

National Park Service
U.S. Department of the Interior



Denali National Park and Preserve

Protocol for monitoring the Vehicle Management Plan (VMP)

Denali National Park and Preserve, Version 1.0

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December 2018

U.S. Department of the Interior
National Park Service

Please cite this document as:

Clark, W. C. and T. A. Bracher. 2018. Protocol for Monitoring the Vehicle Management Plan (VMP), Denali National Park and Preserve. National Park Service, Denali Park, Alaska. Available online at <https://irma.nps.gov/DataStore/Reference/Profile/2258362>.

Vehicle Management Plan Narrative

Version 1.0 (December 2018)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
Add rows as needed for each change or set of changes associated with each version.					

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Introduction

This narrative discusses some history of vehicle management by park management in Denali National Park and Preserve and how a monitoring program, the Vehicle Management Plan (VMP), was developed. This narrative describes monitoring sites and defines indicators used by the VMP to assess traffic impacts on park resources. Details for data collection methods, data management, and analysis methods can be found in a series of standard operating procedures (SOP) published in IRMA under the collection <https://irma.nps.gov/DataStore/Reference/Profile/2257444>.

Study Area

Denali is 2.4 million hectares located in interior Alaska between Anchorage and Fairbanks. For over eighty years, the Denali Park Road (hereafter as the park road) has provided the primary access to Denali National Park and Preserve (Denali; Bryant 2011). Spruce (*Picea mariana*), scrub shrub dwarf birch (*Betula nana*), and willow (*Salix* spp.) dominate the habitat along the park road and mountain avens (*Dryas integrifolia*), graminoids, and sedges dominate higher elevation tundra. Denali has a subarctic climate: Short, cool summers with an average minimum of zero degrees centigrade (C) and average maximum of 24° C (Western Regional Climate Center 2007). Annual precipitation averages 38 centimeters (cm), over half of which occurs during the summer months. Snow cover is generally present from October through early May (Sousanes 2014). Due to the high latitude, daylight varies from more than twenty hours in June to four hours in December. Park visitation exceeds 550,000 annually (IRMA 2018).

Beginning at the park entrance at mile 237 of the George Parks Highway, the park road travels 92 miles west following the valley that separates the Alaska Range to the south from the Outer Range to the north. While traveling the park road, visitors have the opportunity to observe wildlife species in their natural habitats, view the continent's highest peak, and access trail-less wilderness recreation.

Most of the park road is one lane and sections of it hang high above the valley, posing challenges for drivers and managers to ensure the safety of travelers. In 1958, the National Park Service (NPS) began a project that would have significantly altered the character of the road. The intent was to widen and pave the entire road and add guardrails and striping. Conservationists fought to protect the "wilderness atmosphere" of the road. Due to their efforts, the road is only paved to the Savage River Bridge (mile 14.9) and only widened to the Teklanika River (mile 31). Westbound visitors cross the Teklanika River Bridge and experience the rustic character of the road that has persisted since 1937.

The road improvement story is an example of the biggest challenge faced by national parks: balancing the protection of park resources while making those resources accessible for people to enjoy. That challenge is particularly great in Denali, where demand for visitor opportunities to tour the park road is growing but still limited to a single 92-mile road (Figure 1).

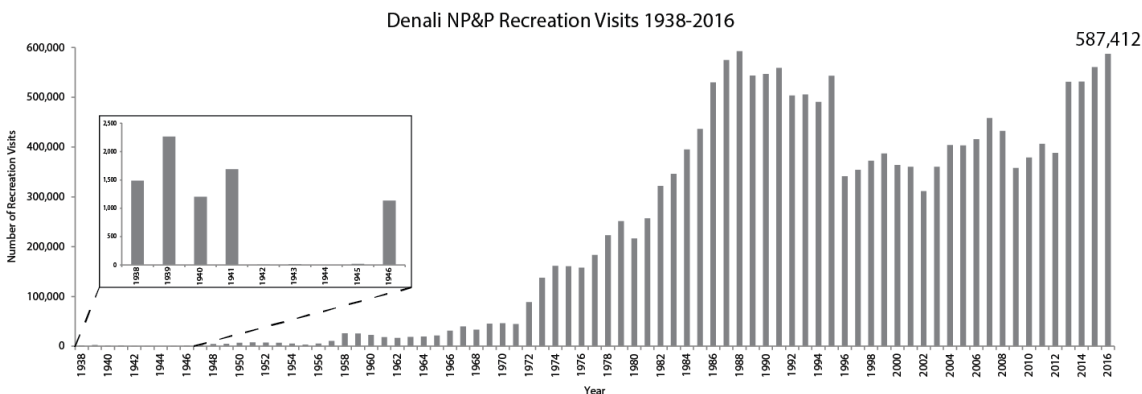


Figure 1. The number of recreation visits has steadily increased since the Alaska Road Commission finished construction of the Denali Park Road for the 1938 summer (Denali National Park and Preserve, Alaska, USA).

In 1972, restrictions were implemented because of anticipated increases in motor vehicle access to Denali resulting from the opening of the George Parks Highway connecting Fairbanks and Anchorage. In 1986, park managers instituted a vehicle limit of 10,512 round trips during the regulatory season, which was allocated among user groups (NPS 1986). The vehicle restrictions were further refined in the 1997 Entrance Area and Road Corridor Development Concept Plan (NPS 1997) and promulgated in special park regulation (36 CFR § 13.930 et seq.) in 2000. The 1997 plan also redefined the regulatory season as the Saturday before Memorial Day through the second Thursday after Labor Day or September 15, whichever came first (hereafter as the road regulatory season).

Denali Park Road Capacity Study

Due to steadily increasing visitation, park managers initiated a road capacity study in 2006 designed to evaluate strategies for transporting visitors on the park road. The “Road Study” addressed concerns for protecting important park resources and values by evaluating the transportation system and determining the carrying capacity of the road (Phillips et al. 2010a, Phillips et al. 2012). An interdisciplinary team of NPS scientists and managers and academic scientists conducted the study over several years assessing the effects of traffic volumes and patterns on the park’s social, biological, and physical environment.

The Road Study included three primary components: (1) an assessment of the relationship between vehicle traffic and wildlife movements and sightings (Phillips et al. 2010b); (2) visitor surveys to identify and quantify key indicators of a high-quality visitor experience on the park road (Manning and Hallo 2010); and (3) the development of a spatially explicit traffic model that integrated the results from the first two components with Global Positioning Systems (GPS) data collected from vehicles traveling the park road to predict the effects of changes in traffic volume and patterns on wildlife movements and visitor experience (Morris et al. 2010).

To identify possible links between vehicle traffic and wildlife behavior, 20 grizzly bears (*Ursus arctos*) and 20 Dall sheep (*Ovis dalli*) were radio collared and tracked using GPS. Data were also collected to determine the number and distribution of the “big five” large mammals: caribou (*Rangifer tarandus*), grizzly bears, Dall sheep, moose (*Alces alces*), and wolves (*Canis lupus*). Traffic data were collected using traffic counters placed at six locations along the park road and wildlife sightings were recorded by bus drivers using touch-panels installed in 20 buses (Phillips et al. 2010b, Phillips et al. 2012).

The results suggested that the volume and pattern of vehicle traffic affects the distribution and movements of wildlife, although the effects were not statistically significant, which is consistent with other research (Yost et al. 2001, Jaeger 2005). The clearest indication of negative impacts from vehicle traffic on wildlife was that Dall sheep increased their rate of movement as they approached the road and sheep were located further from the road during periods of higher traffic volumes. Some bands of sheep migrate between habitats in the Outer Range (primarily winter habitat) and the Alaska Range (primarily summer habitat) (Dalle-Molle and Van Horn 1991). Other bands may use habitats on both sides of the road throughout the summer. In both cases, these sheep must cross the road. Results of the Road Study suggested a reduction in the number of early morning sightings of the big five wildlife species (caribou, Dall sheep, grizzly bear, moose, wolf) followed higher levels of nighttime traffic (4-7 vehicles/hr). Park policy generally restricts large vehicle traffic (> 80,000 pounds gross vehicle weight rating, GVWR, whereas a typical concessionaire bus is 36,000 pounds GVWR) to nighttime hours only, which potentially confounds the effect of traffic during nighttime hours and large vehicle traffic.

Thus, three indicators were identified that directly related to the volume and timing of vehicle traffic to protect wildlife: (1) the spacing of traffic at five sheep crossing locations; (2) the amount of nighttime (2200-0600) traffic; and (3) the hourly rate of large vehicle traffic.

The Road Study used a series of qualitative visitor surveys to identify indicators that could capture the effects of vehicle crowding conditions on visitor experience. Survey participants viewed a series of simulated photographs depicting a range of vehicles at wildlife stops, rest stops, and within iconic viewsapes. Visitor reaction to these photographs was used to calibrate acceptable levels of crowding and provide management guidance for establishing standards (Manning and Hallo 2010). The goal for setting these standards was to maintain or improve current crowding conditions (i.e. numbers of vehicles). Three influential metrics were highlighted from the results: (4) the numbers of vehicles stopped at the same time and location to view wildlife; (5) the number of vehicles simultaneously visible in four scenic viewsapes; and (6) the number of vehicles parked at rest stops at one time.

The concessionaire operates a number of bus types, one of which is specifically for transit, rather than touring. Visitors using transit get on and off the bus to hike or backpack. The effectiveness of serving this need is measured by monitoring (7) the wait time required for hikers to re-board a bus from the side of the park road to get to a second location or to return to the entrance area.

The results of the Road Study were used to inform development of the Denali Park Road Vehicle Management Plan and Environmental Impact Statement (VMP), which formally established the seven indicators (i.e. metrics) of desired resource and visitor experience conditions noted above and developed quantitative standards (i.e. acceptable measureable levels of the metric) to ensure those conditions were maintained (NPS 2012). The VMP was signed by the park's Superintendent in 2012.

A Long-term Plan for Managing the Park Road

The VMP is intended to improve management of vehicle traffic for 15 to 20 years following the next concessionaire contract (NPS 2012)¹. Approval of the VMP commits the park to amend a rule regarding the regulatory *yearly* vehicle limit (10,512) with a *daily* limit of 160 vehicles, which applies only to the controlled section of Denali Park Road (west of the Savage River Bridge at mile 14.9). This rule change requires an update to the U.S. Code of Federal Regulations and has yet to

¹ The first concession contract signed after 2012 was in June of 2016. Thus, VMP monitoring will continue through around 2031-2036.

occur. Currently, Denali is managing for and reporting both the seasonal and daily capacity limits outlined in regulation and policy, respectively.

The goals of the VMP are to ensure that visitors have the opportunity for a high-quality experience, wildlife and other park resources are protected, and the unique and historic character of the park road is maintained. The VMP uses an adaptive management approach to ensure that desired resource and visitor experience conditions are being met as traffic volumes and schedules are adjusted to optimize the transportation system. Adaptive management has been used since the 1970s and promotes flexible decision-making based on new knowledge; evidence-based adjustments are applied to management strategies as results of previous strategies are analyzed and better understood (Holling 1978). Many management plans use adaptive management as a tool due to the uncertainty in complex systems (Johnson 1999, Walters and Holling 1990). The complexity of the behaviors and regulations of park road users and the long-term nature of the VMP make it a fitting system to use adaptive management principles.

The adaptive management strategy includes a four-tiered approach to monitor impacts to visitor satisfaction and natural resources resulting from changes in the transportation system, such as increases in traffic volume or modifications to scheduling: (Tier 1) monitoring well-defined indicators and standards; (Tier 2) monitoring changes in wildlife observations; (Tier 3) monitoring changes in wildlife populations using data from other long-term monitoring programs; and (Tier 4) conducting Before-After Condition Change Assessment (BACCA) studies. We monitor Tier 1 indicators annually throughout the road regulatory season. Some standards are based on absolute maximums (e.g. Toklat rest stop will not exceed 12 buses at one time) while other standards are based on both 1- and 5-year (yr) averages. The 1-yr standard is less strict than the 5-yr standard to allow for an aberrant year of increased activity without condemning the 5-yr standard to failure. The results from this monitoring program will provide empirical data to the decision-making process when managing aspects of the park road including capacity, resource protection – including the visitor experience, and maintenance of historic character.

Lastly, the VMP modifies the boundaries of Wildlife Viewing Subzones previously defined by the Park's 1997 Entrance Area and Road Corridor Development Concept Plan to clarify management objectives necessary for achieving the desired conditions within specific park road segments (NPS 1997; Figure 2). Crowding standards (number of vehicles at wildlife stops, number of vehicles at rest stops, and number of vehicles in viewscapes) were established at different levels for each Subzone. Levels of accepted traffic volume decrease westward to preserve wilderness character.

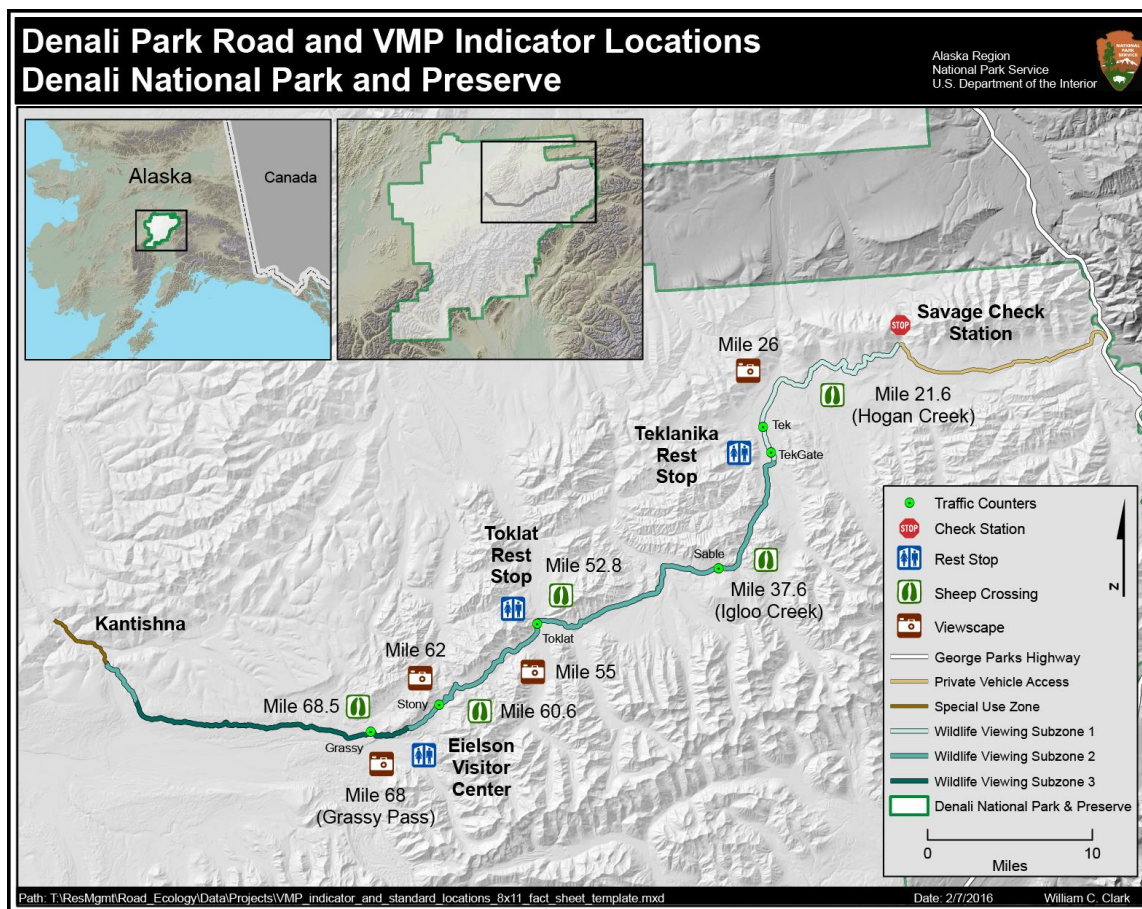


Figure 2 The Denali Park Road corridor traverses the northeast portion of Denali National Park and Preserve, Alaska, USA. There are 12 VMP indicator sites visited by field staff: five sheep gaps, four viewscapes, and three rest stops. VMP standards for wildlife stops and viewscapes vary by Subzone. Six remote, automated traffic counters are also distributed along the road and provide continuous data on traffic volume.

VMP Indicator Descriptions

Indicators are defined in spatially explicit locations between mile 20 and 68 of the Denali Park Road (Figure 2). Four indicators have 1- and 5-yr average standards: (1) Number of vehicles at wildlife stops; (2) number of vehicles in viewscapes; (3) sheep gap spacing; and (4) hiker wait time. The remaining indicators have 1-yr standards only.

Number of Vehicles at Wildlife Stops

Wildlife stops are stochastic events that can occur at any point along the park road. They are defined as one or more vehicles stopped to observe wildlife on the controlled section of road. One or more individual animals, representing one or more species may be present at a given wildlife stop. The most frequent stops are to view caribou, grizzly bears, Dall sheep, moose, and wolves, although vehicles will stop for other species (e.g. fox, ptarmigan, and others). The VMP manages for traffic volume at wildlife stops by establishing thresholds for the number of vehicles stopped to view wildlife in the same location at the same time. The maximum tolerable number of vehicles at wildlife stops varies by Subzone.

A *wildlife event* begins when the first vehicle stops and continues as long as at least one vehicle is present. The wildlife event ends when the last vehicle leaves the animal. Due to staggered bus schedules, it is possible that an animal (i.e. wildlife event) will experience many vehicles in a day

while each vehicle may not experience other vehicles at that animal. To capture visitor experience, the standard for the wildlife stop indicator is evaluated based on each vehicle's perspective. Monitoring the standard for wildlife stops captures the stop duration and traffic volume experienced by each vehicle present at wildlife events for as long as the observer's bus remains at the event. The total time or total number of vehicles at a wildlife event is not captured in monitoring. Each instance of a wildlife event may have several wildlife stops.

Number of Vehicles at Rest Stops

The VMP manages for traffic volumes at the Teklanika and Toklat rest areas and the Eielson Visitor Center (EVC; collectively called rest stops) by establishing standards for the maximum number of vehicles parked at any one time in these locations. The physical design and capacity of each facility's parking lot were used to inform the VMP standard. This standard is intended to ensure restroom wait times are short and capacity not exceeded.

Number of Vehicles in Viewscapes

The VMP identified four viewscapes: mile 26, mile 55, mile 62 (Stony Overlook), and mile 68 (Grassy Pass). The standard for each viewscape is based on the social normative curves developed from visitor surveys and the desired conditions for visitor experience established for the Subzones where the viewscape is located (Manning and Hallo 2010, NPS 2012). The 1- and 5-yr viewscape standards describe the percentage of time that a threshold number of vehicles are concurrently visible within the viewscape. The threshold changes with respect to both the standard level (i.e. 1- or 5-yr) and Subzone. Viewscapes are small (~1.0–1.5 miles) and finite but are meant to be representative of the traffic volume and patterns of the larger landscape in which they are located; crowding conditions of the Subzone should be reflected within the viewscape metric. In most cases, viewscape metrics represent a conservative measure of visible traffic (i.e. a liberal measure of crowding) because the viewscape sites are in areas with large, broad views of the park landscape. In areas with greater road sinuosity, the landscape obstructs visibility of other vehicles.

Sheep Gap Spacing

The VMP identified five locations important to the movement of sheep and other wildlife: mile 21.6 (Hogan Creek), mile 37.6 (Tattler Creek), mile 52.8, mile 60.6, and mile 68.5 (Grassy Pass). Although all points along the park road may be used during seasonal migrations and/or for within-season movements between adjacent habitats, these monitoring locations represent key points to monitor vehicle traffic patterns that may influence wildlife movement. Research suggests that movement patterns of sheep and other wildlife species between habitats bisected by roads may be affected by the volume and type of vehicle traffic (Dalle-Molle and Van Horn 1991). Sheep gaps have both 1- and 5-yr standards. The 1-yr standard requires at least one 10-minute gap in traffic per hour in 22 of 24 hours (90%); the 5-yr standard requires a gap for 23 of every 24 hours (95%).

The indicator and its standard were established to balance the need to allow natural movement and seasonal migratory patterns to persist with the desire to minimize unnecessary restrictions on vehicle traffic, which could displace visitors. The sheep gap monitoring locations were established to encourage scheduling such that there are breaks in traffic along the entire length of the controlled section of the park road. Like viewscapes, sheep gaps are meant to be representative of the traffic volume and patterns of the larger landscape in which they are located; crowding conditions of the Subzone should be reflected within the sheep gap metric. Together, the sheep gap locations should provide a representative sample of the gaps in traffic along the controlled portion of the road corridor.

Nighttime Traffic

The VMP includes an indicator designed to reduce potential negative impacts of nighttime traffic on the following morning's wildlife sightings. The indicator evaluates nightly average and peak traffic rates during nighttime hours (2200-0600). The standard is two-fold: (1) an average of three or fewer vehicles per hour (total west and eastbound) per night and (2) no more than six vehicles in any one hour. The standards are to be met mutually inclusively at least 95% of the time. Nighttime traffic standards are measured using automated traffic counters, which are installed at six locations, however only five sites are used for nighttime traffic analysis: TekGate, Sable, Toklat, Stony, and Grassy. A counter at mile 28 (Tek28) is used to monitor traffic patterns but not to infer impacts on wildlife because of the proximity of the TekGate counter less than two miles to the west.

Hiker Wait Time

The amount of time a hiker waits to be picked up by a bus measures how well the transit service is meeting visitor demand in this principle function. The VMP established 1- and 5-yr standards for hiker wait times: the proportion of hikers waiting less than 30 minutes, less than 60 minutes, and less than 90 minutes to be picked up by a bus. The VMP prioritizes meeting transit service demand over concessionaire tours and charter services.

Large Vehicle Traffic

Work by park scientists shows a positive, direct relationship between gross vehicle weight rating of a vehicle and the amount of noise (defined as non-natural sound) the vehicle produces. Noise has been documented to cause negative effects on the health of animal populations (Barber et al. 2010). Therefore, a large vehicle traffic (> 80,000 GVWR) indicator was established to mitigate negative impacts from vehicle noise on wildlife. The standard is defined as < 5 large vehicles per hour. "Large vehicles" are defined by weight rather than dimension, requiring a weighing system to evaluate this standard. This is a practical challenge for a remote gravel road underlain with discontinuous permafrost and has not been fully implemented.

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Appendix

Denali Park Road Final Vehicle Management Plan: Tier 1 Indicators and Standards

Wildlife Stops:	Number of vehicles stopped at the same location to view wildlife at one time
<i>Wildlife Viewing Subzone 1</i>	75% of wildlife stops will have 3 or fewer vehicles (5-yr average) No one year will have less than 70% of wildlife stops with 3 or fewer vehicles
	90% of wildlife stops will have 4 or fewer vehicles (5-yr average) No one year will have less than 85% of wildlife stops with 4 or fewer vehicles
	95% of wildlife stops will have 5 or fewer vehicles (5-yr average) No one year will have less than 90% of wildlife stops with 5 or fewer vehicles
<i>Wildlife Viewing Subzone 2</i>	75% of wildlife stops will have 2 or fewer vehicles (5-yr average) No one year will have less than 70% of wildlife stops with 2 or fewer vehicles
	90% of wildlife stops will have 3 or fewer vehicles (5-yr average) No one year will have less than 85% of wildlife stops with 3 or fewer vehicles
	95% of wildlife stops will have 4 or fewer vehicles (5-yr average) No one year will have less than 90% of wildlife stops with 4 or fewer vehicles
<i>Wildlife Viewing Subzone 3</i>	75% of wildlife stops will have 1 or fewer vehicles (5-yr average) No one year will have less than 70% of wildlife stops with 1 or fewer vehicles
	90% of wildlife stops will have 2 or fewer vehicles (5-yr average) No one year will have less than 85% of wildlife stops with 2 or fewer vehicles
	95% of wildlife stops will have 3 or fewer vehicles (5-yr average) No one year will have less than 90% of wildlife stops with 3 or fewer vehicles

Rest Stops:

Number of vehicles parked at one time at the Teklanika and Toklat and Eielson rest stops	
<i>Teklanika</i>	No more than 12 buses at one time with a total of no more than 16 vehicles
<i>Toklat</i>	No more than 11 buses at one time with a total of no more than 16 vehicles
<i>Eielson Visitor Center</i>	No more than 10 buses at one time with a total of no more than 19 vehicles

Viewscapes:

Number of vehicles visible at one time in four scenic viewscapes during bus operating hours	
<i>Mile 26 Wildlife Viewing Subzone 1</i>	85% of the time there will be 3 or fewer vehicles visible in the viewscape (5-yr average)
	No one year will have less than 80% of the time with 3 or fewer vehicles visible in the viewscape
	95% of the time there will be 4 or fewer vehicles visible in the viewscape (5-yr average)
	No one year will have less than 90% of the time with 4 or fewer vehicles visible in the viewscape
<i>Miles 55 and 62 Wildlife Viewing Subzone 2</i>	85% of the time there will be 2 or fewer vehicles visible in the viewscape (5-yr average)
	No one year will have less than 80% of the time with 2 or fewer vehicles visible in the viewscape
	95% of the time there will be 3 or fewer vehicles visible in the viewscape (5-yr average)
	No one year will have less than 90% of the time with 3 or fewer vehicles visible in the viewscape
<i>Mile 68 Wildlife Viewing Subzone 3</i>	85% of the time there will be 1 or fewer vehicles visible in the viewscape (5-yr average)
	No one year will have less than 80% of the time with 1 or fewer vehicles visible in the viewscape
	95% of the time there will be 2 or fewer vehicles visible in the viewscape (5-yr average)
	No one year will have less than 90% of the time with 2 or fewer vehicles visible in the viewscape

Sheep Gaps:

Maintenance of at least one 10-minute gap in traffic per hour at designated sheep crossing locations	
<i>Mile 21.6, 37.6, 52.8, 60.6, and 68.5</i>	There will be at least one 10-minute gap in traffic every hour with a 95% success rate (23 of 24 hours with gaps at each crossing) averaged over 5 years
	No one year will have less than 90% success rate (22 of 24 hours with gaps at each crossing)

Nighttime Traffic:

Average number of vehicles per hour per night passing any of the traffic counters west of Savage between 10 p.m. and 6 a.m. (2200-0600)	
--	There will be an average of 3 or fewer vehicles per hour per night (total westbound and eastbound) passing any of the traffic counters with never more than six vehicles in any one hour. Both standards must be achieved at least 95% of the time. This standard will undergo further analysis and development.

Hiker Wait Time:

The amount of time a hiker spends waiting to be picked up by a bus	
<i>Less than 30 minutes</i>	At least 75% of hikers will have wait times of less than 30 minutes for pick-up by a bus, averaged over 5 yrs. No one year will have less than 70% of hikers with wait times of less than 30 minutes.
<i>Less than 60 minutes</i>	At least 95% of hikers will have wait times of less than 60 minutes for pick-up by a bus, averaged over 5 yrs. No one year will have less than 93% of hikers with wait times of less than 60 minutes.
<i>Less than 90 minutes</i>	At least 99% of hikers will have wait times of less than 90 minutes for pick-up by a bus, averaged over 5 yrs. No one year will have less than 98% of hikers with wait times of less than 90 minutes.

Large Vehicle Traffic:

Total number of large (> 80,000 pounds gross vehicle weight rating) vehicles crossing any of the traffic counters west of Savage in any one hour	
--	There will never be more than 4 large vehicles in any one hour crossing any of the traffic counters west of Savage. This standard will undergo further analysis and development.