - B.R Parkway to End of Route	1040	1.47	1000	630	947	541	537	338	508	290
VMT SUMMARY								176,251	133,324	159,412	143,057

Note: AADT -- Annual Average Daily Traffic
VMT-- Vehicle Miles of Travel

* A section of the BLRI near Sims Creek Bridge (at MP 295.4 on the Parkway) was closed during the counts for the construction. U.S. Hwy 221 was used for detour. A counter was placed on the ramp that led to the detour.

National Park Service Traffic Count Program

BLUE RIDGE PARKWAY **2006 TRAFFIC VOLUME SUMMARY**

Sta. ID.	STATION LOCATION	BEGIN DATE	24 HR. VOL.	SEAS. FACT.	ANN. FACT.	SADT	AADT	REF. STA.
10010	B.R.Parkway - U.S. Hwy. 501 to Petites Gap	10/24/06	504	0.8623	0.6040	435	304	10010
10020	B.R.Parkway - U.S. Hwy. 221/460 to Va.Hwy.24	10/24/06	2464	1.0424	0.9636	2568	2374	10020
10031	B.R.Parkway - Mill Mountain Road to U.S.Hwy.220	10/24/06	2900	0.9145	0.8428	2652	2444	10031
10032	RAMP FROM BLUE RIDGE PKWY TO U.S.220	10/24/06	1647	0.9040	0.8240	1489	1357	10032
10050*	B.R. Parkway - U.S.Hwy 321 to U.S.Hwy 221	10/24/06	1454	1.0689	0.8380	1554	1218	10050
10060	B.R. Parkway - N.C.Hwy 226 to Crabtree Meadows	10/24/06	2024	1.0840	0.7860	2194	1591	10060
10070	B.R. Parkway - Folk Art Center to U.S.Hwy.70	10/24/06	2828	0.9257	0.7475	2618	2114	10070
10081	B.R. Parkway - U.S.Hwy.74 to U.S.Hwy.25	10/24/06	6968	1.0294	1.0048	7173	7001	10081
10082	RAMP TO U.S 25 @ JCT U.S 25 & BLUE RIDGE PKWY	10/24/06	3881	1.1169	1.0731	4335	4165	10082
1011	B.R.Parkway - Va. Hwy. 664 to Va. Hwy. 814	10/24/06	691	0.8623	0.6040	596	417	10010
1012	B.R.Parkway - Va. Hwy. 814 to Va. Hwy. 56	10/24/06	637	0.8623	0.6040	549	385	10010
1013	B.R.Parkway - Va. Hwy. 56 to U.S. Hwy. 60	10/24/06	494	0.8623	0.6040	426	298	10010
1014	B.R.Parkway - U.S. Hwy. 60 to Otter Creek	10/24/06	458	0.8623	0.6040	395	277	10010
1015	B.R.Parkway - Otter Creek to U.S. Hwy. 501	10/24/06	868	0.8623	0.6040	748	524	10010
1016	B.R.Parkway - Interstate Rt 64 to Va. Hwy. 664	10/24/06	796	0.8623	0.6040	686	481	10010
1017	B.R.Parkway - Petites Gap to No. Jct. Va. Hwy. 43	10/24/06	484	0.8623	0.6040	417	292	10010
1018	Va.Hwy.43 - B.R.Parkway to Park Boundary	10/24/06	518	1.0424	0.9636	540	499	10020
1019	B.R.Parkway - No. Jct. Va. Hwy. 43 to So. Jct. Va. Hwy. 43	10/24/06	867	1.0424	0.9636	904	835	10020
1020	B.R.Parkway - So. Jct. Va. Hwy. 43 to U.S. Hwy. 221/460	10/24/06	545	1.0424	0.9636	568	525	10020
1021	B.R.Parkway - Va.Hwy.24 to Mill Mountain Road	10/24/06	2830	0.9145	0.8428	2588	2385	10031
1022	B.R.Parkway - U.S.Hwy.220 to Va.Hwy.640	10/24/06	600	0.9145	0.8428	549	506	10031
1023	Mill Mountain Road - B.R Parkway to Park Boundary	10/24/06	798	0.9040	0.8240	721	658	10032
1024	B.R.Parkway - Va.Hwy.640 to Va. Hwy.8.	10/24/06	654	0.9145	0.8428	598	551	10031
1025	B.R.Parkway - Va.Hwy. 8 to Va. Hwy.799.	10/24/06	977	1.0689	0.8380	1044	819	10050
1026	B.R.Parkway - Va.Hwy. 799 to U.S. Hwy.58	10/24/06	1224	1.0689	0.8380	1308	1026	10050
1027	B.R.Parkway - U.S.Hwy 58 to V.A. Hwy.691	10/24/06	820	1.0689	0.8380	876	687	10050
1028	B.R.Parkway - V.A. Hwy.691 to U.S.Hwy 52	10/24/06	1061	1.0689	0.8380	1134	889	10050
1029	B.R.Parkway - U.S.Hwy 52 to V.A. Hwy. 89	10/24/06	783	1.0689	0.8380	837	656	10050
1031	B.R.Parkway - V.A. Hwy. 89 to No. Jct. N.C. Hwy 18.	10/24/06	668	1.0689	0.8380	714	560	10050
1032	B.R.Parkway - No. Jct. N.C. Hwy 18. to U.S.Hwy.21	10/24/06	668	1.0689	0.8380	714	560	10050
1033	B.R.Parkway - U.S.Hwy.21 to Doughton Park	10/24/06	726	1.0689	0.8380	776	608	10050
1034	B.R.Parkway - Doughton Park to So. Jct. N.C. Hwy. 18	10/24/06	732	1.0689	0.8380	782	613	10050
1035	B.R.Parkway - So. Jct. N.C. Hwy. 18 to N.C. Hwy. 16	10/24/06	710	1.0689	0.8380	759	595	10050
1036	B.R.Parkway - N.C. Hwy. 16 to U.S.Hwy 421	10/24/06	701	1.0689	0.8380	749	587	10050
1037	B.R.Parkway - U.S.Hwy 421 to U.S.Hwy. 221/421 Conn.	10/24/06	1056	1.0689	0.8380	1129	885	10050
1038	B.R.Parkway - U.S.Hwy. 221/421 Conn. to U.S.Hwy 321	10/24/06	2156	1.0689	0.8380	2304	1807	10050
1040	Linville Falls Road - B.R Parkway to End of Route	10/24/06	688	1.0840	0.7860	746	541	10060
1041	B.R. Parkway - U.S.Hwy 221 to N.C.Hwy 226	10/24/06	1232	1.0840	0.7860	1335	968	10060
1042	B.R. Parkway - Crabtree Meadows to N.C. Hwy. 80	10/24/06	1142	1.0840	0.7860	1238	898	10060
1045	B.R. Parkway - N.C. Hwy. 80 to Folk Art Center	10/24/06	1237	1.0840	0.7860	1341	972	10060
1046	B.R. Parkway - U.S.Hwy.70 to U.S.Hwy.74	10/24/06	4438	0.9257	0.7475	4108	3317	10070
1047	B.R. Parkway - U.S.Hwy.25 to N.C.Hwy.151	10/24/06	1799	0.8121	0.5538	1461	996	4031
1048	B.R. Parkway - N.C.Hwy.151 to Mt.Pisgah.	10/24/06	1578	0.8121	0.5538	1281	874	4031
1049	B.R. Parkway - Mt.Pisgah. to U.S. Hwy. 276	10/24/06	1572	0.8121	0.5538	1277	871	4031
1050	B.R. Parkway - U.S. Hwy. 276 to N.C.Hwy.215	10/24/06	1165	0.8121	0.5538	946	645	4031
1051	B.R. Parkway - N.C.Hwy.215 to U.S.Hwy.23	10/24/06	988	0.8121	0.5538	802	547	4031
1052	B.R. Parkway - U.S.Hwy.23 to U.S.Hwy.19	10/24/06	973	0.8121	0.5538	790	539	4031
1053	B.R. Parkway - U.S.Hwy.19 to Balsam Mountain Road.	10/24/06	1317	0.8121	0.5538	1069	729	4031
4031	B.R. Parkway - Balsam Mountain Road to U.S Hwy.441.	10/24/06	1251	0.8121	0.5538	1016	693	4031
1054	Balsam Mountain Road - B.R Parkway to Overlook	10/24/06	91	0.8121	0.5538	74	50	4031

Note: AADT -- Annual Average Daily Traffic
SADT -- Seasonal Average Daily Traffic computed using data for the months containing 80% of annual volume.
REF. STA. -- a permanent Automated Traffic Recorder (ATR) reference station used to obtain seasonal and annual adjustment factors for coverage counts.

* A section of the BLRI near Sims Creek Bridge (at MP 295.4 on the Parkway) was closed during the counts for the construction. U.S. Hwy 221 was used for detour. A counter was placed on the ramp that led to the detour.

APPENDIX TWO: STEPS IN THE WARRANTING PROCESS FOR THE BLUE RIDGE PARKWAY

The warranting process for the Blue Ridge Parkway is adapted from FLH Barrier Guide for Low Volume and Low Speed Roads, Appendix A: Roadside Barrier Warrants, November 2005.

BARRIER GUIDE

For Low Volume and Low Speed Roads

Publication No. FHWA-CFL/TD-05-009 **November 2005**

U.S. Department of Transportation
Federal Highway Administration

CTIP

Federal Lands Highway
Commitment to Excellence

Central Federal Lands Highway Division
12300 West Dakota Avenue
Lakewood, CO 80228

A.1 INTRODUCTION

The warranting process for the Blue Ridge Parkway presented in this Appendix is adapted from FLH Barrier Guide for Low Volume and Low Speed Roads, Appendix A: Roadside Barrier Warrants, November 2005. The warranting process was developed using the Roadside Safety Analysis Program (RSAP). A number of assumptions were made concerning factors such as roadway type, cross section elements, hazards and barrier cost. These assumptions reduced the number of variables normally considered to the following:

- Hazard type and size
- Hazard offset
- Traffic volume
- Traffic growth
- Horizontal curvature
- Grade
- Speed

Traffic volume, traffic growth, horizontal curvature and grade are taken into account by a factor termed "Adjusted Traffic Factor" (ATF). ATF is calculated by modifying the initial average daily traffic (ADT) with adjustments for traffic growth, horizontal curvature and grade. The ATF is then used in warranting tables for each hazard type. Speed and hazard offset are considered in the warranting tables.

RSAP was run using these variables to determine the ATF required to yield a benefit/cost (b/c) ratio of both 1.0 and 4.0. If the b/c was less than 1.0, a barrier is clearly not warranted. If the b/c was greater than 4.0 a barrier is warranted. The b/c of 4.0 allowed for barrier systems more expensive than the strong post w-beam (other than the concrete safety shape, stone masonry and precast concrete systems). The range of A TF that resulted in b/c of between 1.0 and 4.0 indicated that barriers are possibly warranted. Some guidelines are provided to assist in the application of engineering judgment concerning the use of barriers in this range.

A.2 STEPS IN THE WARRANTING PROCESS

The steps to determine warrants for roadside barriers on low speed and low volume roads using this procedure are:

2.1 Determine the needed clear zone. Beside the physical constraints of the Parkway's typical road section, the concept of driver expectancy was factored into the NPS/BLRI and FHWA/EFLHD agreeing on using 8' to 10' as the required clear zone for the Blue Ridge Parkway.

2.2 Using Tables 2.3, 2.4, 2.5 and 2.6, identify potential hazards within the clear zone that may warrant barriers. Hazards that may warrant barriers include those in Group 2 if there is a clear crash history or if multiple hazards serve to increase the severity. All hazards in Group 3 may warrant barriers.

2.3 Collect the necessary data to perform the analysis. Such data include the length and width of the hazard; the offset of the hazard from the roadway; speed, present traffic volume and anticipated traffic growth factor of the road; curve radius and grade of the road, if appropriate; available crash data and other concerns such as environmental and aesthetic impacts.

2.4 Calculate the ATF using information from Tables A.1, A.2 and A.3 and the formula presented below. The factors in these tables adjust the initial ADT to account for expected traffic growth and the effects of horizontal curves and grade.

2.5 Select the warranting table or tables (summarized in Table A.5) that most closely approximate the actual hazard. Since it is impossible to anticipate all possible roadside hazards, it may be necessary to use two closely associated tables and interpolate the results.

2.6 Using the A TF with the warranting tables, classify possible roadside barriers as either not warranted, possibly warranted or warranted. If roadside barriers are possibly warranted, consider the factors in Table A.4 to evaluate the need for barriers at that location.

Stone masonry guardwall barrier systems are very expensive. The warranting tables do not fully take into account the expense of these systems. Usually there must be a barrier warrant based on safety to justify these systems but in the case of the Blue Ridge Parkway there is an additional exceptional need to meet aesthetics and architectural design standards.

A.2.2 IDENTIFY POTENTIAL HAZARDS

Once the desired clear zone is determined, fixed objects and roadside features that may be hazards within the clear zone can be identified. There are many conditions that present some degree of risk if struck but are not serious enough to consider shielding with a roadside barrier. Tables 2.3 through 2.6 list hazards and their potential severity. Severity increases from 1 to 3, with Group 3 being the more severe.

Table 2.3: Fixed Objects

Potential Hazard	**Group 1** (Low Severity)	**Group 2** (Moderate Severity)	**Group 3** (High Severity)
Bridge piers, abutments and railing ends			X
Boulders, less than 0.3 m (1 ft) in diameter		X	
Boulders, 0.3 m (1 ft) in diameter or larger			X
Non-breakaway sign and luminary supports		X	
Individual trees, greater than 100 mm (4 in) and less than 200 mm (8 in) diameter	X		
Individual trees, greater than 200 mm (8 in) diameter		X	
Groups of trees, individually greater than 100 mm (4 in) diameter*			X
Utility poles		X	

* Because of driver expectancy, a group of trees at a consistent offset for lengthy distances may experience lower encroachment rates, even though the offset may be within the clear zone. In such instances, it may be appropriate to consider the trees a Group 2 hazard.

Table 2.4: Drainage Features

Potential Hazard	**Group 1** (Low Severity)	**Group 2** (Moderate Severity	**Group 3** (High Severity)
Cross Drain Culvert Ends:			
Exposed culvert ends with no headwalls, 1 m (36 in) in diameter or less		X	
Exposed culvert ends with no headwalls, Greater than 1 m (36 in) in diameter			X
Sloped culvert ends, less than 1.2 m (4 ft) in diameter	X		
Sloped culvert ends, greater than 1.2 m (4 ft) and less than 2.4 m (8 ft) in diameter		X	
Sloped culvert ends, 2.4 m (8 ft) or greater in diameter			X
Vertical headwalls, less than 1.0 m (3 ft) in height		X	
Vertical headwalls, 1 m (3 ft) or higher			X
Headwalls with parallel sloped wingwalls, 0.6 m (2 ft) or less height		X	
Headwalls with parallel sloped wingwalls, Greater than 0.6 m (2 ft) height			X
Headwalls with flared and sloped wing walls, 1.0 m (3 ft) or less height		X	
Headwalls with flared and sloped wing walls, greater than 1.0 m (3 ft) height			X
Culvert end sections with crashworthy grates	X		
Parallel Drain Culvert Ends:			
Exposed culvert ends with no headwalls, less than 0.6 m (2 ft) in diameter	X		
Exposed culvert ends with no headwalls, 0.6 m (2 ft) and less than 1.2 m (4 ft) in diameter		X	
Exposed culvert ends, 1.2 m (4 ft) or greater in diameter			X
Mitered culvert ends, less than 1 m (3 ft) in diameter	X		
Mitered culvert ends, 1 m (3 ft) or greater in diameter		X	
Vertical headwalls, less than 1 m (3 ft) above ditch section		X	

Vertical headwalls, 1 m (3 ft) or higher above ditch section			X

Table 2.5: Grading Features

Potential Hazard	**Group 1** (Low Severity)	**Group 2** (Moderate Severity)	**Group 3** (High Severity)
Parallel Ditches:			
Ditches outside the preferred cross section on Figures 3.6 and 3.7 of the *RDG* and with foreslope flatter than 1 V: 3H	X		
Ditches with foreslopes 1V: 3H or steeper (Deep ditches should also meet the foreslope criteria below)		X	
Slopes			
1V: 3H foreslope less than 2 m (7 ft) high*	X		
1V: 3H foreslope 2 m (7 ft) and higher*		X	
1V: 2H to 1V: 1.5H foreslope less than 4 m (13 ft) high*		X	
1V: 2H to 1V: 1.5H foreslope 4 m (13 ft) high and higher			X
Vertical foreslope or fill wall less than 2 m (7 ft) high		X	
Vertical foreslope or fill wall 2 m (7 ft) and higher			X
Backslopes that are uneven, or with deep erosion ruts, large rocks, and trees		X	
Vertical backs lope with horizontal projections of 200 mm (4 in) or smaller	X		
Vertical backslope with horizontal projections larger than 200 mm (4 in)		X	
Downward intersecting slope (transverse to travel way, such as a river bank) 1V: 4H or steeper, between than 0.5 (2 ft) high to 2 m (6 ft) high		X	
Downward intersecting slope (transverse to travel way, such as a river bank) 1V: 4H or steeper, 2 m (6 ft) or higher			X
Upward intersecting slope (transverse to travel way, such as an overpass fill) 1V: 4H to flatter than 1V: 1.5H, greater than 0.3 m (1 ft) high		X	
Upward intersecting slope (transverse to travel way, such as an overpass fill) 1 V: 1.5 H or steeper, greater than 0.3 m (1 ft) high			X

* Slopes are assumed to be relatively smooth and free of obstacles. If slopes are uneven, have deep erosion ruts, large rocks and trees or other vegetation that may cause a vehicle to be

unstable, then the classification should be increased one category. Conditions at the bottom of these slopes must also be evaluated.

Table 2.6: Other Features

Potential Hazard	**Group 1** (Low Severity)	**Group 2** (Moderate Severity)	**Group 3** (High Severity)
Parallel smooth retaining wall or cut slope	X		
Retaining wall parallel or flared away from approaching traffic at flatter than 1:8	X		
Retaining wall flared away from approaching traffic at 1:8 or steeper		X	
Water at a depth of 0.3 m (1 ft) to 1 m (3 ft)		X	
Water at a depth of 1 m (3 ft) or deeper			X

A.2.3 COLLECT THE NECESSARY DATA

Collect the necessary data to perform the analysis. Such data include the length and width of the hazard; the offset of the hazard from the roadway; speed, present traffic volume and anticipated traffic growth factor of the road; curve radius and grade of the road, if appropriate; available crash data and other concerns such as environmental and aesthetic impacts.

A.2.4 CALCULATION OF THE ADJUSTED TRAFFIC FACTOR

Calculation of the ATF used in the warranting tables is determined by the following formula--ATF = AADT x TG x HC x DG.

Where: AADT is Annual Average Daily Traffic and that number is found in Appendix A, NPS Traffic Monitoring Program, Coverage Count and Data, November 2006

TG is Traffic Growth and this factor value is found in Appendix B, Calculation of the Adjusted Traffic Factor, Table A.1.

HC is Horizontal Curve and this factor value is found in Appendix B, Table A.2.

DG is Down Grade and this factor value is found in Appendix B, Table A.3.

Table A.1: Traffic Growth Adjustment Factor, TG

Annual Growth Factor	Adjustment Factor
0%	1.00
1%	1.10
2%	1.21
3%	1.34
4%	1.49
5%	1.65

Table A.2: Horizontal Curve Adjustment Factor, HC

Radius		Adjustment Factor (HC)	
Meters	Feet	Hazard on Outside of Curve	Hazard on Inside of Curve
586 or greater	1,911 or greater	1.00	1.00
441 - 585	1,431 -1,910	1.50	1.25
351 - 440	1,151 - 1,430	2.50	1.50
291 - 350	951 - 1,150	3.50	1.75
290 or less	950 or less	4.00	2.00

Table A.3: Down Grade Adjustment Factor, DG

Percent Down Grade	Adjustment Factor (DG)
0-2%	1.00
2.1% - 3.0%	1.10
3.1% - 4.0%	1.40
4.1% - 5.0%	1.70
5.1% - 6.0%	1.90
6.1 % and larger	2.00

For example, a road has an initial ADT of 350 and a projected annual growth factor of two percent. The hazard being analyzed is on the outside of a 500 m (1,700 ft)horizontal curve and on a downgrade of four percent. The A TF is:

ATF = Initial ADT * TG * HC * DG

ATF = 350 * 1.21 * 1.50 * 1.40

ATF = 889

A.2.5 APPLICATION OF THE WARRANTING TABLES

The warranting tables will yield one of three results:
1. A barrier is not warranted.
2. A barrier is possibly warranted.
3. A barrier is warranted.

If the result is that a barrier is "possibly warranted", the decision to place barriers cannot be clearly quantified and additional considerations must be made. Table A.4 lists the considerations that might be applied in this evaluation.

Table A.4: Barrier Warrant Considerations for "Possibly Warranted" Conditions

Consideration	Barrier is more warranted if:	Barrier is less warranted if:
Adjusted Traffic Factor	ATF is at the high end of range	ATF is at the low end of range
Roadway cross section	Section elements are more severe than assumed	Section elements are less severe than assumed
Size of hazard does not fit the assumption	Hazard is larger	Hazard is smaller
Hazard does not fit the description in the warrant table	Hazard is more severe	Hazard is less severe
Expected cost of barrier	Expected costs will be low	Expected costs will be high
Multiple hazards exist at the site	Many additional hazards	
Operating speed	Likely to exceed design speed	At or below design speed
Crash history	Clear crash pattern	No crash pattern
Aesthetic impacts		Serious concerns
Environmental impacts		Serious concerns

It is difficult to quantify the considerations outlined in Table A.4 if more than one consideration is applicable. This table is intended to aid in the necessary exercise of professional judgment.

A.2.6 WARRANTING TABLES

The tables in this section were developed using RSAP. The following assumptions were made in the analyses:

- Costs. A life cycle of 20 years and a discount of four percent were assumed. Costs for roadside barriers were assumed to be $68.40 per m ($18.00 per ft), plus $2,000.00, to account for end treatments.

- Roadway characteristics. Two-lane, two-way rural collector roads were assumed, with 3.4 m (11 ft) lanes and 0.6 m (2 ft) shoulders. Truck volumes of ten percent were also assumed.

- Segments were assumed to be 600 m (2,000 ft) long, with no grade and no curvature (the ATF accounts for grade and curvature).

- Several hazards from Group 3 (discussed in Section 2.3) were analyzed at varying offsets and sizes.

- Guardrail lengths were estimated using minimal lengths of need. Length of need was calculated to the appropriate clear zone for the speed and ADT. All lengths were rounded to the nearest 3.81 m (12.5 ft) section. Guardrail offsets were assumed to be 0.6 m (2 ft) from the hazard for speeds of 50 km/h (30 mph) and less, 1.0 m (3 ft) for speeds of 55 km/h to 70 km/h (35 to 44 mph), and 1.2 m (4 ft) for speeds of 80 km/h (50 mph) and greater, with a maximum offset of 3.0 m (10ft).

The warranting tables are based on benefit/cost (b/c) ratios of both 1.0 and 4.0. Considering the assumptions if conditions do not result in a b/c of at least 1.0, then a roadside barrier is clearly not warranted. If a b/c of 4.0 or greater is found, then a barrier is clearly warranted. At conditions between 1.0 and 4.0 a barrier may be warranted, and is designated as "possibly warranted."

These tables are appropriate only for rural two-lane roads with speeds of 80 km/h (50 mph) or less and initial traffic volumes less than 2,000 vehicles per year. If the tables are used for other conditions, the results will not be dependable.

Table A.5: Key to Warranting Tables

Hazard	Table
Fixed object, 1.2 m (4 ft) X 1.2 m (4 ft)	A.6
Fixed object, 1.2 m (4 ft) X 3.0 m (10 ft)	A.7
Vertical headwall, 1.0 m (3 ft) high	A.8
Headwall with flared wing walls, 1.2 m (4 ft) high	A.9
1V:2H foreslopes, 4 m (13 ft) high	A.10
1V:2H foreslopes, 14 m (46 ft) high	A.11
Vertical foreslopes, 4 m (13 ft) high	A.12
Group of trees, 30 m (100 ft) long	A.13
Water, 1 m (3 ft) deep	A.14

In the warranting tables, length is measure parallel to the road and width is perpendicular to the road.

Table A.6: Barrier Warrants for Fixed Object 1.2 X 1.2 meters
Metric Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 3.5 m	0 - 249	250 - 999	1,000 (+)
	3.6 - 4.9 m	0 - 249	350 - 1,399	1 ,400 (+)
	5.0 - 6.0 m	0 - 499	500 - 2,399	2,400 (+)
	6.1 - 6.6 m	0 - 1,199	1,200 (+)	
	6.7 - 7.2 m	0 - 2,999	3,000 (+)	
	7.3 (+) m	All		
60 km/h	1.0 - 2.3 m	0 - 299	300 - 1,399	1,400 (+)
	2.4 - 4.9 m	0 - 399	400 - 1,899	1,900 (+)
	5.0 - 6.0 m	0 - 799	800 - 4,999	5,000 (+)
	6.1 - 7.2 m	0 - 1 ,299	1,300 (+)	
	7.3 (+)	All		
50 km/h	0.6 - 1.7 m	0 - 799	800 - 4,999	5,000 +)
	1.8 - 2.9 m	0 - 999	1,000 (+)	
	3. 0 - 3.5 m	0 - 1 ,199	1,200 (+)	
	3.6 - 4.2 m	0 - 1,299	1,300 (+)	
	4.3 (+) m	All		
30 km/h	All	All		

Note: This is the most appropriate table to use for an unprotected end of a bridge wall.

Table A.7: Barrier Warrants for Fixed Objects 4 Feet X 4 Feet

U.S. Customary Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 11 ft.	0 - 249	250 - 999	1,000 (+)
	12 -15ft	0 - 249	350 - 1 ,399	1 ,400 (+)
	16 -19ft	0 - 499	500 - 2,399	2,400 (+)
	20 - 21 ft	0 - 1,199	1,200 (+)	
	22 - 23 ft	0 - 2,999	3,000 (+)	
	24 (+) ft	All		
40 mph	3 - 7ft	0 - 299	300 - 1,399	1 ,400 (+)
	8 -15ft	0 - 399	400 - 1,899	1,900 (+)
	16 -19ft	0 - 799	800 - 4,999	5,000 (+)
	20 - 23 ft	0 -1,299	1,300 (+)	
	24 (+) ft	All		
30 mph	2 - 5ft	0 - 799	800 - 4,999	5,000 (+)
	6 - 9ft	0 - 999	1,000 (+)	
	10 -11ft	0 - 1,199	1,200 (+)	
	12 -13ft	0 -1,299	1,300 (+)	
	14 ft (+)	All		
20 mph	All	All		

Note: This is the most appropriate table to use for an unprotected end of a bridge wall.

Table A.8: Barrier Warrants for Fixed Object 1.2 meters Wide X 3.0 meters Long

Metric Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 3.5 m	0 - 149	150 - 599	600 (+)
	3.6 - 4.8 m	0 - 199	200 - 949	950 (+)
	4.9 - 6.0 m	0 - 399	400 - 1,699	1,7007+)
	6.1 - 6.6 m	0 - 999	1,000 (+)	
	6.7 - 7.2 m	0 - 2,499	2,500 (+)	
	7.3(+) m	All		
60 km/h	1.0 - 2.3 m	0 - 199	200 - 899	900 (+)
	2.4 - 4.8 m	0 - 249	250 - 1,099	1 ,100 (+)
	4.9 - 6.0 m	0 - 699	700 - 4,799	4,8007+)
	6.1 - 6.6 m	0 - 1 ,149	1 ,150 (+)	
	6.7 (+) m	All		
50 km/h	0.6 -1.7 m	0 - 599	600 - 3,599	3,600 (+)
	1.8 - 2.9 m	0 - 799	800 (+)	
	3. 0 - 3.6 m	0 - 949	950 (+)	
	3.7 - 4.2 m	0 -1,049	1,050 (+)	
	4.3 - 4.8 m	0 -1,749	1,750 (+)	
	4.9 - 5.4 m	0 - 2,499	2,500 (+)	
	5.5 (+) m	All		
30 km/h	0.6 - 1.1 m	0 - 4,999	5,000 (+)	
	1.2 (+) m	All		

Table A.9: Barrier Warrants for Fixed Object 4 Feet Wide X 10 Feet Long

U.S. Customary Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 11 ft.	0 - 149	150 - 599	600 (+)
	12 -15ft	0 - 199	200 - 949	950 (+)
	16 -19ft	0 - 399	400 - 1,699	1,700 (+)
	20 - 21 ft	0 - 999	1,000 (+)	
	22 - 23 ft	0 - 2,499	2,500 (+)	
	24 (+) ft	All		
40 mph	3 -7ft	0 - 199	200 - 899	900 (+)
	8 -15ft	0 - 249	250 - 1,099	1 ,100(+)
	16 -19ft	0 - 699	700 - 4,799	4,800 (+)
	20 - 21 ft	0 - 1 ,149	1 ,150 (+)	
	22 (+) ft	All		
30 mph	2 - 5ft	0 - 599	600 - 3,599	3,600 (+)
	6 - 9ft	0 - 799	800 (+)	
	10 -11ft	0 - 949	950 (+)	
	12 -13ft	0 -1,049	1,050 (+)	
	14 -15ft	0 - 1 ,749	1,750 (+)	
	16 -17ft	0 - 2,499	2,500 (+)	
	18 (+) ft	All		
20 mph	2 - 3 ft	0 - 4,999	5,000 (+)	
	4 (+) ft	All		

Table A.10 Barrier Warrants for Vertical Headwall 1.0 Meter High X 2.4 Meters Long

Metric Units

Speed	Hazard Offset	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 2.3 m	0 - 299	300 - 1,199	1,200 (+)
	2.4 - 3.6 m	0 - 349	350 - 1 ,499	1,500 (+)
	3.7 - 4.8 m	0 - 399	400 - 1,899	1,900 (+)
	4.9 - 5.4 m	0 - 999	1,000 (+)	
	5.5 - 6.0 m	0 - 1,799	1,800 (+)	
	6.1 (+)m	All		
60 km/h	1.0 - 2.3 m	0 - 599	600 - 3,199	3,200 (+)
	2.4 - 3.6 m	0 - 699	700 - 4,999	5,000 (+)
	3.7 - 4.8 m	0 - 899	900 (+)	
	4.9 - 5.4 m	0-2,999	3,000 (+)	
	5.5 (+) m	All		
50 km/h	0.6 -1.7 m.	0 -1,700	1,800(+)	
	1.8 - 2.3 m	0 -1,999	2,000 (+)	
	2.4 - 2.9 m	0 - 2,199	2,200 (+)	
	3.0 - 3.6 m	0 - 2,399	2,400 (+)	
	3.7 (+) m	All		
30 km/h	All	All		

Table A.11: Barrier Warrants for Vertical Headwall 3 Feet High X 8 Feet Long

U.S. Customary Units

Speed	Hazard Offset	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 7 ft.	0 - 299	300 - 1,199	1,200 (+)
	8 -11 ft	0 - 349	350 - 1 ,499	1,500 (+)
	12 -15 ft	0 - 399	400 - 1,899	1,900 (+)
	16 -17 ft	0 - 999	1,000 (+)	
	18 -19 ft	.0 -1,799	1,800 (+)	
	20 (+) ft	All		
40 mph	3 - 7 ft.	0 - 599	600 - 3,199	3,200 (+)
	8 -11 ft	0 - 699	700 - 4,999	5,000 (+)
	12 -15 ft	0 - 899	900 (+)	
	16 -17 ft	0 - 2,999	3,000 (+).	
	18 (+) ft	All		
30 mph	2 - 5 ft.	0 - 1,700	1,800 (+)	
	6 -7 ft	0 - 1,999	2,000 (+)	
	8 - 9 ft	0 - 2,199	2,200 (+)	
	10 -11 ft	0 - 2,399	2,400 (+)	
	12 (+) ft	All		
20 mph	All	All		

Table A.12: Barrier Warrants for Headwall with Flared Wing Walls 1.2 Meters High X 2.0 Meters Long X 2.4 Meters Wide

Metric Units

Speed	Hazard Offset	Adjusted Traffic Factor (A TF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 1.7 m	0 - 599	600 - 3.599	3,600 (+)
	1.8 - 2.3 m	0 - 649	650 - 3,799	3,800 (+)
	2.4 - 3.6 m	0 - 699	700 (+)	
	3.7 - 4.2 m	0 - 899	900 (+)	
	4.3 (+) m	All		
60 km/h	1.0 - 2.3 m	0 -1,099	1,1 00 (+)	
	2.4 - 3.6 m	0 -1,399	1,400 (+)	
	3.7 - 4.2 m	0 - 1,999	2,000 (+)	
	4.3 (+) m	All		
50 km/h	All	All		
30 km/h	All	All		

Table A.13: Barrier Warrants for Headwall with Flared Wing Walls
4 Feet High X 6 Feet Long X 8 Feet Wide

U.S. Customary Units

Speed	Hazard Offset	Effective ADT		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 5 ft.	0 - 599	600 - 3.599	3,6007(+)
	6 -7ft	0 - 649	650 - 3,799	3,800 (+)
	8 -11ft	0 - 699	700 (+)	
	12 -13 ft	0 - 899	900 (+)	
	14 (+) ft	All		
40 mph	3 - 7 ft.	0 -1,099	1 , 1 00 (+)	
	8 -11ft	0 -1,399	1,400 (+)	
	12 -13ft	0 - 1,999	2,000 (+)	
	14 (+) ft	All		
30 mph	All	All		
20 mph	All	All		

Table A.14: Barrier Warrants for 1V: 2H Foreslopes 4 Meters High X 30 Meters Long

Metric Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 2.3 m	0 - 549	550 - 2,999	3,000 (+)
	2.4 - 3.6 m	0 - 599	600 - 3,599	3,600 (+)
	3.7 - 4.8 m	0 - 749	750 - 4,999	5,000 (+)
	4.9 - 5.4 m	0 -1,399	1,400 (+)	
	5.5 - 6.0 m	0 - 3,999	4,000 (+)	
	6.1 (+) m	All		
60 km/h	1.0 - 3.4 m	0 - 949	950 (+)	
	2.4 - 3.6 m	0- 1,049	1,050 (+)	
	3.7 - 4.2 m	0-1,249	1,250 (+)	
	4.3 - 4.8 m	0 - 1,499	1,500 (+)	
	4.9 - 5.4 m	0 - 3,199	3,200 (+)	
	5.5 (+) m	All		
50 km/h	0.6 - 2.3 m	0- 2,149	2,150 (+)	
	2.4 - 2.9 m	0 - 2,349	2,350 (+)	
	3.0 - 3.6 m	0 - 3,399	3,400 (+)	
	3.7 (+) m	All		
30 km/h	All	All		

Table A.15: Barrier Warrants for 1V: 2H Foreslopes 13 Feet High X 100 Feet Long

U.S. Customary Units

Speed	Hazard Offset From Edge of TravelWav	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 7 ft.	0 - 549	550 - 2,999	3,000 (+)
	8 -11ft	0 - 599	600 - 3,599	3,600 (+)
	12 -15ft	0 - 749	750 - 4,999	5,000 (+)
	16 -17ft	0 -1,399	1,400 (+)	
	18 -19ft	0 - 3,999	4,000 (+)	
	20 (+) ft	All		
40 mph	3 -7ft	0 - 949	950(+)	
	8 -11ft	0 -1,049	1,050 (+)	
	12 -13ft	0 -1,249	1,250 (+)	
	14 -15ft	0 -1,499	1,500 (+)	
	16 -17ft	0 -3,199	3,200 (+)	
	18 (+) ft	All		
30 mph	2-7ft	0-2,149	2,150 (+)	
	8 -10 ft	0 - 2,349	2,350 (+)	
	10 -11ft	0 - 3,399	3,400 (+)	
	12 (+) ft	All		
20 mph	All	All		

Table A.16: Barrier Warrants for 1V: 2H Foreslopes 14 Meters High X 30 Meters Long

Metric Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 2.3 m	0 -149	150 - 649	650 (+)
	2.4 - 3.6 m	0 - 199	200 - 749	750(+)
	3.7 - 4.8 m	0 - 249	250 - 899	900 (+)
	4.9 - 6.0 m	0 - 399	400 - 1,599	1,600 (+)
	6.1 - 7.2 m	0 - 899	900 (+)	
	7.3 (+)	All		
60 km/h	1.0 - 2.3 m	0- 249	250 - 949	950 (+)
	2.4 - 3.6 m	0 - 299	300 - 1,249	1 ,250 (+)
	3.7 - 4.8 m	0 - 349	350 - 1,599	1,600 (+)
	4.9 - 5.4 m	0 - 549	550 - 3,149	3,150 (+)
	5.5 - 6.0 m	0 - 1,299	1,300 (+)	
	6.1 (+)	All		
50 km/h	0.6 - 2.3 m	0 - 599	600 - 3,199	3,200 (+)
	2.4 - 3.6 m	0 -749	750 (+)	
	3.7 - 4.2 m	0 - 799	800 (+)	
	4.3 (+) m	All		
30 km/h	0.6 - 2.3 m	0 - 3,799	3,800 (+)	
	2.4 (+) m	All		

Table A.17: Barrier Warrants for 1V: 2H Foreslopes 46 Feet High X 100 Feet Long

U.S. Customary Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 7 ft.	0 - 149	150 - 649	650 (+)
	8 -11ft	0 - 199	200 -749	750 (+)
	12 -15ft	0 - 249	250 - 899	900 (+)
	16 -19ft	0 - 399	400 - 1,599	1,600 (+)
	20 - 23 ft	0 - 899	900 (+)	
	24 (+-) ft	All		
40 mph	3 - 7 ft.	0 - 249	250 - 949	9507 (+)
	8 -11ft	0 - 299	300 - 1,249	1,250 (+)
	12 -15ft	0 - 349	350 -1,599	1,600 (+)
	16 -17ft	0 - 549	550 - 3,149	3,150 (+)
	18 -19ft	0-1,299	1 ,300 (+)	
	20 (+) ft	All		
30 mph	2 - 7 ft.	0 - 599	600 - 3,199	3,200 (+)
	8 -11ft	0 - 749	750 (+)	
	12 -13ft	0 - 799	800 (+)	
	14 (+) ft	All		
20 mph	2 - 7 ft.	0 - 3,799	3,800 (+)	
	8 (+) ft	All		

Table A.18: Barrier Warrants for Vertical Foreslopes 4 Meters High X 30 Meters Long

Metric Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF\		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 2.3 m	0 - 249	250 - 1,099	1,100 (+)
	2.4 - 3.6 m	0 - 349	350 - 1,499	1,500 (+)
	3.7 - 4.8m	0 - 449	450 - 1,999	2,000(+)
	4.9 - 6.0 m	0 - 2,999	3,000 (+)	
	6.1 (+)m	All		
60 km/h	1.0 - 2.3 m	0 - 249	250 - 1,099	1,1 00 (+)
	2.4 - 3.6 m	0 - 349	350 - 1,499	1,500 (+)
	3.7 - 4.8 m	0 - 449	450 - 1,999	2,000 (+)
	4.9 - 5.4 m	0 - 2,999	3,000 (+)	
	5.5 (+) m	All		
50 km/h	0.6 - 2.3 m	0 - 249	250 - 1,099	1 , 1 00 (+)
	2.4 - 3.6 m	0 - 349	350 - 1,499	1,500 (+)
	3.7 - 4.8 m	0 - 449	450 - 1,999	2,000 (+)
	4.9 (+) m	All		
30 km/h	0.6 - 2.3 m	0 - 249	250 - 1,099	1,100 (+)
	2.4 - 3.6 m	0 - 349	350 - 1,499	1,500 (+)
	3.7 (+) m	All		
		i		

Table A.19: Barrier Warrants for Vertical Foreslopes
13 Feet High X 100 Feet Long

U.S. Customary Units

Speed	Hazard Offset From Edge of Travel Way	Adiusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 7 ft.	0 - 249	250 - 1,099	1,100 (+)
	8 -11ft	0 - 349	350 - 1 ,499	1,500 (+)
	12 -15ft	0 - 449	450 - 1,999	2,000 (+)
	16 -19ft	0 -2,999	3,000 (+)	
	20 (+) ft	All		
40 mph	3 - 7 ft.	0 - 249	250 - 1,099	1,100 (+)
	8 -11ft	0 - 349	350 - 1 ,499	1,500 (+)
	12 -15ft	0 - 449	450 - 1,999	2,000 (+)
	16 -17ft	0 -2,999	3,000(+)	
	18 (+)ft	All		
30 mph	2 - 7 ft.	0 - 249	250 - 1,099	1,100 (+)
	8-11ft	0 - 349	350 - 1 ,499	1,500 (+)
	12-15ft	0 - 449	450 - 1,999	2,000 (+)
	16 (+)	All		
20 mph	2 - 7 ft.	0 - 249	250 - 1,099	1,100 (+)
	8 -11ft	0 - 349	350 - 1 ,499	1,500 (+)
	12 (+)	All		

Table A.20: Barrier Warrants for Group of Trees 2.4 Meters Wide X 30 Meters Long

Metric Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 2.3 m	0 - 149	150 - 549	550 (+)
	2.4 - 3.6 m	0 - 199	200 - 749	750 (+)
	3.7 -4.8 m	0 - 249	250 - 899	900 ()+
	4.9 - 6.0 m	0 - 349	350 - 1 ,499	1,500(+)
	6.1 - 7.2 m	0 -749	750 (+)	
	7.3 (+)	All		
60 km/h	1.0 - 2.3 m	0 - 249	250 - 999	1,000 (+)
	2.4 - 3.6 m	0 - 299	300 - 1,249	1 ,250 (+)
	3.7 -4.8 m	0 - 349	350 - 1,649	1,650 (+)
	4.9 - 5.4 m	0 - 599	600 - 3,199	3,200 (+)
	5.5 - 6.0 m	0 - 799	800 (+)	
	6.1 (+)	All		
50 km/h	0.6 - 2.3 m	0 - 449	450 - 2,149	2,150 (+)
	2.4 - 3.6 m	0 - 599	600 - 2,999	3,000 (+)
	3.7 - 4.2 m	0 - 799	800 (+)	
	4.3 (+) m	All		
30 km/h	0.6 - 2.3 m	0 - 2,599	2,600 (+)	
	2.4 - 2.9 m	5,000 (+)		
	3.0 (+) m			

Table A.21: Barrier Warrants for Group of Trees
8 Feet Wide X 100 Feet Long

U.S. Customary Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 7 ft.	0 - 149	150 - 549	550 (+)
	8 -11ft	0 - 199	200 -749	750 (+)
	12 -15ft	0 - 249	250 - 899	900 (+)
	16 -19ft	0 - 349	350 - 1,499	1,500 (+)
	20 - 23 ft	0 - 749	750 (+)	
	24 (+) ft	All		
40 mph	3 - 7 ft.	0 - 249	250 - 999	1,000 (+)
	8 -11ft	0 - 299	300 - 1,249	1 ,250 (+)
	12 -15ft	0 - 349	350 - 1,649	1,650 (+)
	16 -17ft	0 - 599	600 - 3,199	3,200 (+)
	18 -19ft	0 - 799	800 (+)	
	20 (+) ft	All		
30 mph	2 - 7 ft.	0 - 449	450 - 2,149	2,150 (+)
	8 -11ft	0 - 599	600 - 2,999	3,000 (+)
	12 -13ft	0 - 799	800 (+)	
	14 (+) ft	All		
20 mph	2 - 7 ft.	0 - 2,599	2,600 (+)	
	8 - 9ft	5,000 (+)		
	10 (+)			

Table A.22: Barrier Warrants for Water 1.0 Meters Deep X 30 Meters Long

Metric Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
80 km/h	1.2 - 2.3 m	0 - 249	250 -1,099	1,100 (+)
	2.4 - 3.6 m	0 - 349	350 - 1 ,499	1,500 (+)
	3.7 - 4.8 m	0 - 449	450 - 1,999	2,000 (+)
	4.9 - 6.0 m	0 - 2,999	3,000 (+)	
	6.1 (+) m	All		
60 km/h	1.0 - 2.3 m	0 - 249	250 - 1,099	1,1 00 (+)
	2.4 - 3.6 m	0 - 349	350 - 1 ,499	1,500 (+)
	3.7 - 4.8 m	0 - 449	450 - 1,999	2,000 (+)
	4.9 - 5.4 m	0 - 2,999	3,000 (+)	
	5.5 (+) m	All		
50 km/h	0.6 - 2.3 m	0 - 599	600 - 3,199	3,200 (+)
	2.4 - 3.6 m	0 - 749	750 (+)	
	3.7 - 4.2m	0 - 799	800 (+)	
	4.3 (+) m .	All		
30 km/h	0.6 - 2.3 m	0 - 3,799	3,800 (+)	
	2.4 (+) m	All		

Table A.23: Barrier Warrants for Water 3 Feet Deep X 100 Feet Long

U.S. Customary Units

Speed	Hazard Offset From Edge of Travel Way	Adjusted Traffic Factor (ATF)		
		Not Warranted	Possibly Warranted	Warranted
50 mph	4 - 7 ft.	0 - 249	250 -1,099	1,100 (+)
	8 -11 ft	0 - 349	350 - 1,499	1,500 (+)
	12 -15 ft	0 - 449	450 - 1,999	2,000 (+)
	16 -19 ft	0 - 2,999	3,000 (+)	
	20 (+) ft	All		
40 mph	3 - 7 ft.	0 - 249	250 - 1,099	1 , 1 00 (+)
	8 -11 ft	0 - 349	350 - 1 ,499	1,500 (+)
	12 -15 ft	0 - 449	450 -1,999	2,000 (+)
	16 -17 ft	0 - 2,999	3,000 (+)	
	18 (+) ft	All		
30 mph	2 - 7 ft.	0 - 599	600 - 3,199	3,200 (+)
	8 -11 ft	0 - 749	750 (+)	
	12 -13 ft	0 - 799	800 (+)	
	14 (+) ft	All		
20 mph	2 - 7 ft.	0 - 3,799	3,800 (+)	
	8 (+) ft	All		

SAMPLE PROBLEM

The following are example applications of the warranting process described in this Appendix and are applicable to the Blue Ridge Parkway.

Problem 1.

Roadway data: There is a tangent section with 3.0 m (10 ft) lanes, 1.2 m (4 ft) stabilized turf shoulders and a 46 m (150 ft)-long horizontal curve on a 240 m (800 ft) radius. The whole section is on a 3 percent downward grade.

Traffic data: 417 present AADT with a 1 percent annual growth factor. Design speed is 80 km/h (50 mph). AADT numbers are taken from tables in Appendix One. On the tangent section actual speeds may exceed the posted speed of 45.

Hazard data: The hazard is a 1V:1.5H fill slope 18 m (60 ft) high, offset 1.8 m (6 ft) from the edge of travel way on the outside of the horizontal curve. The slope is 150 m (500 ft) parallel to the road, including both the horizontal curve and the tangent section. There are some small scattered trees on the slope.

Other issues: Because of the remote location, barrier construction is expected to be costly. Crash data indicate that there have been 4 accidents in the past five years in the curve section. Two of those incidents resulted in personal injuries but no fatalities. This area is a maintained vista so there are visual and cultural resource values to be considered.

Solution:

1. The embankment hazard is at an offset of 1.2 m (6 ft). For Parkway the clear zone is 8 feet. The slope is within the clear zone in both the tangent and curved sections. The slope is outside the clear zone for opposing traffic.

2. From Table 2.5, the slope is a Category 3.hazard so a barrier should be considered.

3. The following ADT adjustment factors were obtained from Tables A.1, A.2 and A.3:

TG = 1.10
HC = 1.00 for the tangent section and 4.00 for the curved section.
DG = 1.10

4. The Adjusted Traffic Factor (A TF) for the tangent section is:

   A TF = ADT * TG * HC * DG

   AFT = 417 * 1.10 * 1.00 * 1.10

   ATF = 504

5. The Adjusted Traffic Factor (ATF) for the curved section is:

   A TF = ADT * TG * HC * DG

   ATF = 417 * 1.10 * 4.00 * 1.10

   A TF = 2,018

6. From Table A.17, guardrail is possibly warranted on the tangent section and is clearly warranted on the curved section.

7. For the curved section, the following issues from Table A.4 are considered in determining to place a roadside barrier:

   Reasons to use barrier:
   - ATF is at the high end of range
   - Hazard is larger than assumed in Table A.17
   - Hazard is more severe than assumed in Table A.17
   - Operating speed likely to exceed design speed
   - Clear crash pattern

   Reasons to not use barrier
   - Expected costs will be high
   - Aesthetic impacts
   - Environmental impacts

In this case a roadside barrier would be recommended for the horizontal curve section and not for the tangent section. This determination initiates Step 2: Historic Integrity and Effects Screening.

As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historic places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. Administration. [NPS 601/100273]