Bighorn National Forest

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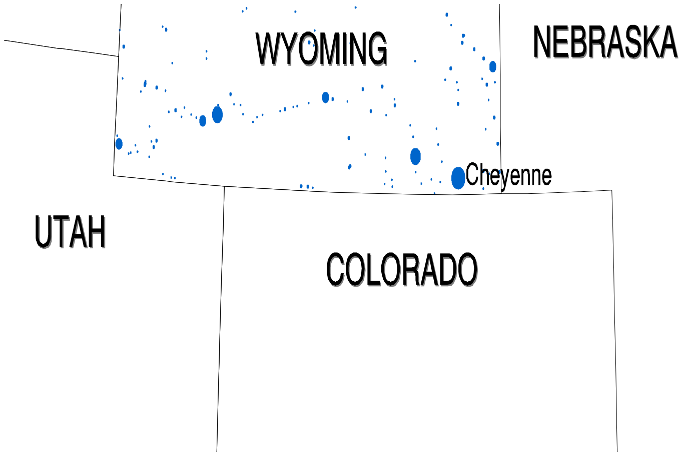
Roads Analysis Report

Forest-wide Analysis



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Executive Summary

Introduction

On January 12, 2001, the Forest Service issued the final National Forest System Road Management Rule. This rule revises regulations concerning the management, use, and maintenance of the National Forest Transportation System. The final rule is intended to help ensure that additions to the National Forest System road network are essential for resource management and use; that construction, reconstruction, and maintenance of roads minimize adverse environmental impacts; and that unneeded roads are decommissioned and restoration of ecological processes are initiated.

This report documents the information and analysis procedure used for the Bighorn National Forest roads analysis. This analysis is designed to provide decision-makers with critical information to develop road systems that are safe and responsive to public needs and desires, are affordable and efficiently managed, have minimal negative ecological effects on the land, and are in balance with available funding for needed management actions.

Roads analysis is a six-step process. The steps are designed to be sequential with an understanding that the process may require feedback and iteration among steps over time as an analysis matures.

- 1. Setting up the analysis
- 2. Describing the situation
- 3. Identifying the issues
- 4. Assessing benefits, problems and risks
- 5. Describing opportunities and setting priorities
- 6. Reporting (Key Findings)

The amount of time and effort spent on each step differs by project based on specific situations and available information. The process provides a set of possible issues and analysis questions; the answers can help managers make choices about road system management.

The product of this analysis is a report for decision-makers and the public that documents the information and analyses used to identify opportunities and set priorities for future national forest road systems. The key products of this roads analysis for subforest scale analyses include the following:

- A watershed risk assessment for all of the 6th-level watersheds on the forest.
- A map of all of the 6th-level watersheds on the forest that displays the results of the watershed risk assessment.
- A map that displays the existing level 3, 4, and 5 road system on the forest.
- A road risk versus value matrix that identifies 4 categories of roads that were evaluated on a road-by road basis.

- A road risk versus value graph based on the road matrix.
- A map of the potential minimum level 3, 4, and 5 road system for the forest.
- A narrative response to most of the 71 questions in Chapter 4.

During subforest scale roads analysis, the team should first review watershed risk assessment, including watershed risk assessment maps. This review will help determine how roads are affecting watershed health in the analysis area and the road-related decisions that can address the watershed health.

All classified and unclassified roads within the analysis area should be mapped and inventoried. The existing level 3, 4, and 5 road system map will help identify the roads system, but additional GPS field work may be necessary.

The team should then review, validate, and update the information in the road versus risk matrix based on local knowledge of the level 3, 4, and 5 roads. Changes to the risk and values of these roads may result in changes to the road graph and potential minimum level 3, 4, and 5 road system. The results of these road valuations can be used to develop road management alternatives for these roads, including relocation, upgrades, increasing or decreasing maintenance levels, and possible decommissioning.

During Step 4 of the roads analysis, the team should review the forest scale responses to the 71 questions in this step. Where the forest scale responses do not adequately address the subforest scale analyses, the team should provide additional information. For example, at the subforest scale, the economic questions can better assess road-related costs and benefits. The road risk versus value matrix provides annual and deferred maintenance costs by individual road to help assess road-related costs for economic analyses.

The teams need to ensure that all road-related decisions from subforest scale roads analyses are documented in Road Management Objectives (RMO) and that all INFRA and GIS databases are subsequently updated.

Please see Chapter 5 for a more detailed explanation of guideline and use of the roads analysis results.

Key findings

Shared maintenance is not occurring on key access roads.

The Forest should continue to pursue formal road maintenance agreements with the counties interested in sharing maintenance to more efficiently use taxpayer funds.

Some roads are not under appropriate jurisdictions.

A preliminary review of the database shows several roads listed under questionable jurisdictions. However, this was based on data that had not been updated as the Forest acquired legal jurisdiction on roads. Efforts to update and correct the data files should continue.

Road maintenance funding is not adequate to maintain and sign roads to standard.

Even with the focus on potential minimum road system, our current budgets don't cover road maintenance costs. The Bighorn National Forest currently receives approximately $800,000 per year for all road maintenance, before cost pools and overhead taps. To maintain the level 3, 4, and 5 road system to standard would cost approximately $1.45 million.

Using the subforest level roads analysis process could result in continued reductions of the Forest road maintenance obligations through decommissioning of level 1 and 2 roads.

Road access may not be adequate for future management needs.

Arterial and collector roads are not being maintained to the standards specified in the 1985 Forest Plan. The road system will continue to degrade, and this will compromise future access on existing roads. The timber program still has additional road access needs to meet the 1985 Forest Plan and may very well have additional road needs under the revised plan. There may be future access needs for other management activities.

There are potential environmental impacts from the road system that need to be prioritized and evaluated for future analyses at a subforest level scale.

This roads analysis process identified individual roads that represented high potential for environmental risks. Categories 2 and 3 from the Road Risk-Value Graph identified approximately 216 miles of these roads. The watershed risk table (table 14, page 94) identifies watersheds most at risk.

Chapter 4 provides more information in response to this issue.

Introduction

Background

In August 1999, the Washington Office of the USDA Forest Service published Miscellaneous Report FS-643 *Roads Analysis: Informing Decisions about Managing the National Forest Transportation System*. The objective of roads analysis is to provide decision-makers with critical information to develop road systems that are safe and responsive to public needs and desires, are affordable and efficiently managed, have minimal negative ecological effects on the land, and are in balance with available funding for needed management actions.

In October 1999, the agency published Interim Directive 7710-99-1 authorizing units to use, as appropriate, the road analysis procedure embodied in FS-643 to assist land managers making major road management decisions. The Rocky Mountain Region of the Forest Service then published a roads analysis guidance document as a supplement to Appendix 1 of FS-643. This document provides guidance concerning the appropriate scale for addressing the roads analysis.

On March 3, 2000, the Forest Service proposed to revise 36 CFR Part 212 to shift emphasis from transportation development to managing administrative and public access within the capability of the lands. The proposal was to shift the focus of National Forest System road management from development and construction of new roads to maintaining and restoring needed roads and decommissioning unneeded roads within the context of maintaining, managing, and restoring healthy ecosystems.

On January 12, 2001, the Forest Service issued the final National Forest System Road Management Rule. This rule revises regulations concerning the management, use, and maintenance of the National Forest Transportation System. Consistent with changes in public demands and use of National Forest System resources and the need to better manage funds available for road construction, reconstruction, maintenance, and decommissioning, the final rule removes the emphasis on transportation development and adds a requirement for science-based transportation analysis. The final rule is intended to help ensure that additions to the National Forest System road network are those deemed essential for resource management and use; that construction, reconstruction, and maintenance of roads minimize adverse environmental impacts; and that unneeded roads are decommissioned and restoration of ecological processes are initiated.

Process

Roads analysis is a six-step process. The steps are designed to be sequential with the understanding the process may require feedback and iteration among steps over time as an analysis matures. The amount of time and effort spent on each step differs by project based on specific situations and available information. The process provides a set of possible issues and analysis questions for which the answers can help managers make choices about road system management. Decision-makers and analysts determine the relevance of each question, incorporating public participation as deemed necessary. The following six steps guided the process.

- Step 1. Setting up the analysis
- Step 2. Describing the situation
- Step 3. Identifying the issues
- Step 4. Assessing benefits, problems and risks
- Step 5. Describing opportunities and setting priorities
- Step 6. Reporting (Key Findings)

Products

The product of an analysis is a report for decision-makers and the public that documents the information and analyses used to identify opportunities and set priorities for future national forest road systems. Included in a report is a map displaying the known road system for the analysis area, and the risks and opportunities for each road or road segment. A report may also include other maps and tables necessary to display specific priorities and changes in a road system.

This Report

This report documents the information and analysis procedure used for the Bighorn National Forest roads analysis. The report contains a table rating each road for recreation values, resource values, watershed risks, and wildlife risks. It contains management guidelines and opportunities for future actions that will impact the Forest roads system. It includes a map of the Forest, the existing maintenance level 3, 4, and 5 roads system and geographic division maps with the potential minimum level 3, 4, and 5 roads system.

Chapter 1 Setting up the analysis

Objectives of the Analysis

Establish the level and type of decision-making the analysis will inform

The roads analysis project will be used to support the Bighorn Forest Plan Analysis of the Management Situation (AMS) and subsequent subforest scale and project analyses. It is intended to identify prioritized opportunities, which address watershed health or road maintenance. It will also be used in developing forest wide standards and guidelines and geographic area direction for the forest plan revision effort.

Identify Scale/Analysis Area

The analysis will:

- Be at the forest scale for the Bighorn National Forest (1.1 million acres) in northern Wyoming, Region 2 of the National Forest System
- Concentrate on maintenance level 3, 4, and 5 roads, though levels 1 and 2 may be used for some specific resource analyses.
- Be spatial or Geographic Information System (GIS)-based whenever possible.
  Use only existing information.
- Use information and data that is consistent with that used in the Bighorn Forest plan revision effort.

Interdisciplinary Team Members and Participants

The Core Interdisciplinary Team and their specialties:

Phillip Fessler, Team Leader	Forest Transportation Engineer	Supervisor's Office
Bryce Bohn	Hydrologist	Supervisor's Office
Jon Warder	Wildlife/TES Program Mgr.	Supervisor's Office
Ruth Beckwith	Landscape Architect	Supervisor's Office
Chris Thomas	Silviculture	Supervisor's Office
Bernie Bornong	Silviculture	Supervisor's Office
Scott Gall	Range	Powder River Ranger District

Galen Roesler	Fire	Supervisor's Office

Extended team members and their specialties:

Kevin Khung	Recreation Staff Officer	Supervisor's Office
Dee Ann Burkes	Writer-Editor	Supervisor's Office
DeeDee Arzy	GIS Specialist	Supervisor's Office
Jonathan Wilson	Engineering	Supervisor's Office
Rick Laurent	Archeologist	Supervisor's Office
Cindy Gradin	Law Enforcement	Supervisor's Office
Gayle Laurent	Lands, Special Uses	Supervisor's Office
Craig Cope	Wilderness / Recreation	Supervisor's Office

Analysis Plan

The main analysis process considered all 303.24 miles of maintenance level 3, 4, and 5 roads in the Forest roads database (this includes roads that are not under Forest jurisdiction or maintenance, as well as those that are). It was a two-step, integrated approach that considered issues, data, and information and systematically addressed all roads in a single analysis.

Step 1 considered the following:

- Issues.
- Road locations.
- Annual and deferred maintenance costs.
- Recreation use values.
- Resource management values.
- Watershed risk.
- Wildlife risk.

The interdisciplinary team (IDT) factored all of the items listed and assigned a low, medium, or high value rating to recreation use and resource management. The IDT also assigned a low, medium, or high risk rating for watershed risk, wildlife risk, and road maintenance costs to each of the roads in the system

In Step 2, the IDT grouped the two value ratings into a single low, medium or high rating and grouped the two risk ratings into a single low, medium or high rating. This resulted in each road having a set of descriptive coordinates that indicated their value and risk (e.g., high value, low risk). The descriptive coordinates for each road were plotted on a graph with four quadrants representing the following categories:

- Category 1 – High Value, Low Risk
- Category 2 – High Value, High Risk
- Category 3 – Low Value, High Risk
- Category 4 – Low Value, Low Risk

The results of this exercise are listed in the Road Management Category column in Appendix C – Road Matrix Table. High and low values and high and low risks were easy to plot into their associated quadrants. Medium Values and Medium Risks were collected along an x-axis or y-axis and defaulted into the adjacent quadrant so that effectively no medium categories were possible in the final allocation (see Road Risk-Value Graph, page 90, for final results).

Once the roads were assigned into one of the four categories, recommendations for future actions could be limited to those four categories. This simplified the final product and made it possible to map the possible future road system in total.

IDT members conducted resource specific analyses to derive the data that appears in the Road Matrix (e.g., watershed risk, recreation use value) and the information to answer the questions in Chapter 4 – Assessing Benefits, Problems, and Risks.

Information Needs

The IDT identified the following information sources to use for the analysis:

- Social assessment for Bighorn Plan Revision.
- Deferred maintenance costs in INFRA.
- INFRA travel routes.
- Potential Public Forest Service Road (PFSR) project submittals.
- Suitable Timber Base for the 1985 Bighorn Forest Plan and ASQ analysis, 1991.
- Roadless area inventory for the Bighorn plan revision.
- Economic assessment for Bighorn plan revision.

The IDT also identified the following GIS base map needs:

- Roads (all).

- Trails.
- 6^{th}-level watersheds.
- Streams and riparian areas.
- Geological hazards.
- Soil map units.
- Management Area prescriptions from 1985 Forest Plan.
- Recreation Opportunity Spectrum
- Developed recreation sites.
- Land status.
- Occurrence of threatened and endangered species.
- Research Natural Area and Special Interest Area maps from Bighorn plan revision.

The IDT also identified the following information that could be used in the analysis process:

- Wyoming Department of Transportation traffic counts.
- Wyoming Game and Fish hunter numbers to identify roads most likely to be important to hunters.

Chapter 2 Describing the situation

The Analysis Area

The Bighorn National Forest is located in northeast Wyoming. The climate varies from semi-arid in the lower elevations to cool and humid in the high elevations. Well-known attractions include the Medicine Wheel Historic Site, Medicine Wheel Passage Scenic Byway, Cloud Peak Skyway Scenic Byway, Bighorn Scenic Byway, and for some of the best snowmobiling in the area. The Forest is comprised of approximately 1.1 million acres of land ranging from desolate sagebrush flats, to heavily timbered areas. Large, open meadows surrounded by seas of timber and sheer rock outcroppings best summarize the general lay of the Forest. 3 major scenic byways, US 14, 14A, and 16 traverse the Forest. Interstate 90 runs north along the eastern face of the range from Buffalo to the Montana State Line.

The National Forest Transportation System

General Description

The transportation system on the Bighorn National Forest serves a variety of resource management and access needs. Most roads on the Forest were originally constructed for commercial access purposes including grazing, timber, and mineral extraction. Others resulted from construction of water storage and transmission projects for municipal water supplies. Over the past 100 years, an extensive road network has been developed and continues to serve commercial, recreation, and administrative purposes and provide access to private lands.

There are two goals for the transportation system in the 1985 Bighorn Forest Plan:

- Develop a transportation system that meets land and resource management needs at lowest cost and least disturbance to the environment.
- Manage motorized travel on the transportation system and off-roads to protect land and resource values at lowest cost and with a minimum of regulations.

Meeting these goals is measured by the miles of road construction, reconstruction, and decommissioning (physical closures).

There are currently 1,544 miles of inventoried, classified[1] National Forest System (NFS) roads on the Bighorn National Forest transportation inventory. The three ranger districts, Powder River, Tongue, and Medicine Wheel/Paintrock, share management of the road system. The Wyoming counties of

[1] Classified roads are wholly or partially within or adjacent to NFS lands that are determined to be needed for long-term motor vehicle use, including state roads, privately owned roads, NFS roads, and other roads authorized by the Forest Service.

Sheridan, Johnson, Bighorn, and Washakie have roads, which are within or provide public access to the National Forest.

Approximately seventeen percent (261 miles) of the NFS roads are managed and maintained for public use with low-clearance vehicles (passenger cars). These roads receive the highest traffic and are the most costly to maintain to standard. They are the focus of this forest scale roads analysis.

NFS roads are maintained to varying standards depending on the level of use and management objectives. There are five maintenance levels (also referred to as levels) used by the Forest Service to determine the work needed to preserve the investment in the road. These maintenance levels are described in *FSH 7709.58 – Transportation System Maintenance Handbook*. Levels 3, 4, and 5 provide access for passenger car traffic and make up the backbone of the Forest transportation system. The following table summarizes the miles of level 3 through 5 roads under Forest Service jurisdiction or maintenance.

Table 1. Objective Maintenance level 3, 4, and 5 roads (all roads on forest)

Maintenance Level	Forest Total
3	162
4	98
5	1
Total	261

The remaining 1,283 miles of inventoried NFS roads are either restricted to motor vehicle traffic use (maintenance level 1) or managed only for high-clearance vehicles such as pickup trucks and four-wheel drive vehicles (maintenance level 2). These roads are single-purpose, low volume roads normally single-lane and unsurfaced.

Other roads (unclassified[2]) on National Forest System land have been identified in the field and added to the Forest transportation inventory. There are approximately 274 miles of these unclassified roads. The majority of these roads have been created by off-road vehicle traffic. These roads are awaiting management decisions on whether or not to include them as part of the transportation system or to decommission or restrict them to further use. The analysis for these decisions will be made at the watershed or project scale.

[2] Unclassified roads are roads on NFS lands that are not managed as part of the Forest transportation system (unplanned roads, abandoned travelways, and off-road vehicle tracks that have not been designated and managed as a trail, and those roads that were once under permit or other authorization and were not decommissioned upon termination of the authorization.)

Meeting Forest Plan Objectives

Appendix B in the 1985 Forest Plan is a schedule of planned arterial and collector road construction and reconstruction for the planning period. Arterials and collectors are the roads used to provide primary access to large portions of the national forest. Arterials normally serve as connections between towns, major county roads or state highways and are main thoroughfares through the Forest. Collectors link large areas of the Forest to arterials or other main highways. A total of 15.3 miles of new construction and 66.5 miles of reconstruction were planned. To date, 0.0 miles of construction and 31.1 miles of reconstruction have been accomplished. This is approximately 47% of the planned accomplishments. Declining timber sales and reduced capital investment programs are the primary reasons for not meeting forest plan expectations. Also not all roads listed in the Plan are still classified as arterial or collector. Some are level 2 and 3 roads for timber sale access that were not built or built to a lower standard than originally planned. Other projects were dropped as a result of changes in management objectives for the roads in response to public comments during project scoping.

General direction in the 1985 Forest Plan (page III-83) states that the minimum maintenance level for all arterial roads and open collector roads is at least level 3 and the minimum maintenance level for all open local roads is level 2. It also states that all closed roads shall be managed as level 1 roads. According to the current inventory, the Forest is not meeting this direction. Maintenance levels of Forest arterial and collector roads are shown in the following table.

Table 2. Inventoried operational maintenance levels of all Forest arterial and collector roads (miles).

Maintenance Level	Arterial	Collector
1	0	1.59
2	17.8	20.85
3	67.0	97.5
4	46.0	10.26
5	1.1	0
Total Miles	**131.9**	**130.2**

According to the current inventory, 40.2 miles of arterial and collector roads are not being maintained to the level directed by the 1985 Forest Plan. The following table lists the roads not meeting this direction:

Table 3. Arterial and collector roads not maintained to forest plan standards.

Road Number	Name	Functional Class	Maintenance Level
10	HUNT MOUNTAIN	A - ARTERIAL	2 - HIGH CLEARANCE VEHICLES
293	COFFEEN PARK	C - COLLECTOR	2 - HIGH CLEARANCE VEHICLES
12	MEDICINE MTN-LITTLE MTN	C - COLLECTOR	2 - HIGH CLEARANCE VEHICLES
13	MED WHEEL RANGER STA.	C - COLLECTOR	2 - HIGH CLEARANCE VEHICLES
11	SHEEP MTN	C - COLLECTOR	2 - HIGH CLEARANCE VEHICLES
25	CANYON CREEK	C - COLLECTOR	2 - HIGH CLEARANCE VEHICLES

Budget

The Forest budget allocation for planning, construction, and maintenance of roads has been averaging $800,000 per year from 1997 to 2001. There has been an increasing trend in the funding level for roads. However, the annual cost to maintain the entire road system to standard is considerably higher than the amount allocated by Congress. In prior years, congressionally appropriated road funding was supplemented by road construction and maintenance work performed by timber purchasers through the commercial timber sale program. This program has declined steadily and is a mere fraction of the program of a decade ago.

From 1998 through 2000, the Forest conducted road condition surveys to determine the actual cost of maintaining the road system to standard. Work items were also recorded to determine the cost of road maintenance work deferred in previous years due to lack of funding. Finally, road improvement work necessary to bring the roads up to the desired objective was identified and documented. Upon analysis of the data collected, it becomes obvious that the Forest is substantially under funded for the size of the road system it manages (see Table 4).

Table 4. Summary of needed funds for road maintenance and operations for FS maintenance or Jurisdiction Roads.

Maint. Level	Total Miles	Annual Maintenance		Deferred Maintenance	
		$/mile	Total $	$/mile	Total $
1	581	$683	$396,823	$886	$514,766
2	760	$920	$699,200	$2,316	$1,760,160
3	191.6	$6,561	$1,257,088	$8,109	$1,553,684
4	77.7	$5,991	$465,500	$14,730	$1,144,521
5	0.0	$20,558	$0	$24,220	$0
Total	**1,610**		**$2,818,611**		**$4,973,131**

Source: 1998-2000 Road Condition Surveys

Due in large part to this funding shortfall, there is a need to identify and prioritize the minimum road system necessary for access to and management of the National Forest.

Chapter 3 Identifying issues

Identifying Issues

Issues were generated from public response to the Notice of Intent to revise the Bighorn National Forest Plan (2000), local knowledge of the roads analysis ID team members, and public response to a variety of project proposals, and discussion with other public agencies. The Forest Supervisor reviewed and accepted the following issues with the exception of two public-generated issues #8 (Forest scale) and #4 (subforest scale). The issues were sorted into two categories: forest scale and subforest scale. The forest scale issues will be addressed through this roads analysis project. Subforest scale issues will be recommended for addressing at a scale below the forest level. Examples of subforest analyses are watershed or geographic area assessments or specific project proposals.

Forest Scale Issues

1) Shared road maintenance is not occurring on key access roads. Currently there are few road maintenance agreements between the Forest Service and the counties.

- Heavy log truck traffic from National Forest System roads onto some arterial county roads results in increased maintenance needs straining the resources of the counties.
- Road maintenance operations by the counties and Forest Service could be more efficient if shared maintenance agreements were in place.
- Some primary county roads that access National Forest lands could be designated as Forest Highways to become eligible for Federal Highway Administration funding.

2) Some roads may not be under the appropriate jurisdictions.

- Some roads have been under Forest Service jurisdiction for many years. Due to changing use, it might be more appropriate for them to be under county jurisdiction. For some roads, the reverse situation may exist.

3) Road maintenance funding is not adequate to maintain and sign roads to standard.

- One of the objectives of the Roads Analysis Process is to identify the minimum road system needed for public access and land management purposes. Congressionally appropriated road maintenance funding is approximately 20% of what is needed for the current system.
- Directional, warning, and road number signing needs to meet legal standards. Some National Forest System roads do not meet the standards.

4) Road access may not be adequate for future management needs.

- The arterial and collector road system on the Forest was developed over several decades to access different portions of the Forest, often to manage different resources and provide for a variety of public uses. It was not planned forest-wide. This roads analysis will identify opportunities for comprehensive transportation planning.

5) There are potentially adverse environmental impacts from the current road system. Roads causing adverse impacts should be prioritized for evaluation at a subforest level scale.

- Scientific studies and documentation in the past decade have revealed a number of adverse environmental impacts caused by roads.

6) High road densities in some areas of the Forest are causing adverse impacts to resources and users.

- High road densities, especially roads open to motorized vehicles, are fragmenting habitat for some species, degrading the quality of big game hunting, creating conflict between non-motorized and motorized users, and may be affecting watershed health in some areas.

7) The public was concerned that decisions about reducing or reconfiguring the Forest's transportation system might be made without the benefit of public involvement. Forest roads are an integral part of the entire public road system on the Forest. People rely on them to drive to their jobs, recreate on the Forest, to visit friends and relatives and for many other purposes. Decisions that will change the existing system will occur through public involvement and a site-specific analysis that considers effects on any roads in the system now or proposed for addition or deletion from the system in the future.

Subforest Scale Issues

1) Forest access for winter recreation may not be adequate.

    - Increasing snowmobile and cross-country ski use in some areas of the Forest is creating parking congestion problems and safety concerns and may be limiting the number of users and kinds of use. Better access to these heavily used areas needs to be planned and built.

2) Both small all-terrain vehicles (ATVs) and highway vehicles are used on the same roads and occasionally at the same time. This can be a safety problem.

    - Limited sight distance is creating a safety problem on some roads. Limited road maintenance funding to increase sight distance (e.g., reconstruction or roadside clearing) has been a problem.
    - Wyoming State Statute permits use of "public roads" by ATVs that are registered as motorcycles with licensed operators. Many ATVs driven on forest roads are not registered, and many riders are not licensed operators. Bighorn National Forest employees have had near-miss experiences with unlicensed operators or operators driving unregistered ATVs. In some cases, the ATV operators were going too fast or were inexperienced. While the issue of licensing operators and registering all-terrain vehicles is outside the scope of this analysis, the concern about safety is not.

Chapter 4 Assessing benefits, problems, and risks

Introduction

For the purpose of this roads analysis, the June 11, 2001 version of the R-2 Roads Analysis Supplement to FS-643 was used as the guideline for this step. This guideline document provides direction and suggestions about the best scale at which each question could be answered. The IDT used the overall guidance provided but decided it would attempt to answer most of the questions at the forest scale to provide at least background information for each question for referencing and citing purposes during subforest scale roads analyses.

Current Road System Benefits, Problems, and Risks

Aquatic, Riparian Zone, and Water Quality (AQ)

Analysis of the aquatic questions in this forest scale roads analysis focuses on identifying watersheds where there is a high risk of watershed function and/or aquatic species being affected by the road system. This will help prioritize those watersheds on which to focus sub-forest analyses. For this reason, all inventoried roads were considered, including all classified roads (maintenance levels 1-5) and all unclassified roads that have been inventoried and are in the database. Looking at all the roads allowed a broad-scale assessment of the risk to watershed function associated with the entire road system rather than just the arterials and collectors. The broad forest scale analysis provides the basic framework for watershed or project level analysis. Subforest scale analyses will identify site-specific areas being affected by the road system and opportunities to address these concerns.

Map analysis was used to determine which level 3-5 roads are at the highest risk of degrading water quality. These roads are identified in the road matrix.

The Bighorn NF initiated the concept of geographic area assessments in the mid-1990s, and originally envisioned that one of the nine geographic area assessments would be completed each year. This work would feed into site-specific National Environmental Policy Act (NEPA) project analysis, and would be used in Forest Plan monitoring and revision. Two assessments were completed, on the North Fork of Powder River and on Clear Creek/Crazy Woman Creek. The process was abandoned in about 1996.

Beginning in 2001, the Forest Plan revision interdisciplinary team re-initiated this concept for revision. *Ecosystem Analysis at the Watershed Scale*, a federal guide for watershed analysis, was used to develop a series of questions that form the organization for each assessment. Some topic/resource areas were determined to be better addressed at the National Forest scale, as opposed to the geographic area scale. For example, geographic areas do not bind most wildlife species, and repetition in the document can be avoided by addressing such topics once at the National Forest scale. The topics analyzed at the National Forest scale are listed in the Table of Contents for the forest-wide assessment.

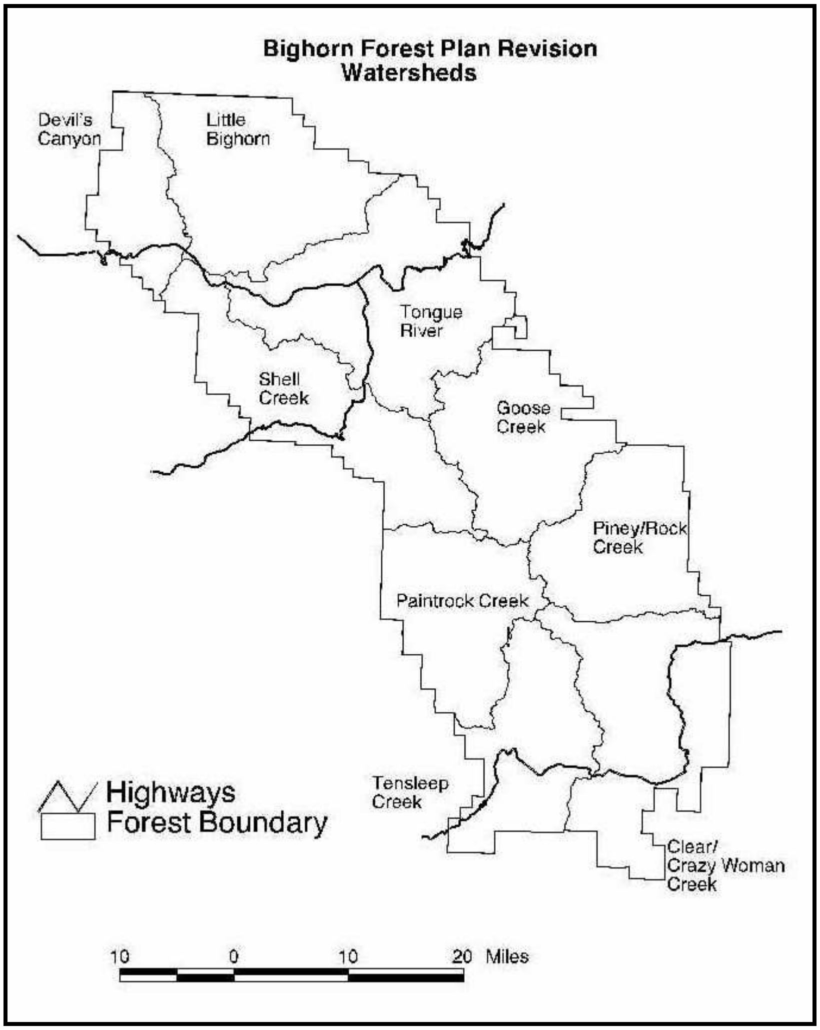

Figure 1. Nine Geographic Areas on the Bighorn National Forest

AQ 1: How and where does the road system modify the surface and subsurface hydrology of the area?

Roads expand the channel network, convert subsurface flow to surface flow, and reduce infiltration on the road surface. All of these factors affect the overall hydrology in a watershed, particularly the quantity and timing of flow.

The channel network is expanded by road ditches, which create stream channels in previously unchannelized portions of the hillside. Road ditches also intercept subsurface flow and convert it to surface flow. An expanded channel network augments peak flows since water traveling as concentrated surface flow reaches the channel faster than water traveling as subsurface flow (Wemple et al. 1996). Reduced infiltration contributes to additional surface flow since water does not infiltrate for storage in the soil profile, but rather runs off as overland or surface flow. Storage and movement of water through the soil profile as subsurface flow regulates and sustains base flows. When roads disrupt these processes, more water becomes available during peak flows, and less water is available to sustain base flows.

While the effects of roads on the hydrology of an area depend largely on local factors, road density is an indicator of the road system's relative potential for modifying surface and subsurface hydrology; the higher the road density, the greater the potential for the road system to affect the hydrology. Road density was calculated for each 6th level watershed, and watersheds were classified as having extreme, very high, high, medium, or low potential for hydrological effects based on relative road densities (Watershed Risk Assessment). The aquatic specialist report identifies the range of values, which represent the low, moderated, high and extreme ratings for road densities as well as other parameters used in questions AQ1-4, AQ6, and AQ9.

Road density categories were determined using forest-wide road density averages. Road densities were calculated using acres of national forest system lands (including wilderness) within each 6th level HUC. Road miles were calculated using miles of class 1-5 national forest system roads within each 6th level HUC. Densities were ranked and then grouped to show the distribution of road densities across the forest (see Figure 2).

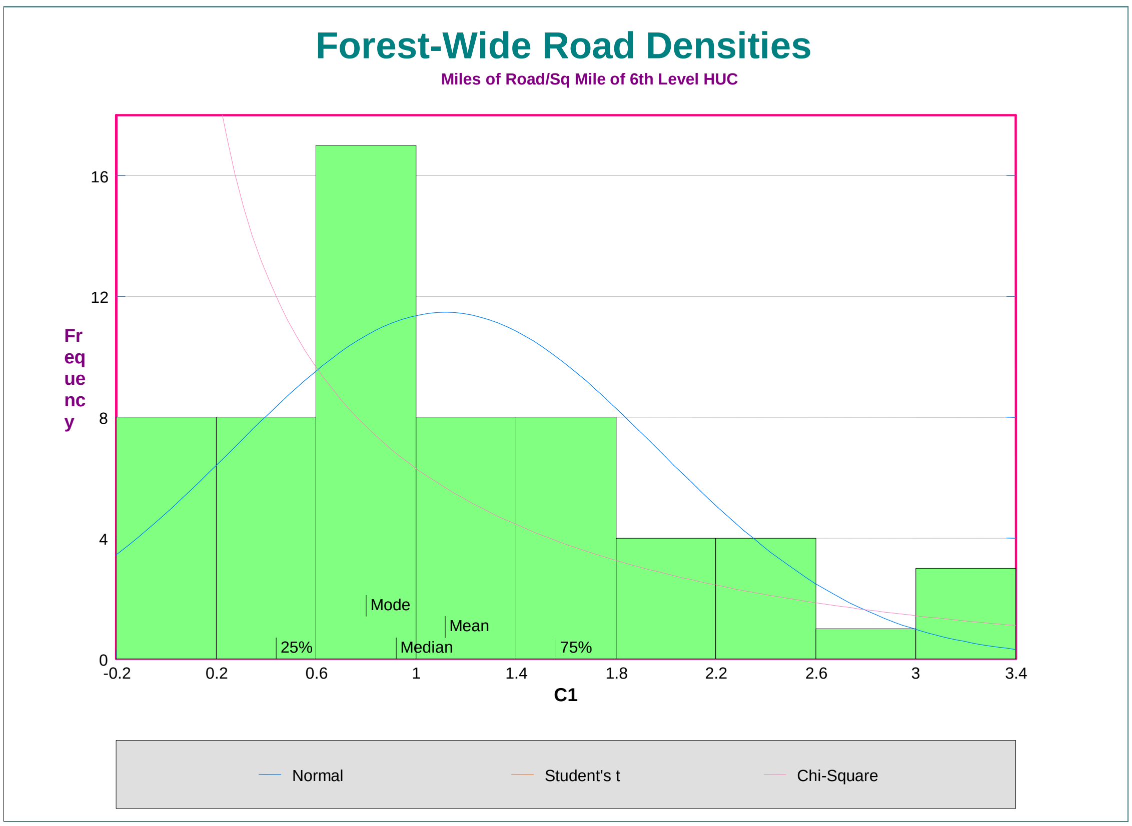

Figure 2. Forest-wide road densities

The following road density rankings were generated from the distribution show in Figure 2.

Table 5. Forest wide road density ranges

Road Density Rating	Ranges (miles/sq mile of ws)	Number of HUC 6 watersheds
Low	0.00 - 0.44	41
Moderate	0.45 - 1.12	17
High	1.13 - 1.56	12
Very High	1.57 - 2.41	8
Extreme	2.42 - 3.35	6

The following table shows the ratings by watershed for each factor.

Table 6. Forest wide road density ratings

Geographic Area	# of level 6 HUC's with high road density ratings	# of level 6 HUC's with very high road density ratings	# of level 6 HUC's with extreme road density ratings	Total # of HUC 6 watersheds
Little Bighorn	2	0	1	3
Tongue River	1	1	0	2
Devil's Canyon	1	1	0	2
Shell Creek	3	0	1	4
Goose Creek	0	0	0	0
Piney/Rock	0	0	0	0
Paintrock	0	2	1	3
Clear-Crazy	2	3	1	6
Tensleep	2	2	0	4

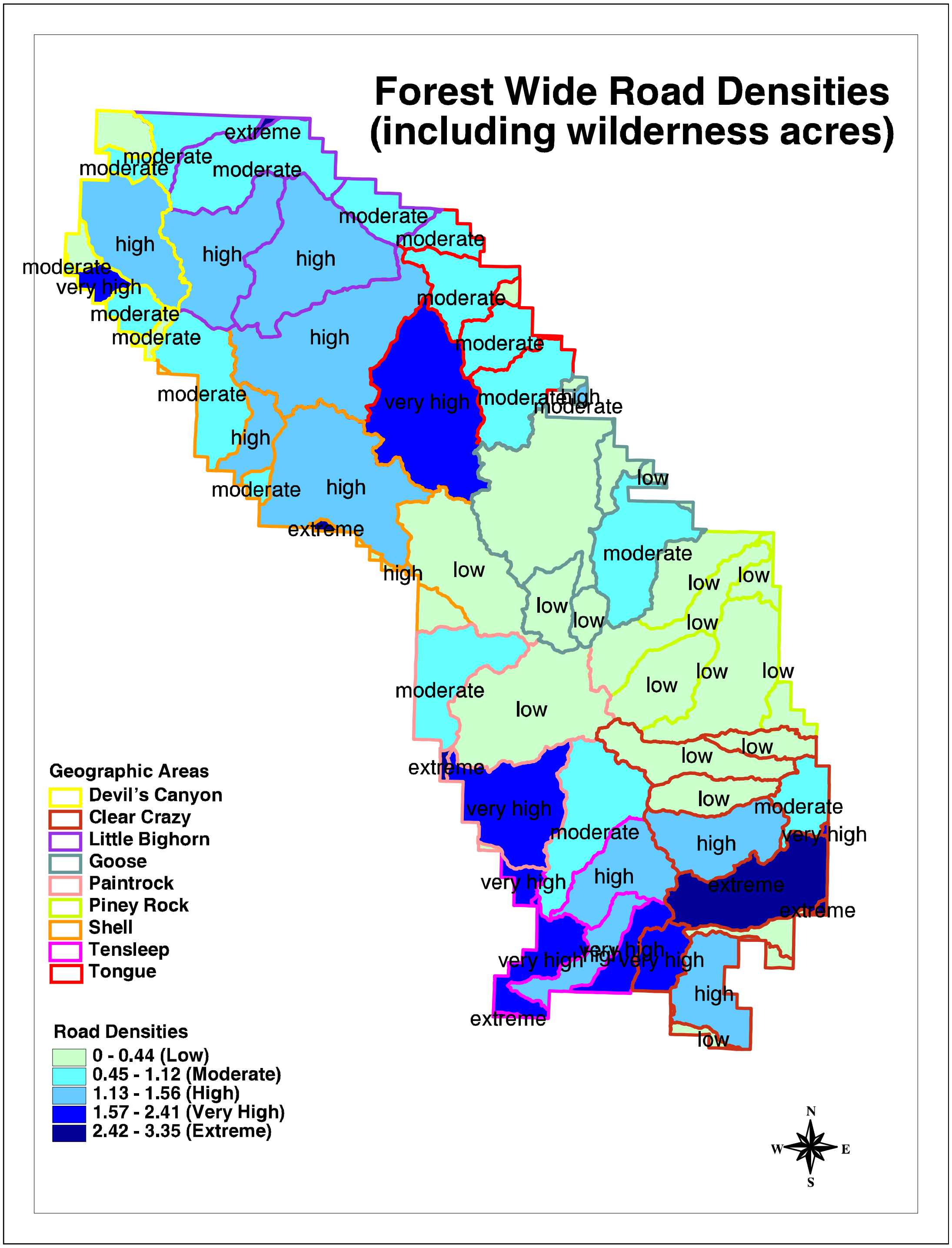

Figure 3. Forest wide road densities

The following is a list of opportunities/recommendations to consider if roads are likely to modify surface and subsurface hydrology:

- Design roads to minimize interception, concentration, and diversion potential.
- Design measures to reintroduce intercepted water back into slow subsurface pathways.

- Use outsloping and drainage structures to disconnect road ditches from stream channels rather than delivering water in road ditches directly to stream channels.
- Evaluate and eliminate diversion potential at stream crossings.

AQ 2: How and where does the road system generate surface erosion?

Surface erosion is highly dependant on soils, road surfacing, road grade, age of the road, traffic volumes, and the effectiveness and spacing of drainage structures. The greatest surface erosion problems occur in highly erodible terrain, particularly landscapes underlain by granitic or highly fractured rocks (USFS 2000). Studies have found that sediment delivery to stream systems is highest in the initial years after road construction, although raw ditch lines and road surfaces with little binder can remain chronic sources of sediment.

Drainage structure, function, and spacing are key to minimizing the amount of surface flow, which directly affects surface erosion. The Water Conservation Practices Handbook (FSH 2509.25) provides guidelines for drainage structure spacing. Drainage structures should be close together on silt-sand soils with little to no binder on steep slopes and further apart on gravel roads surfaces with moderate binder and little to no fines on flat or minimum grades.

To evaluate surface erosion potential, we determined the amount (percent of the watershed) of soils with high erosion potential and miles of road on highly erodible soils in each 6th level watershed. The density of road-stream crossings and the density of road miles within 200 feet of a stream were used as secondary indicators of the potential for eroded materials to be delivered to the stream system. The following table summarizes the number of watersheds with high or extreme factors in each geographic area.

Table 7. Forest wide watershed risk

Geographic Area	% of area with severely erodible soils	# of 6th level HUC with v. high or extreme road stream crossing densities	# of 6th level HUC with a high, very high or extreme density of roads within 200 feet of stream courses	# of 6th level HUC with a high, very high or extreme road densities
Little Bighorn	13%	3	1	0
Tongue River	9%	2	1	1
Devil's Canyon	13%	2	0	1
Shell Creek	2%	4	0	1
Goose Creek	4%	0	0	0
Piney/Rock	1%	0	0	0
Paintrock	3%	3	0	3
Clear-Crazy	> 1%	6	0	5
Tensleep	5%	4	3	3

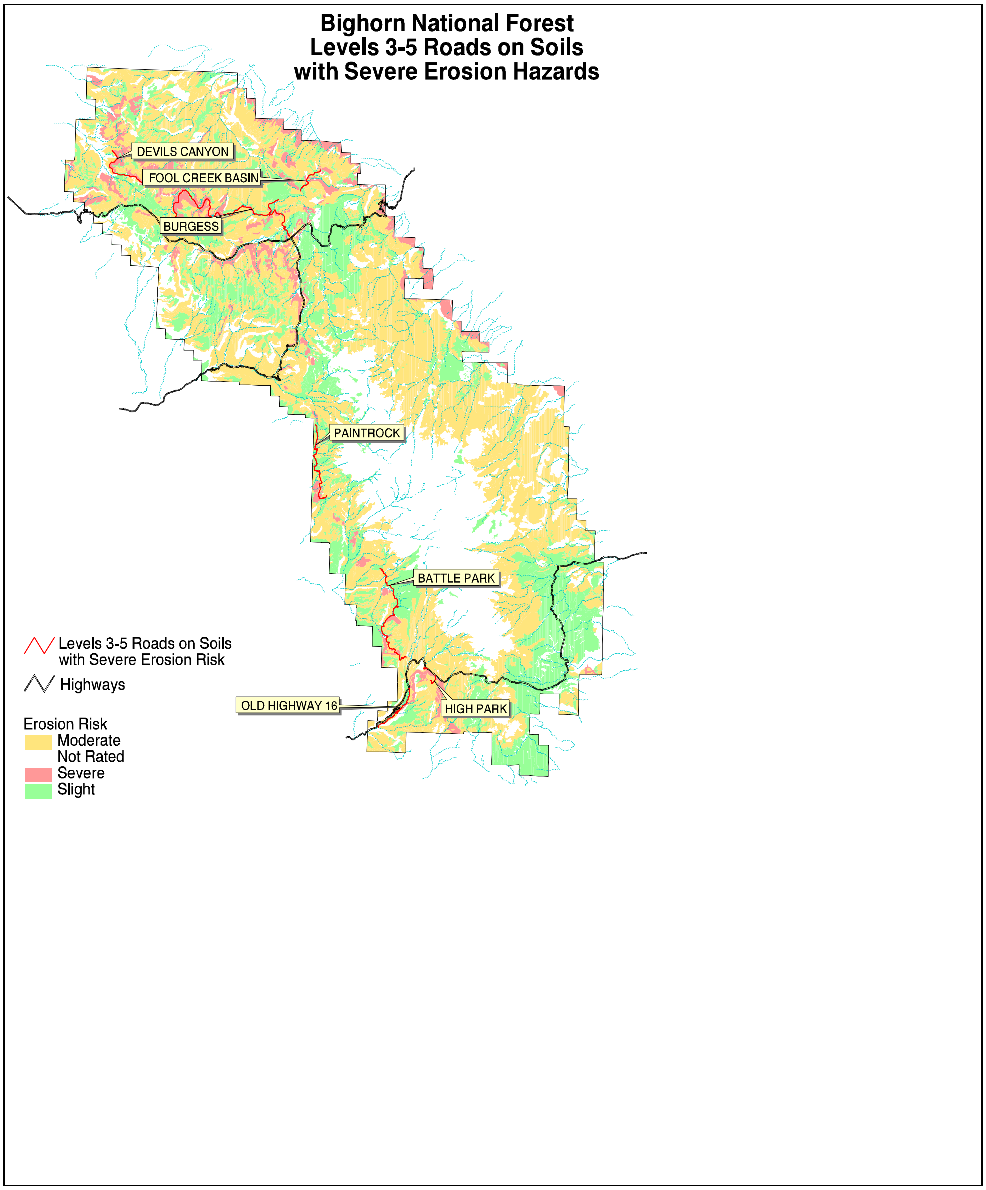

Figure 4. Levels 3-5 Roads on Erodible Soils

The primary opportunities to reduce surface erosion identified in a sub-forest scale roads analysis should include:

- Increasing the number and effectiveness of drainage structures.
- Improving the road surface by either gravelling, or adding a binding material to those roads that have native surfaces with no inherent binder.

AQ 3: How and where does the road system affect mass wasting?

Road related mass wasting results from 1) improper placement and construction of road fills and stream crossings, 2) inadequate culvert sizes to accommodate the peak flows, sediment loads, and woody debris, 3) roads located on soils prone to mass wasting, and 4) water diversion onto unstable hill slopes.

The sensitivity of an area to mass wasting depends on the interaction of the soils and underlying bedrock, slope steepness, and the subsurface hydrology. Mass wasting is not a widespread concern on the Bighorn National Forest, but does occur in localized areas. Project-level analyses will need to consider the effects of maintenance level 1-2 roads on mass wasting and potential concern areas for new road construction.

More in-depth analysis from sub-forest scale analyses will identify areas where the interaction of the soils, underlying bedrock, slope steepness, and subsurface hydrology are creating high priority concern areas. This analysis will also help us identify watersheds where additional road construction may cause mass wasting. Opportunities to address existing roads in areas with high mass wasting potential include:

- Road relocation to an area with more stable soils.
- Relocation of drainage structures to that the outlets are on less sensitive areas which may include flatter slopes and better-drained soils.

AQ4: How and where do road-stream crossings influence local stream channels and water quality?

Road-stream crossings have the potential to directly and indirectly affect local stream channels and water quality. Poorly designed crossings directly affect hydraulic function when they constrict the channel, when they are misaligned relative to the natural stream channel, or when improperly sized culverts are installed. Road-stream crossings also act as connected disturbed areas where water and sediment are delivered directly to the stream channel. Connected disturbed areas are defined as "high runoff areas like roads… that discharge surface runoff into a stream or lake…connected disturbed areas are the main source of damage in all regions" (FSH 2509.25-99-2).

Increasing peak flows through the extended channel network (see AQ1) increases the energy available for in-channel erosion, which affects stream stability and increases sedimentation. The biggest water quality concern associated with the road system is sediment delivered to the stream system through connected disturbed areas.

The density of road-stream crossings in each 6th level watershed was used to determine those watersheds where the road-stream crossings posed the highest risk to local stream channels and water quality. Watersheds were determined to have a high, medium, or low priority for further evaluation through a sub-forest scale roads analysis.

Figure 5. Forest wide stream crossing densities

Table 8. Forest wide stream crossing density ratings

Stream Crossing Density Rating	Ranges (crossings/sq mile)	Number of HUC 6 watersheds
Low	0.00 – 0.75	49
Moderate	0.76 – 1.13	14
High	1.14 – 2.02	16
Very High	2.03 – 2.92	4
Extreme	2.93 – 5.45	1

Opportunities to improve concern areas identified through sub-forest scale analyses include:

- Designing crossings to pass all potential products including sediment and woody debris, not just water.
- Realign crossings that are not consistent with the channel pattern.
- Change the type of crossing to better fit the situation; for example, consider bridges or hardened crossings on streams with floodplains, and consider bottomless arch culverts in place of round pipe culverts.
- Add cross-drains near road-stream crossings to reduce the connected disturbed area.
- Reduce the number of road-stream crossings to minimize the potential for adverse effects.

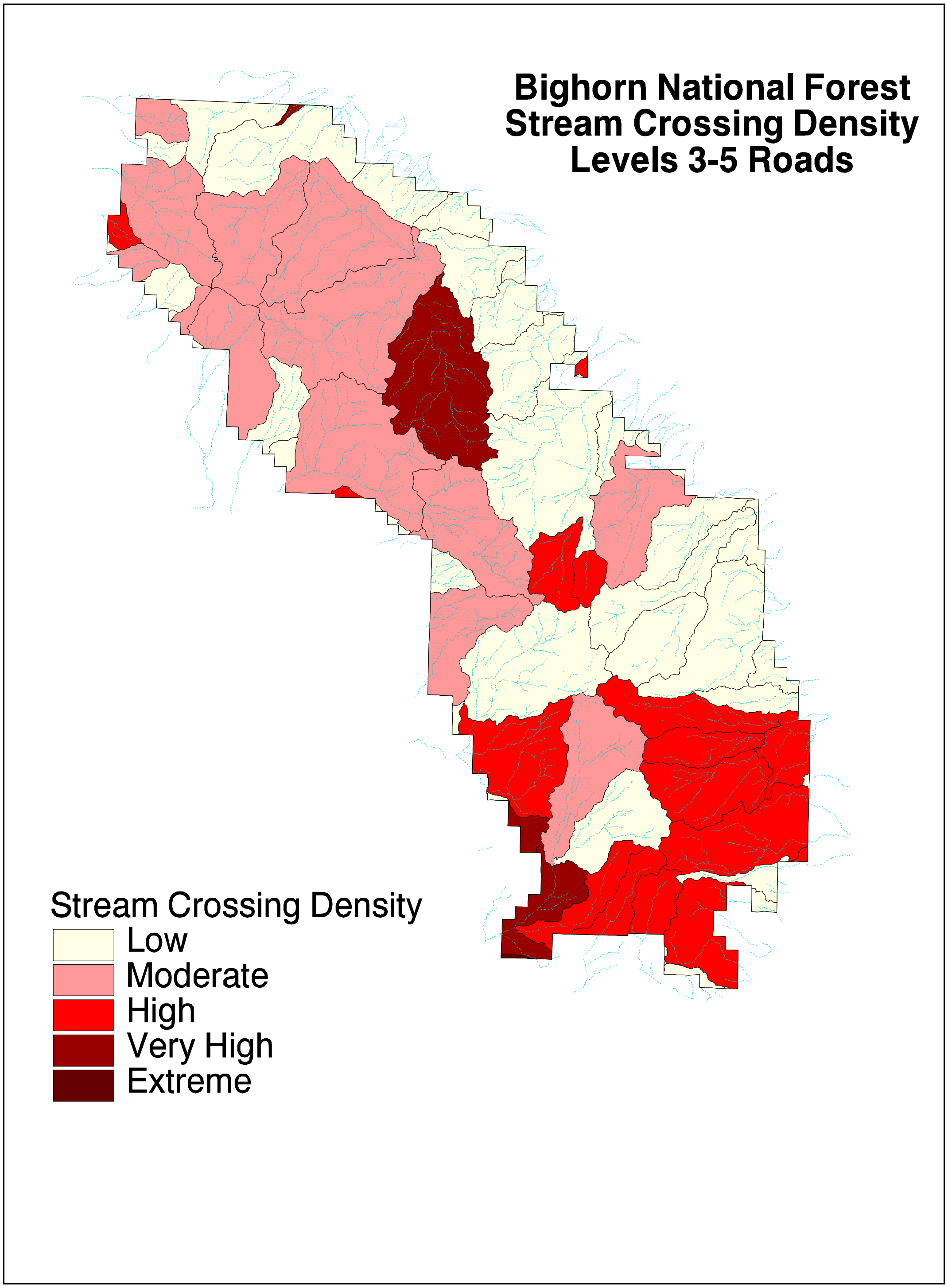

Figure 6. Forest wide stream crossing density

AQ 5: How and where does the road system create potential for pollutants, such as chemical spills, oils, deicing salts, or herbicides to enter surface waters?

Anywhere roads run adjacent to or across streams or floodplains, there is some potential for spilled pollutants to access streams. Poorly designed cross drains may transport spilled pollutants to standing or flowing water bodies. Generally, these pollutants are not transported in bulk across the Bighorn National Forest. County weed programs do use herbicides on the Forest and will create some potential for pollutant contribution in the case of vehicle or equipment accidents. Log haulers and other heavy equipment associated with harvest and road activities carry sufficient fuel and oil to cause localized water quality problems should an accident occur. This is minimized by stipulations in timber sale contracts that specify haul speeds, fueling practices, weather or road moisture limitations, and other aspects of the operations. Forest road maintenance crews are also trained to utilize safe areas and procedures for refueling heavy equipment. The potential for pollutant associated with log haulers would be highest on those roads commonly used for timber harvest access, particularly maintenance levels 3-5 roads.

The application of magnesium or calcium chloride for road dust abatement may affect water quality, but past studies have found that the effects can only be detected after many years of repeated year-round application (Heffner 1997). Typically, magnesium or calcium chloride is only applied 1-2 times per year on roads requiring it, generally, maintenance level 4 and higher roads. This factor should be considered when upgrading the maintenance level to 4 or higher. This may be a concern in areas where aquatic threatened, endangered, and sensitive species are present.

Magnesium and calcium chloride may be used during the winter months as de-icing gents, although this is not a common practice on highways that run through the Bighorn National Forest. If and or when de-icing salts are used, the application rates are often higher than for dust abatement, the chemicals do not bind with soils (or the pavement as in the case of de-icing), and the frequency of applications is generally higher. Fore these reasons the use of these salts for de-icing purposes has a higher potential for affecting water quality. One study found that wells contaminated with chloride were on average 24 feet away from the treated highway. In a worst-case scenario, a stream with a flow of 20 cubic feet per second resulted in a chloride concentration of 275 ppm in a 24-hour period. The concentration was slightly above the drinking water standard and below the tolerance limits for trout (Heffner 1997).

AQ 6: How and where is the road system "hydrologically connected" to the stream system? How do the connections affect water quality and quantity?

The road system is hydrologically connected to the stream system where there are connected disturbed areas (see AQ2 and AQ4). This includes road-stream crossings, as well as areas where roads are adjacent to stream courses and there is an insufficient buffer strip between the road or road drainage structures and the stream system. As discussed in AQ1, the extended channel network can increase peak flows. As discussed in AQ4, water quality can be degraded where connected disturbed areas increase sediment delivery to the stream system. Connected disturbed areas with highly erodible soils are the most likely to deliver sediment to the stream system.

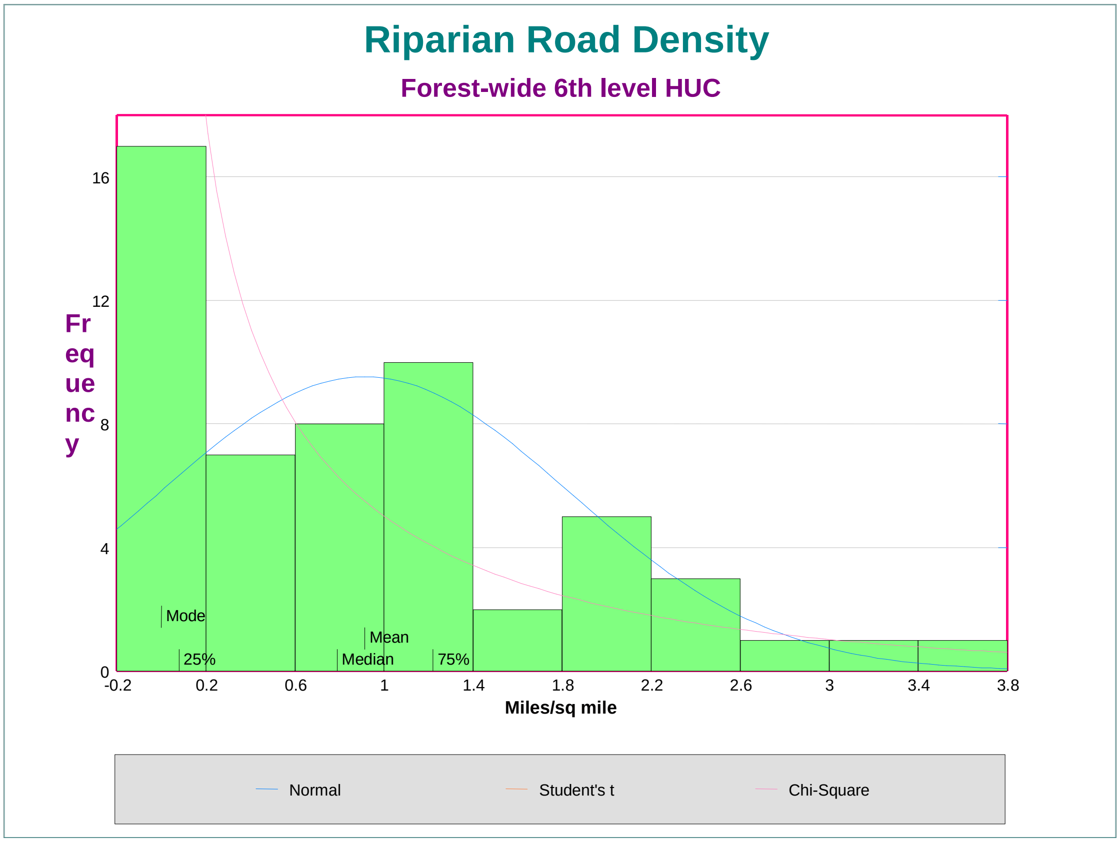

Figure 7. Forest wide riparian road densities

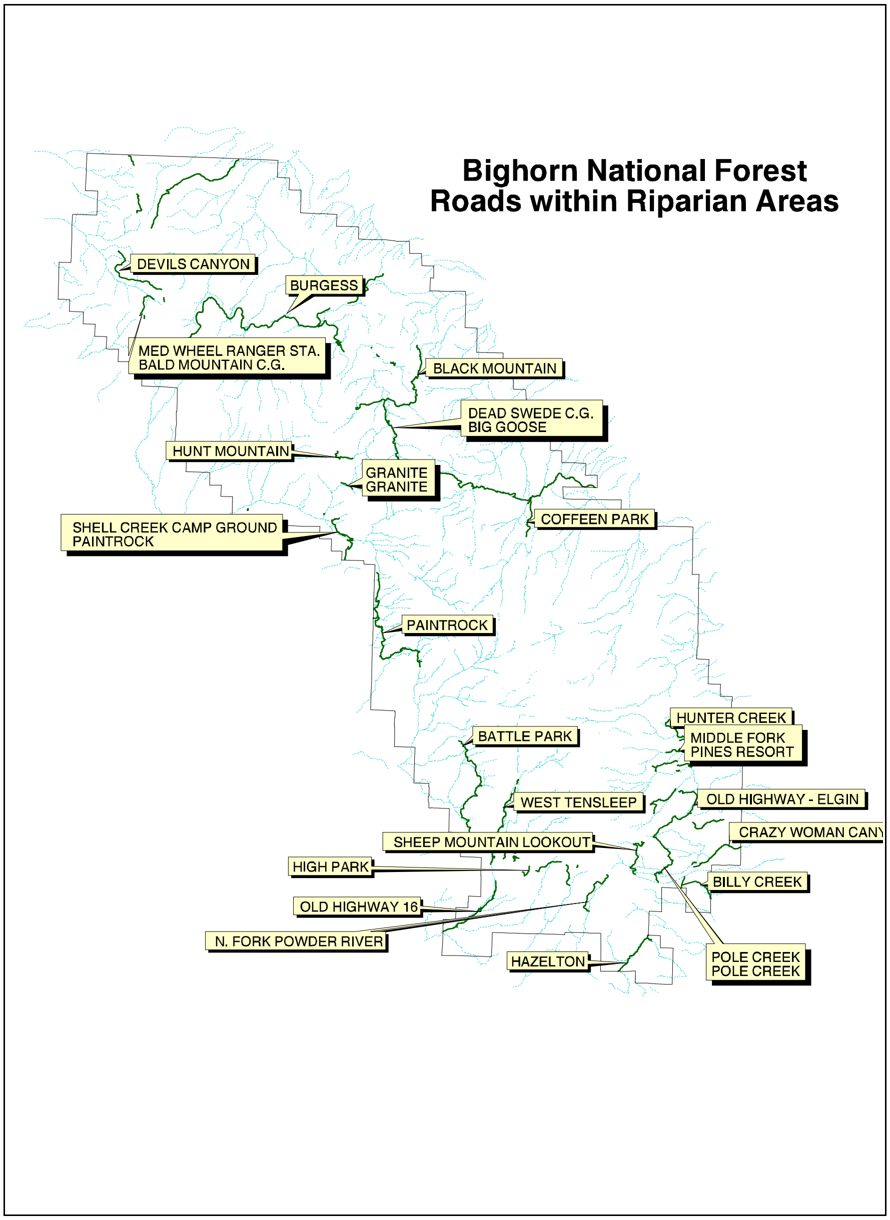

Figure 8. Levels 3-5 Roads in Riparian

Table 9. Riparian Road Density Ratings

Riparian Road Density Rating	Range (miles of road/sq mile of riparian)	Number of HUC 6 watersheds
Low	0.00 – 0.08	42
Moderate	0.09 – 0.91	19
High	0.92 – 1.22	10
Very High	1.23 – 1.83	3
Extreme	1.84 – 3.57	10

All the factors identified in AQ1-4 were used to develop an overall watershed risk rating. The overall risk rating represents the potential for hydrologically connected areas that can affect both water quality and water quantity.

Table 10. Forest wide area with above average watershed risk

Geographic Area	Area (sq miles) with high, very high, extreme watershed risk	Number of 6th level watersheds with high, very high, extreme watershed risk	Percent of geographic area with high, very high, extreme watershed risk
Little Bighorn	1.10	1	0%
Tongue River	203.69	3	74%
Devil's Canyon	62.11	3	65%
Shell Creek	86.10	1	39%
Goose Creek	1.18	1	1%
Piney/Rock	0.00	0	0%
Paintrock	51.48	1	31%
Clear-Crazy	215.59	7	88%
Tensleep	69.52	4	44%

There are 392.43 square miles of watersheds with a high risk factor, 423.16 square miles with very high risk level, and 267.60 square miles with extreme risk levels. The geographic area with the highest percentage of its area in a high risk factor is Clear-Crazy.

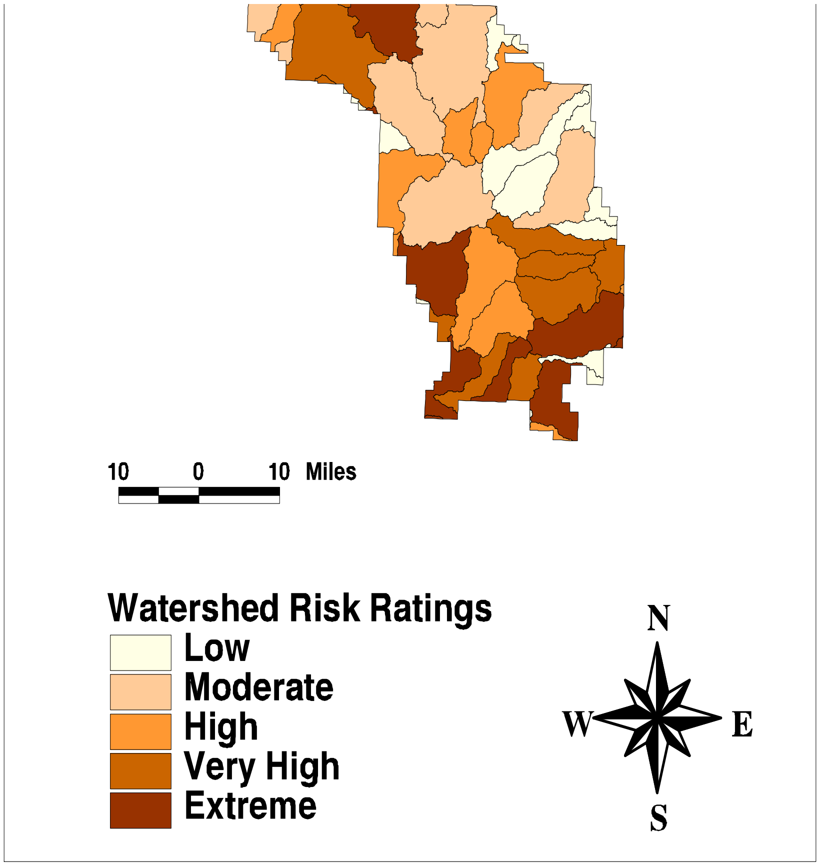

Figure 9. Forest wide watershed risk map

Watersheds with extreme and high-risk ratings would be the priority for sub-forest scale analysis. Analysis at this smaller scale would identify site-specific problem areas and opportunities for reducing the effects of the road system on water quality and quantity.

Opportunities to address concern areas identified in sub-forest scale analyses are the same as in AQ1, AQ2, and AQ 4. Additional opportunities include relocating roads adjacent to stream channels to a position higher on the hill slope away from streams.

AQ 7: What downstream beneficial uses of water exist within the area? What changes in uses and demand are expected over time? How are they affected or put at risk by road-derived pollutants?

Downstream beneficial uses of water in the area are outlined in the objectives of the Wyoming pollution control program as outlined in W.S. 35-11-102. These objectives are specifically designed to maintain the best possible quality of waters commensurate with the following beneficial uses:

- Agriculture
- Protection and propagation of fish and wildlife
- Industry
- Human consumption
- Recreation
- Scenic value

The pollution control program is also designed to achieve the goal of the federal act, which is to achieve, wherever attainable, surface water quality which provides for the protection and propagation of fish, shellfish, wildlife, and recreation in and on the water.

There are four classes of surface water in Wyoming (see *Water Quality Rules and Regulations* for specific listings).

Class 1 – Those waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices.

Class 2 – Those surface waters, other than those classified as Class 1, which are determined to:

- Be presently supporting game fish; or
- Have the hydrologic and natural water quality potential to support game fish; or
- Include nursery areas or food sources for game fish.

Class 3 – Those surface waters, other than those classified as Class 1, which are determined to:

- Be presently supporting non-game fish only; or
- Have the hydrologic and natural water quality potential to support non-game fish only; or
- Include nursery areas or food sources for non-game fish only.

Class 4 – Those surface waters, other than those classified as Class 1, which are determined to not have the hydrologic or natural water quality potential to support fish and include all intermittent and ephemeral streams. Class 4 waters shall receive protection for agriculture uses and wildlife watering.

Except for the North Tongue watershed, which is classified as Class 1, all waters within the boundary of the Bighorn National Forest are designated as Class 2.

Changes in classification and designated uses sometimes occur over time as knowledge of certain water bodies increases or as stakeholders petition the Wyoming Department of Environmental Quality (WYDEQ). Classifications can be either upgraded or downgraded through this public process with commensurate changes in protected designated uses.

Demands for most water uses are following an increasing trend. With increases in population, public private lands recreation, agriculture, and industry, controversy over appropriate uses of water will also grow. Most major river basins in the West are fully or over-appropriated, adding complexity to the problem of determining the best use of the state waters.

Several of the designated uses for on-forest water body classes can be affected by road-derived pollution. Either Class 1 or 2 water bodes can include cold and warm water game fish and non-game fish support as designated uses. These are detrimentally affected if sediment from forest roads surpasses the tolerance of the fish and prey (aquatic invertebrate) populations or if roads cause channel instability that degrades aquatic habitat (see AQ1-4 and AQ6). The Class 1 non-degradation standard can be violated if water quality is lowered through lack of best management practices during road design, building or maintenance; it can also be violated if these conservation practices are implemented but are not effective.

Table 11. Forest wide streams with known impairments

Geographic Area	Streams listed on 2000 305(b) report	Type of impairment	Location of impairment (on forest or off forest)	Reason for impairment
Little Bighorn	None	~	~	~
Tongue River	None	~	~	~
Devil's Canyon	None	~	~	~
Shell Creek	None	~	~	~
Goose Creek	Beaver Creek Big Goose Creek Goose Creek Jackson Creek Kruse Creek Little Goose Creek Park Creek Rapid Creek Sacket Creek Soldier Creek	Impaired Impaired Impaired Impaired Impaired Impaired Impaired Impaired Impaired Impaired Impaired Impaired	Off-Forest	Big Goose and Little Goose Creeks were placed on the 1998 303(d) list due to exceedences of the standard for fecal coliform bacteria below the forest boundary. Sheridan County Conservation District has begun a project to determine the sources of contamination in these watersheds and has begun locally led efforts to mitigate the sources.
Piney/Rock	Rock Creek	Threatened	Off-Forest	Physical degradation below forest boundary.
Paintrock	None	~	~	~
Clear-Crazy	Crazy Woman Clear Creek	Threatened Threatened	Off-Forest On-Forest	Off-forest diversions Hunter Creek sediment. TMDL completed
Tensleep	None	~	~	~

AQ 8: How and where does the road system affect wetlands?

Roads can affect wetlands directly by encroachment, and indirectly by altering hydrologic surface and subsurface flow paths. Encroachment results in a loss of wetland area directly proportional to the area disturbed by the road. Alteration of they hydrologic flow paths can affect wetland function with the effects extending beyond the area directly affect by the road. The watershed conservation Practices Handbook (FSH 2509.25) provides measures to protect wetlands.

During project level analyses, opportunities to reduce the effects of the road system on wetlands include the following:

- Relocate roads out of wetland areas.
- Where relocation is not an option, use measures to restore the hydrology of the wetland. Examples include raised prisms with diffuse drainage such as French drains.
- Set road-stream crossing bottoms at natural levels of wet meadow surfaces.

AQ 9: How does the road system alter physical channel dynamics, including isolation of floodplains, constraints on channel migration, and the movement of large wood, fine organic matter, and sediment?

Roads can directly affect physical channel dynamics when they encroach on floodplains or restrict channel migration. Floodplains help dissipate excess energy during high flows and recharge soil moisture and groundwater. Floodplain function is compromised when roads encroach on or isolate floodplains. This can increase peak flows. When peak flows increase, more water is available for in-channel erosion, which, in turn, affects channel stability. Restricting channel migration can cause channel straightening which increases the stream energy available for channel erosion. This can also result in channel instability. Altering channel pattern affects a stream's ability to transport materials, including wood and sediment.

This analysis used the miles of road within 200 feet of a stream as an initial indicator of where the road system might be affecting physical channel dynamics. The concerns are greatest on reaches with floodplains where the streams naturally meander.

There are approximately 685.73 square miles of watersheds with high, very high, extreme road densities within riparian areas.

AQ 10: How and where does the road system restrict the migration and movement of aquatic organisms? What aquatic species are affected and to what degree?

Migration and movement of aquatic organisms are primarily restricted at road-stream crossings with culverts. Generally, the restriction is on upstream migration, although downstream migration can also be affected. This results form hanging culverts, high flow velocities in culverts, and inadequate depths for fish migration. In some locations migration barriers are desirable to protect native species. While culverts can affect the migration of amphibian species, the greatest concern is the effect on fish species.

Brook trout are the most widely distributed fish species on the Bighorn National Forest. Other non-native fish species include rainbow and brown trout. The primary native species of concern is the Yellowstone Cutthroat trout (YCT).

The forest is annually evaluating the potential for migration barriers associated with maintenance level 1-2 roads within each geographic area. The following table shows which geographic areas have been surveyed for migration barriers.

Table 12. Watersheds with migration barrier information

Geographic Area	Has this watershed been inventoried for migration barriers?
Little Bighorn	Y
Tongue River	Y
Devil's Canyon	Y
Shell Creek	N
Goose Creek	N
Piney/Rock	N
Paintrock	Y
Clear-Crazy	N
Tensleep	Y

Restorative actions are being made to treat stream crossings that are known migration barriers. Actions to address the problem stream crossings include:

- Reset the culvert to eliminate the limiting factor;
- Replace the problem culvert with an alternative crossing structure such as a bridge, hardened low-water ford, or bottomless pipe-arch.

AQ 11: How does the road system affect shading, litter fall, and riparian plant communities?

The road system directly affects riparian communities where it impinges on riparian areas. Roads can indirectly affect riparian communities by intercepting surface and subsurface flows and routing these flows so that riparian areas dry up and the riparian vegetation is replaced with upland vegetation. Riparian communities play a vital role in providing shade. Removal or degradation of these communities can affect stream stability and water temperatures, which in turn, affects aquatic habitat. The Watershed Conservation Practices Handbook (FSH 2509.25) provides measures to protect riparian areas.

Opportunities to address concerns found in watershed or project level analyses include:

- Relocate roads out of riparian areas;
- Restore the hydrology in riparian areas that have been dewatered by the road system.

AQ 12: How and where does the road system contribute to fishing, poaching, or direct habitat loss for at-risk aquatic species?

High traffic roads adjacent to streams with fish are the most likely to contribute to fishing and poaching. This is not generally considered an issue on the Bighorn National Forest and does not significantly affect aquatic populations and at-risk aquatic species.

The road system contributes to direct habitat loss where mass movements associated with roads directly impact stream channels (AQ3), where sediment is delivered directly to the stream channel through connected disturbed areas (AQ6), at road-stream crossings (AQ4), and where the road system is restricting channel migration and isolating floodplains (AQ9). Areas of particular concern are watersheds with Yellowstone Cutthroat trout populations that were identified as high risk potential in AQ3, 4, 6 and 9. Opportunities to address problem areas would be similar to hose previously identified.

AQ13: How and where does the road system facilitate the introduction of non-native aquatic species?

The introduction of non-native species occurs primarily through stocking of non-native fish. The Wyoming Game and Fish Department coordinates stocking locations with the Forest Service to ensure that non-native aquatic species are not being introduced into waters containing native fish species or waters that provide high quality habitat for native species reintroduction.

AQ14: To what extent does the road system overlap with areas of exceptionally high aquatic diversity or productivity or areas containing rare or unique aquatic species or species of interest?

The road system generally has moderate to low overlap with areas of exceptionally high aquatic diversity or aquatic species of interest. The primary species of interest include Yellowstone Cutthroat trout, boreal toads, tiger salamander, and wood frog. Watersheds containing cutthroat trout and sensitive amphibian species were identified. Those that have a high risk of resource damage associated with roads and containing sensitive aquatic populations would be a priority for more detailed watershed or project level analyses.

This analysis identified 6 watersheds where species of interest were present in watersheds with high, very high, or extreme overall risk ratings.

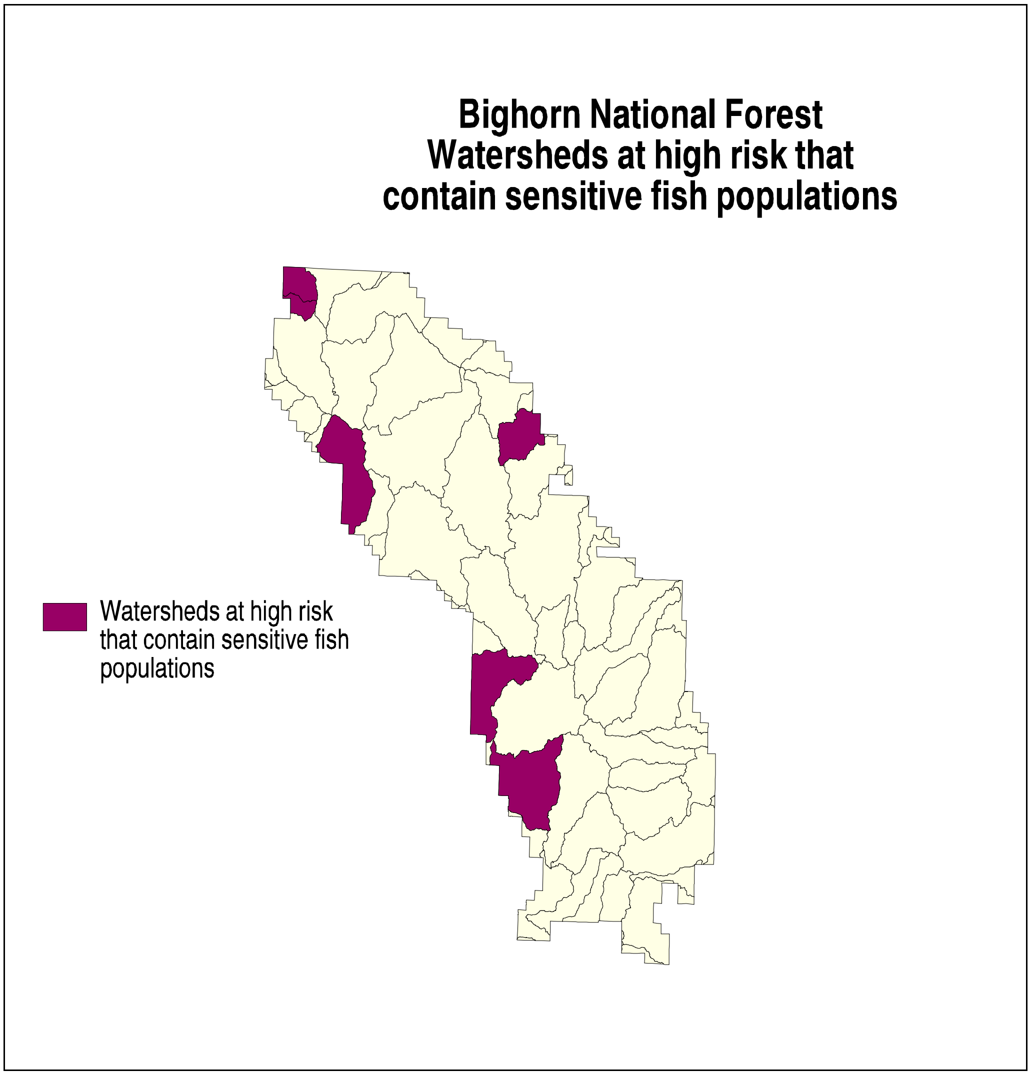

Figure 10. Sensitive fish populations in high risk watersheds

AQ Summary

The roads analysis provided important insights on the effects that levels 3-5 roads may be having on the condition of aquatic resources on the Bighorn National Forest. The following roads and watersheds have consistently shown to be at the highest risk in most of the important categories described above. These roads and watersheds should be investigated further to insure the long-term health of the aquatic resources within the Bighorn National Forest.

Watersheds with aquatic resources at highest risk from levels 3-5 roads:

- South Tongue
- Middle Paintrock Creek
- Tensleep Creek
- Canyon Creek

- Crazy Woman Creek
- Clear Creek

Levels 3-5 Roads with highest risk to aquatics. These roads have some or all of their length within 50 meters of streams and are located on soils with severe erosion potential.

- Meadowlark Road 426
- Bull Creek Campground Road 428
- High Park Road 429
- Battle Park Road 24
- Old Highway 16 Road 18
- West Tensleep Road 27
- Alkali Road 338
- Paintrock Road 17
- Devil's Canyon Road 14
- Burgess Road 15
- North Tongue Campground Road 158
- Burgess Picnic Ground Road 162
- Fool Creek Road 168

Water Production (WP)

WP1: How does the road system access, construction, maintaining, monitoring, and operating water diversion, impoundments, and distribution canals or pipes?

The existing road system is sufficient to access existing water diversion, impoundments, and distribution canals and pipes. The larger impoundments and diversion tend to be accessed by the arterial and collector roads. However, the Forest does have numerous agricultural ditches and reservoirs that are closed to public access and are accessed by their permittees on a "by request" basis. This access is for inspection and maintenance and is required by their permit. Public motorized access on these roads is generally restricted, and extensive use by the permittee is usually addressed with maintenance requirements in their permit.

WP2: How does road development and use affect water quality in municipal watersheds?

This is addressed by project on a case-by-case basis for road development. Thus far, use has not been identified as a concern or problem for water quality in the existing municipal watersheds.

Table 13. Municipal watersheds

Geographic Area	Municipal watersheds	Communities Served
Little Bighorn	None	
Tongue River	Tongue River	City of Dayton, WY
		City of Ranchester, WY
	Wolf Creek	Eaton's Dude Ranch
Devil's Canyon	None	
Shell Creek	Shell Creek	City of Shell, WY
Goose Creek	Big Goose Creek	City of Sheridan, WY
		VA Medical Center
Piney/Rock	None	
Paintrock	None	
Clear-Crazy	Clear Creek	City of Buffalo, WY
		Paradise Guest Ranch
Tensleep	None	

WP3: How does the road system affect access to hydroelectric power generation?

The Bighorn National Forest does not have any hydroelectric power generation facilities.

Minerals Management (MM)

MM 1: How does the road system affect access to locatable, leasable, and salable minerals?

Affected Environment: Minerals and Geology:

The Forest Service administers its minerals program to:

Encourage and facilitate the orderly exploration, development, and production of mineral resources from National Forest System lands, and,

Ensure that exploration, development, and production of mineral resources are conducted in an environmentally sound manner and that these activities are integrated with planning and the management of other National Forest recourses. (FSM 2802)

Mineral resources are separated into three categories: locatable, leasable, and saleable.

Locatable Minerals are those deposits subject to location and development under the General Mining Law of 1872 (as amended). The Forest Service does not manage the mineral resources on National Forest System lands. That authority rests with the Secretary of the Interior. Forest Service authority is directed at the use of the surface of National Forest System lands in connection to the operations authorized under the United States mining laws (30 U.S.C 21-54), which confer a statutory right to enter upon the public lands to search for minerals. Forest Service regulations at 36 C.F.R. 228, Subpart A provide that operations shall minimize adverse environmental impacts to the surface resources, which includes the following:

- Using all practicable measures to maintain and protect wildlife habitat affected by an operation.
- Reclaiming surface disturbances, where practicable.
- Rehabilitating wildlife habitat.

Additionally, the regulations require that roads needed for mineral activities shall be constructed and maintained to minimize or eliminate damage to resource values (including wildlife). Unless otherwise authorized, roads that are no longer needed for operations shall be closed to normal traffic, bridges and culverts removed, and the road surface shaped to as near a natural contour as practicable and stabilized.

The Bighorn National Forest is open under the general mining laws in which the right of exclusive possession is vested in the discovery of a valuable mineral deposit. The existing road system has been sufficient to meet locatable requests to date. Some areas of public lands located within the jurisdictional boundaries of the Bighorn National Forest have been withdrawn from mineral entry through the Bureau of Land Management. This means mineral entry/activity of any sort are not allowed. These areas include, but are not limited to, Congressionally designated Wilderness areas, Research Natural Areas, National Recreation Areas, Administrative Sites, Special Interest Areas, etc. Locatable minerals are addressed in the 1985 Bighorn National Forest Resource Management Plan.

Access is provided to people with mineral rights throughout the Forest and these routes may be closed to the general public. Arterial and collector roads are used to access individual claims and access is addressed on an individual basis. The vast majority of roads constructed into mining claims are/will be temporary. Where reconstruction/construction and reclamation are necessary for access, bonding is required as part of Operating Plans or Notice of Intent.

Leasable Minerals are federally owned fossil fuels (oil, gas, coal, oil shale, etc), geothermal resources, sulfur, phosphates, and uranium. These minerals are subject to exploration and development under leases, permits, or licenses issued by the Secretary of the Interior, with Forest Service consent. The 1920 Mineral Leasing Act (as amended) together with the 1989 Federal Onshore Oil and Gas Leasing Reform Act provide the authority and management direction for federal leasable minerals on National Forest System lands. In addition, mineral leasing on the Grasslands is authorized under the 1947 Mineral Leasing Act for Acquired Lands.

Withdrawals of unclassified lands from operations of the mineral leasing acts are requested only in exception situations. Classified lands, other than wilderness, which are not by law or otherwise withdrawn from operations under the mineral leasing acts include Wild and Scenic Rivers, National Recreation Areas, National Historic Sites, Natural Areas, and other specific classifications. In these areas, the Forest Service recommends leasing activities only when terms and conditions can be applied that will protect the purpose for which the lands were classified.

Road access for leasable minerals is generally planned and developed on a large grid and on an individual basis. Production of leasable minerals will require some high-standard haul roads. Existing arterial and collector roads are utilized to access the general proximity and are sufficient for that purpose. Transportation plans are generally developed as part of each leasable activity.

Salable Minerals include mineral materials, otherwise known as "common varieties" which generally include deposits of sand, gravel, clay, rock or stone used for a number of purposes including road surfacing, construction materials, and landscaping. The disposal of these materials is by a materials contract issued at the discretion of the Forest Service. All contracts contain requirements for reclaiming the sites, as much as practicable, to pre-mining conditions.

Existing arterial and collector roads are sufficient to gain access to the general proximity of salable proposals.

The value of salable common variety minerals is very sensitive to transportation costs. However, the Forest Service has total discretionary authority for disposal of common variety minerals and is not obligated by any statutory requirements.

Terrestrial Wildlife (TW)

TW1: What are the direct and indirect effects of the road system on terrestrial species *habitat*?

There are three primary factors impacting terrestrial species habitats from roads. The first impact is the direct loss of actual habitat (vegetation or otherwise) from road construction. The second impact is a potential or indirect barrier to species movements. The third impact is from a potential or indirect "fragmentation" of existing habitats, whereby additional edge features are created as a result of roads.

There are several documents that present data on roads for the Forest written as part of the plan revision. The Forest-wide Assessment titled "Transportation System, Roads" depicts road information at the broad scale and provides definitions of the various classes of roads. Each Geographic Area assessment also includes an analysis of roads, including road densities, at that scale. Finally, the aquatic section of this roads analysis package also describes information pertinent to riparian areas regarding roads (miles, stream crossings) and road densities within riparian areas. In total, there are approximately 1,818 miles of road in the Forest, including maintenance levels 1 – 5 and unclassified (user-created) roads. This equates to an overall road density of 1.27 miles per square mile.

Approximately 713 acres of habitat have been removed through the construction of 261 miles of Level 3 – 5 roads. These figures do not include the acres or miles of road affected by Highways 14, 14A, and 16, which are another 120 miles or 525 acres. Although not considered a part of this analysis, an additional 1,555 acres of habitat (1,557 miles) have been removed through construction of Level 1 and 2 roads, and unclassified roads (user-created). Level I roads are those that are either temporarily or permanently closed, and may revegetate within 5 years of their closure, providing some habitat values. The direct loss of habitat to roads can also include slumping or sediment transport, thereby covering vegetation prior to it reaching any stream courses and affecting aquatic habitats. Road construction may also modify certain rock features that may have provided habitat for some species. Although less of an impact, road right of ways are typically revegetated, though often more disturbed than surrounding vegetation or habitat features. An additional several hundred acres of habitat have been lost due to facilities constructed in association with the roads, such as cabins, campgrounds, lodges, or administrative sites. Roads can also change the chemical and physical attributes of the roadside area or influence zone, due to dust, chemicals from vehicles and road surfaces, and water runoff. While the above amounts of habitat have been lost due to roads, and other changes in the habitat have or are occurring, it is not currently likely that the impacts from the Level 3 – 5 roads have caused a significant loss of habitat that would lead toward a negative trend in viability for any species on the Forest.

Roads do enable manipulation of the Forest to improve existing habitat. Access to alter older seral stages towards younger conditions through mechanical treatments have benefited big game and other species, such as foraging habitat for lynx.

Roads may function as barriers to some wildlife species, either through their inability to cross the road surface or from cut/fill features or fences associated with the roads and right-of-ways. Fences are currently designed to minimize this potential barrier to big game species, and fences that cross known highly used migration routes are typically modified. Few antelope occur on the Forest, which are typically most affected by fences. Barriers may also occur to some invertebrates or amphibian species (Ruediger, pers. comm.) where they are not able to cross the wider expanse of Level 3 – 5 roads. Flying species are typically not affected by roads as barriers, except for the mortality factor described in the third question. As an exception, roads may also modify habitat by allowing easier access to habitats by species or individuals that are accustomed to traveling on roads, or through the aerial space above them if in forested surroundings (Bennett, 1991). Level 3 – 5 roads on the Forest are not currently known to be a barrier that is detrimental to any species' habitat, or causing a negative trend in viability to any species.

Habitat fragmentation can result from roads that bisect or otherwise break up existing habitat patterns. Some species may prefer more contiguous blocks of habitat, and the interruption by a road may render the habitat less suitable from this standpoint. This effect is difficult to describe, and even more difficult to quantify in habitats that are naturally "fragmented", where meadows and other community types or features are interspersed among forested habitat, and where natural disturbances such as fires provide continuous variations of structural stages of communities, such as occur on the Bighorn. Habitat fragmentation has been more quantified through studies in more contiguous habitat areas. Effects to species are somewhat speculative, with no known effects to existing species on the Bighorn. Three studies have occurred on the Bighorn that deal with trying to quantify habitat fragmentation. These studies, along with other current literature, were summarized in the white paper prepared as part of the forest-wide assessments conducted for the revision (Bornong and Warder, 2002). The research conducted on the Forest for fragmentation (Merrill 1997) was inconclusive in finding any effects to species. The subject of fragmentation needs to be tracked through further research in the future, and effects from the Level 3 – 5 roads on terrestrial species' habitats are speculative at this stage.

One way of summarizing the effects to wildlife and other resources is to evaluate the overall percent of roaded vs. unroaded areas at the forest-wide scale. As a result of current management activities, approximately 572,000 acres (50%) of the Forest are in an unroaded condition. This includes 187,000 of wilderness and 385,000 acres of roadless areas. Roadless areas were mapped in January of 2003 as part of the plan revision process, and do not contain any FS system roads. There were reductions in the amount of roadless areas from the original RARE II analysis conducted previously, which was approximately 56% of the Forest (not including wilderness). The amount of roadless areas managed for in the future will vary by alternative in the DEIS accompanying the revised plan, and according to the roadless rule. Refer to the roadless analysis portion of the DEIS.

As another consideration, road placements should be examined at the forest-wide scale. In general, roads have been placed on the flatter, more productive soils throughout the Forest, as opposed to the steeper unproductive soils. This is primarily due to a desire to minimize erosion on steeper slopes, and to access the most productive timber or other resources found on the flatter slopes. Refer to the aquatics questions in this analysis to view the number of acres and miles of road in the riparian areas on the Forest. These areas are typically the best wildlife habitat as well, due to the higher value vegetation and water found in these sites. Effects to riparian and flat sites are disproportionate at the forest-wide scale.

TW2: How does the road system facilitate human activities that affect *habitat*?

Historically, roads were constructed into the Forest to facilitate resource use. The major uses of the Forest have traditionally been for livestock grazing and timber harvest. Both of these activities can affect habitat for a variety of wildlife species, typically by modifying the habitat from a natural condition through a change in vegetation or structure for terrestrial species, or other changes in the physical and biological environment. The effects of both of these activities will be described more fully in the DEIS prepared for the revised plan.

More recently, road systems have facilitated recreation activities, including camping, hiking, fishing, wildlife viewing, and other activities that can affect habitat. The increased demand for hiking trails over the past few decades have resulted in construction of larger trail networks that have removed or modified some habitat. Losses of habitat to user-created roads and trails have also occurred, as well as losses of habitat due to dispersed or developed camping. Many of these impacts are concentrated in riparian areas, where roads were initially placed due to ease of construction as a function of slopes and gradient. Riparian areas are the most important habitat type to both terrestrial and aquatic species, and losses or modification of habitat in these areas have been the most dramatic. Human activities also commonly concentrate along riparian areas (e.g. fishing, hiking) due to the proximity to water. Streambanks and vegetation have been trampled in some localized areas of the Forest due to this type of use.

In addition, roads have facilitated the suppression of fires throughout the Forest, which has led to a change in fire frequencies in some vegetation communities, primarily shrub and low elevation coniferous communities. These changes have resulted in more dense and mature conditions in these two community types than likely occurred historically. Fire suppression has not likely had significant effects on communities in lodgepole pine and spruce/fir due to the longer fire frequencies in these community types. Conversely, roads have also allowed the manipulation (primarily mechanical and prescribed fire) of some vegetation communities creating diversity in habitat structural stages.

TW3: How does the road system affect legal and illegal human activities? What are the effects on wildlife *species*?

The response to this question will focus on the effects of roads to species, rather than species' habitats. Roads in themselves do not lead to moral or immoral behavior in people, but human activities are typically more evident along road networks.

Trombulak and Frissell (2000) provide an adequate synopsis of the effects of roads on species. There are several factors covered in this publication, including mortality from road construction, mortality from collision with vehicles, and modification of animal behavior. Other more subtle effects to species may also occur. During road construction, the removal of habitat may lead to mortality in individuals, depending somewhat on the season in which roads are constructed.

Following establishment of the roads, mortality may result from collisions with vehicles, though this is largely dependent on speed and volume of traffic. Speed and traffic volume would be highest on Level 5 roads and lowest on Level 3 roads. Species or individuals of species typically become cognizant of this threat and avoid collisions by modifying behavior, though many big game and non-game species are killed each year, from invertebrates to moose, with largely unknown levels of effects to populations of species.

Roads also provide increased human access to areas, potentially disturbing wildlife species either through the noise associated with people, the presence of people, or their activities. This may have more substantial effects at critical stress periods for some wildlife, such as on big game winter range or avian breeding seasons. Research has also been conducted on the Forest on elk, showing that behavior is modified beginning in early July in response to human disturbances (Sawyer, 1997). While roads may be desirable in some areas to provide hunter access to some big game populations, there are also noticeable levels of where too much hunter access modifies big game behavior causing inadequate hunter harvest, as demonstrated with the elk security concept (Hillis et al, 1991). Increased human access has also led to higher trapping rates for some carnivores such as marten (Ruggiero et al, 1994). The social assessment conducted as part of the forest-wide assessments (Blevins and Jensen 2002) demonstrated that wildlife viewing and fishing have been two of the largest uses of the Forest, and the potential disturbances from these activities should not be disregarded due to the potential for influencing animal behavior, in potentially year-round conditions. Obviously, road systems are also necessary for the enjoyment of these pursuits by people, requiring a balance of planning. Road systems have also allowed for reducing species abundance for some species such as beaver, where impediments to road maintenance have been commonly treated by removal of individuals and their dam structures.

Also associated with this potential modification in animal behavior may be the impact from increased predation, competition for prey, or introduction of non-native species that could displace species or their habitat. Competition for prey can be demonstrated in the effects to lynx from coyotes or bobcats having increased winter access to primary prey, snowshoe hare, as a result of road systems and associated recreation activities (Ruediger et al, 2000). Roads are also a common vector or access point for non-native species, plant or animal, due to transportation facilitated by people and their equipment or vehicles, both intentionally and unintentional. Increased or altered predation may result on species as a result of roads, where some animals target roadside habitat due to changes in animal abundance or occurrence in these areas.

A final aspect of road systems may have the aspect of isolating populations of wildlife should the roads prove to be sufficient barriers (Bennett, 1991). Population isolation could lead to increased problems associated with genetic isolation of species. This effect is not likely prevalent due to the more rural aspect of the Forest and mobility of most species, however this effect from roads may be significant to some aquatic species due to barriers imposed by culverts or other structures.

Most species are adaptable to human disturbances, and none have been known to become extinct, imperiled, or rare from disturbances alone on the Forest, as there are seldom mortality issues associated with these disturbances, unless illegal activities are occurring (e.g. shooting or harassment of wildlife). Species' response to disturbances is variable among individuals of the species. Grizzlies and wolves, the two known extirpated species, were extirpated prior to the development of a larger road network. Lynx, though unknown if they are extirpated from the Forest or not, may have been influenced by roads through trapping, prey competition, or other affects. Historic records indicate the lynx may have had a resident population, and this is not known to currently be the case.

Road densities are perhaps the most common method of measuring the potential for species' effects. The scale at which the road density is viewed should be somewhat matched to species' assessment needs. For the purposes of this analysis, densities of Level 3-5 roads are not nearly as extensive as the Level 1 and 2 roads. Open road and motorized trail densities by geographic area and 6th order Hydrologic Unit Code watersheds were calculated and displayed as part of the geographic area assessments, and may also be found in the aquatics section of this document. The highest open road and motorized trail density in a 6th order HUC watershed occurs in Muddy Cr. at 3.1 miles of road per square mile. Out of 74 6th order watersheds, 30 have road densities less than one mile per square mile, 34 more have less than 2 miles per square mile, and 10 watersheds have less than 3.1 miles per square mile.

The road densities of the larger volume roads (3 – 5) are not likely having an adverse effect on species such that a trend toward federal listing or other rarity could be applied for any species not currently listed. This is due to the low density of these roads and relatively minor effects to any specific species. More specific analysis will occur for watershed or project based roads analyses that include Level 1 and 2 roads, and unclassified roads.

TW4: How does the road system directly affect unique communities or special features in the area?

Forest-wide, the unique communities or special features would include wetlands or riparian areas, cliffs or rock scree or rock outcrops, caves or karst topography, old growth conifer, alpine tundra, aspen, and potentially other features. Road system effects to aquatic resources (wetlands, riparian) are described in another portion of this document.

With regard to rock outcrops, scree, or cliffs, the existing highways and road network of Level 3 – 5 roads do provide access to people to some of these sites, though roads typically do not go through these sites due to difficulty in construction. People have been afforded increased access to these areas for recreational activities, such as rock climbing, and disturbance to wildlife may occur along these highway corridors or access points from associated activities as described under question 3. Neither the loss of rock habitat to roads nor people's associated activities with road access are currently suspected of being a limiting factor to wildlife in these sites.

Caves on the Forest are located primarily on either side of the mountain range in the steeper limestone features. Roads and trails do provide increased access to some of these features, though no caves or karst features are currently known to be impacted by roads themselves. These features are typically most impacted by recreational activities, which cause a degradation of habitat within caves or karst features.

Old growth conifer has not been thoroughly mapped on the Forest. Some of the Level 3 – 5 roads have been constructed through some of this habitat type. A direct loss of habitat or possible fragmentation of this habitat type could have occurred. Due to the limited network of these larger volume roads, the amount lost is likely small. Most of the impacts of Forest roads to this habitat type would be from Level 2 roads.

Alpine tundra can be described as grasslands above 9,000', with more fragile soils and a short growing season. While portions of the highways and other high volume roads cross these habitats on the Forest, the amount of habitat lost is not likely significant in relation to the overall abundance of this habitat type, as most of it is located in the wilderness area where roads are not a factor. Grasslands are likely locations for roads due to ease of construction, and it is estimated that approximately 170 acres out of the 50,000 acres total of this habitat type have been impacted on the

Forest by highways and Level 3 – 5 roads. It is not thought that these roads are a significant loss to this habitat type currently (0.3%), nor are effects likely noticeable to species dependent upon them.

Aspen is an important wildlife habitat on the Forest due to forage values and the potential for snag cavities, and occupies less than 1% of the land area (approximately 10,000 acres). Roads have been built through and alongside aspen stands, though the exact acres are not known due to mapping inconsistencies. Roads have allowed more aspen to be regenerated due to management treatments, which has likely outweighed the loss of habitat acres. Treated aspen is typically fenced due to the high level of ungulate browsing, both domestic and wild.

In addition to the above special features, the Wyoming Natural Diversity Database has also identified rare communities based on assemblages of rare species or for other purposes on the Forest. GIS analysis indicates that there are Level 3 – 5 roads and highways that cross the Big Goose, Medicine Mountain, Woodrock, Leigh Canyon, and the Powder River Pass communities, which are 5 out of the 16 sites identified by WYNDD. While there may be some compromises or affects to these sites from these roads, the sites were also designated after the roads were in place. Currently none of the species for which these communities were identified are being threatened by the roads themselves. As these communities include many areas and different habitat types, it is difficult to quantify effects to them. Some of these biological communities are based on presence of rare plant species, of which one and possibly others are tied to early seral habitat conditions and actually have the strongest populations in areas of road cuts, such as Physaria lanata.

Similar to biological communities, Research Natural Areas can also be considered as a special community. There are currently no Level 3 – 5 roads or highways known to be impacting the Research Natural Areas currently identified, or within the four that are likely to be added in the plan revision, as by default these were developed around potential road impacts. Only one potential RNA that would not likely be added during the revision, the Crazy Woman site, had a Level 3 – 5 road through it, though several potential RNAs had Level 2 roads through them that detracted from the value of the site as an RNA.

Ecosystem Functions and Processes (EF)

EF 1: What ecological attributes, particularly those unique to the region, would be affected by roading of currently unroaded areas?

In addition to the RNAs and biological communities described in the previous question, other areas to consider would include roadless areas, wild and scenic rivers, wilderness areas, and any potential special interest areas (such as management prescription 2.1 or 3.1). The evaluations of roadless areas for potential wilderness were conducted as part of the plan revision, and can be referred to in response to this question. The unique features described in the previous response may all occur within roadless areas.

The evaluation of potential wild and scenic rivers also addressed this subject similarly. Refer to that documentation to address these sites.

With regard to special interest areas, these management prescriptions (2.1/3.1) are primarily being considered for those areas where a high density of cultural/historical resources occur. While some of these areas already have roads through them, additional roading could possibly increase visitor use/abuse of historical sites. It is presumed that roads added into the areas would avoid any known sites, so no direct effect would be likely.

EF2: To what degree do the presence, type, and location of roads increase the introduction and spread of exotic plant and animal species, insects, diseases, and parasites? What are the potential effects of such introductions to plant and animal *species* and *ecosystem function* in the area?

Roads may influence the spread of exotic organisms (plants and animals) through the direct effects of vehicles transporting organisms on them, or through the indirect effect of habitat alteration created by road construction that favor early seral species, such as noxious weeds. There are also indirect consequences such as increased access by people that have purposely transported plants and animals, both aquatic and terrestrial, for various reasons. Roads and trails have been shown to be primary vectors for these types of introductions (Trombulak and Frissell 2000). The resulting effects of these introductions may include a switch in species composition of vegetative and animal communities (e.g. noxious weeds replacing native vegetation, removal of certain fish by introduced predatory fish) or a loss of foraging opportunities for wildlife and livestock due to weed invasion.

While there are other vectors besides roads, noxious weeds have become established in some areas of the Forest, though they are primarily localized and not of epidemic proportions. The following table represents primary species, and the estimated acres, which total approximately 19,000 acres or approximately 1.7% of the Forest. Acres are not representative of solid infestations, but typically of varying intensities. Sources of information include the acres reported by Counties doing treatment work on the Forest, and from the 1998 Noxious Weed Treatment Environmental Assessment conducted by the Forest.

Species	Acres
Canada Thistle	10,960
Yellow Toadflax	550
Leafy spurge	10
Hoary Cress (Whitetop)	150
Russian knapweed	115
Musk thistle	30
Houndstongue	7,000
Spotted knapweed	105
Common tansy	10
Total	18,930

The non-native blister rust (white pine) affecting limber pines is not necessarily associated with roads. No native species have been known to be lost due to introductions of non-native species, though some have been impacted, such as the Yellowstone cutthroat trout. It is not anticipated that there would be any vegetation species lost, or significant acreage expansions from noxious weeds, primarily due to the climate of the Bighorns.

EF 3: How does the road system affect ecological disturbance regimes in the area?

Ecological disturbance regimes include insect (mountain pine beetle, spruce beetle, Douglas fir beetle) and disease (dwarf mistletoe, comandra and white pine blister rusts, root rots) infestations, blow down, flood, drought, and fire. Roads may exacerbate or limit these effects, but most are typically a function of time and randomness in location that overpower the effects of roads. In addition, the disturbance elements often can be exacerbated by another, such as increased risk of fire following an insect and disease outbreak.

Insects and disease can both be increased and decreased by roads. Through road construction, downed trees may provide habitat for insects and disease, or construction could stress nearby trees or other vegetation making it more susceptible to insects and disease. However, roads have also typically led to management actions being taken to suppress these agents where management has highlighted commodity uses of timber.

Blow down occurs largely independent of roads, as demonstrated by several recent events in the past decade. However, roads provide the access to manage stands of timber, creating some diversity of size and age classes that can increase the resilience of the forest to blow down.

Floods and drought are not typically influenced by roads. Indirectly, roads may contribute increased sediment during floods, or greater barriers or evaporation of water from soil surfaces during drought, or roads or culverts may form extra barriers to aquatic species during low water periods. However, these effects are not likely currently significant to the magnitude of the disturbance regime itself.

Fire is perhaps the most influenced disturbance regime. Roads and the forest management options they can provide can create a break in the fuel continuity reducing the fire spread in low to moderate wind conditions, depending on fuel types. Fires are also capable of spotting across roads in many circumstances. In addition, road networks have greatly facilitated the suppression of fires, which has had the most effect in fire regimes that are normally characterized by frequent fire intervals, such as grass, brush, and ponderosa pine types. This effect was discussed above.

These above disturbance agents will continue to operate independent of road systems, and only in limited areas or for few vegetation types have the road systems provided a more noticeable effect, due primarily to fire suppression.

EF 4: To what degree does the presence, type, and location of roads contribute to the control of insects, diseases, and parasites?

As mentioned above, roads can provide people access to directly manipulate vegetation conditions that can alter insect and disease extent, and the resilience of the forest to these agents. However, this emphasis is typically only applied in areas where future harvest is desired, and/or where existing roaded areas occur. Many insect and disease outbreaks occur regardless of human intervention due to the effects of drought or other stressors on host vegetation. With over 50% of the Forest in currently unroaded status, insects and disease that originate in these areas would likely expand into the roaded areas due to adjacency and similar mature stand conditions of most vegetative types.

EF 5: What are the adverse effects of noise caused by developing, using, and maintaining roads?

As the effects associated with noise are at a localized scale, this is not addressed at the forest scale. In general, noise is primarily an effect to animal species, and was discussed above. Noise can also vary by current weather patterns. Some individuals or species become readily adapted to noise from roads, while others may avoid areas with heavy traffic due to noise or construction.

Economics (EC)

EC 1: How does the road system affect the agency's direct costs and revenues? What, if any, changes in the road system will increase net revenue to the agency by reducing cost, increasing revenue, or both?

Concerning direct costs and revenues, costs include the cost of construction, maintenance and, eventually, rehabilitation. The cost of construction on most Bighorn NF roads was borne by the agency. In addition, timber purchasers through the use of "purchaser credit" paid for the construction cost of many roads on the Bighorn NF, where the purchaser would construct roads for a "credit" against the stumpage price. When stumpage prices were insufficient to pay for construction costs, the agency paid the timber companies to construct the roads. Currently, the agency pays for road construction, although there is an effort to have special use permit holders, summer home owners and others that directly benefit by a particular road may pay for it.

Concerning maintenance, the cost is generally borne by the agency. However, there are instances where maintenance costs are shared between lodges, resorts, or private in-holdings with the agency in a manner that is commensurate with use. Certain Forest permittees such as timber purchasers perform the actual maintenance commensurate with their use. There is also another program that is just beginning to surface that could turn several roads into public roads, and maintenance would come from a share of the county's share of the federal gas tax. These roads are referred to as PFSR's, or Public Forest Service Roads. Roads that are nominated and become designated for this program receive funding from a share of the gas tax, and, in return, these roads become public roads. These roads can remain under the jurisdiction and maintenance of the Forest Service, or can be turned over the governing county for jurisdiction and maintenance. There are no administrative privileges set aside for PFSR's, as they are entirely open to the public, year round. Currently, the roads that have been nominated for this program include: FSR 14 (Devil's Canyon Road), FSR 27 (West Tensleep Road), FSR 21 (Tie Hack Reservoir Road), portions of FSR 26 (Big Goose Road), FSR 31 (Pole Creek Road), and FSR 15 (Burgess Road). In addition to these nominations, there is a list containing approximately 244 miles of road, primarily the entire length of maintenance level 3 and 4 roads on the forest, that have been designated as "POTENTIAL," PFSR's. This designation means that the road could sometime in the future be turned into a public road.

There currently are no direct net revenues generated by the Bighorn NF road system. In some cases, road uses pay a "maintenance fee", or pay for "rock replacement". However, these fees pay for their use, as opposed to being cash generating to the agency.

EC (2): How does the road system affect the priced and non-priced consequences included in economic efficiency analysis used to assess net benefits to society?

This is a project-scale question, not a forest scale question.

EC (3): How does the road system affect the distribution of benefits and costs among affect people?

This is a project-scale question, not a forest scale question.

EC Summary:

The Bighorn NF maintenance level 3, 4, and 5 road system currently costs the agency approximately $ 1,750,000 per year, which is far below the current annual allocation for road maintenance of approximately $800,000.

The IDT assessed options on how to increase revenue make up for the road maintenance shortfall in funding. Some opportunities to increase road maintenance funding may exist through the Recreation Fee DEMO for developed campgrounds, and to ensure that special-use permit holders pay their share of road maintenance.

The R2 Guidance for this question directs that roads should be placed in one of three categories:

a. Roads that will always be kept open – For the Bighorn Forest-wide RAP, which considers only levels 3,4, and 5 roads, all of the roads fall into this category.

b. Roads that will be closed due to serious resource damage or annual budgetary constraints. At this time, it is not known how many, or specifically, which roads, fall into this category.

c. Roads that do not fall into either of those categories. This may include all other roads, aside from those stated in paragraph (a), above.

Commodity Production

Timber Management (TM)

TM(1): How does the road spacing and location affect logging system feasibility?

This question is most applicable at the project-level roads analysis scale, when specific road and logging systems are designed. However, it does play a role at the Forest scale, in the determination of timber suitability, management area allocation, and economic efficiency considerations.

All timber sales on the Bighorn National Forest have been logged using conventional, ground-based, equipment. The trees are either felled by hand with chainsaws or cut mechanically with a feller/buncher, and then yarded to the landing with ground based skidders. In general, a road spacing of 2000 to 3000 feet is economical for ground-based skidding, although this varies due to slope, topography, size of the timber, and other factors. In general, close road spacing results in quick turn times and higher production that reduces yarding cost and increases stumpage value. On the other hand, closer road spacing increases the total road cost due to more roads, although this total cost can be reduced with the use of temporary roads.

Other logging systems, such as cut-to-length, cable and helicopter systems have not been utilized on the Bighorn NF. Some considerations of these systems and road location and spacing:

a. Cut-to-length: This system has been utilized on several R2 National Forests. This system uses a mechanical processor that cuts, limbs, and bucks logs to length, at the stump. The logs are then brought to the landing on a forwarder. It is possible to yard logs longer distances with a forwarder, thus increasing the width of the road spacing. However, due to high initial purchase price and relatively low cut volumes per acre, the cut-to-length system has not proven to be more economical than conventional rubber tired systems in this Region. If cut-to-length systems were required in timber sales to increase road spacing, stumpage values would be reduced and there would be a high likelihood of no-bid sales.

b. Cable (skyline) logging systems are not common within Region 2, and have never been used on the Bighorn National Forest. The road location in particularly important for cable logging. Most cable systems employ uphill yarding. Roads located above the unit and along the slope "break" (where the slope changes from gentle to steep) provide better cable deflection that usually increases production and reduces ground disturbance. Long cable yarding distances (more than 1600 feet) require larger size equipment and wider roads. The amount of steep slope cable yarding opportunities was analyzed during the 1994 ASQ analysis, and that report will be considered for Forest Plan revision. Cable systems usually require more roads than conventional ground systems, and many of the cable roads are on relatively steep side slopes.

c. Helicopter logging has been utilized just off the Bighorn National Forest. The Bighorn NF offered a helicopter sale of some of the units from the 1993 Blow down near the headwaters of the Little Bighorn River, but there were no bids. This logging system is very expensive. Most of the Bighorn is at a high enough elevation that a helicopter's lift capacity is greatly reduced, which makes helicopter logging even more expensive. Helicopter logging feasibility is improved by locating roads and landings to provide downhill yarding and short yarding distances (less than ½ mile).

Road construction is carefully analyzed when timber sales are designed and is utilized when it is determined to be economically and technically necessary to achieve resource management objectives. The most efficient road spacing that would maximize timber stumpage values is not always acceptable because it often conflicts with other resource management objectives.

One final note on timber sale roads. Many of the roads constructed during the 1960s and 1970s were left open for public access. People now camp, cut firewood, hunt, and do many other activities along these roads. In fact, many of the existing roads were constructed with the dual timber and recreation purpose in mind. An example of this is the Pole Creek Road, which was constructed for the Link Timber Sale in the mid-1970s. The environmental document showed the increasing motorized recreation need from the booming Powder River Basin, and this sale was used to construct the final "link" of the all-weather, gravel road that had been started from either end by previous sales. While today's budgeting procedures utilized the "primary purpose" principle, it is very clear that timber sale roads can provide other resource benefits.

TM (2-3): How does the road system affect managing the suitable timber base and other lands? How does the road system affect access to timber stands needing silvicultural treatment?

The process for determining lands that are suitable for timber management is defined in the National Forest Management Act (NFMA) implementing regulations at 36 CFR 219.27, and are:

a. Identify all forested land; deduct all non-forested land.

b. Subtract forest land not available, including wilderness, research natural areas, wild and scenic river corridors, and administrative sites such as campgrounds.
c. Subtract forest land with non-industrial wood such as juniper, limber pine, and cottonwood.
d. Subtract forest land where irreversible damage is likely to occur if managed for timber production. These are areas with steep slopes, unstable soils, etc.
e. Subtract forest land where restocking cannot be assured within five years.
f. Subtract forest land where adequate response information is not available. These are areas where there is not enough information to predict response to timber management.

The result of the above steps is the land tentatively suited for timber production. That is, it meets the minimum legal requirements to be available for timber production. The recently completed Forest Plan revision timber suitability analysis identified about 340,000 acres out of the 1,107,670 acre Bighorn National Forest as tentatively suitable. There are about 735,349 total forested acres on the Bighorn NF.

g. The last step in the suitability analysis is to determine the suitable land from the tentatively suitable land base. This step subtracts lands identified as not appropriate for timber production because they were assigned in the Forest Plan to other resource uses. For example, in some alternatives being considered in Revision, some areas of the forest are being allocated to certain primitive recreation objectives that preclude timber harvest for timber production purposes.

Under the 1985 Forest Plan, approximately 260,000 acres were identified as suitable for timber production. The Allowable Sale Quantity was calculated from growth and yield projections based on these areas only. During the past 17 years of Forest Plan implementation, as the forest conducted project level planning and implemented those projects, silviculturists and interdisciplinary teams have further refined the suitable timber base.

Timber management on the Bighorn NF is economically feasible only if road access is present or is constructed for the timber sale. One administrative change that has been made since the 1985 Forest Plan went into effect is the discontinuation of the "purchaser credit" for timber sale constructed roads. Until about the late 1990's, when timber purchasers constructed or reconstructed roads for timber sales, they were able to offset the cash price of timber they paid to the US Government with the "credit" they received to build the roads. Essentially, the US Government used the timber value to pay for the road system. However, the purchaser credit option was discontinued. Currently, the cost of the road is deducted directly from the "value" or receipts the US Government receives for the timber.

Without an adequate road system, the 1985 Forest Plan management goals and objectives cannot be accomplished. Maintenance level 3, 4, and 5 roads typically provide access for multiple use objectives, including timber harvest, and motorized recreation. According to the Forest Plan appendix B, Arterial and Collector Roads Summary, there were 15.3 miles of new construction, and 66.5 miles of road re-construction estimated for the period 1989 through 1993.

During the past few years of various roadless analyses, we found that approximately 150,000 acres of the current suited land base of 260,000 acres is within the 1978 RARE II inventoried roadless areas. Under current administrative rules, timber harvest within inventoried roadless areas can only be approved by the Regional Forester. The Forest Plan revision will make new roadless and suitable timber land allocations, and the suited timber land will be in areas available for road access.

The Forest Plan revision process will inventory, evaluate, and make recommendations on how to manage roadless areas. A full range of management alternatives will be considered. Some alternatives plan for accessing the existing roadless areas for timber management and other resource objectives, while other alternatives plan for maintaining the roadless character of the existing roadless areas.

Special Forest Products

SP(1): How does the road system affect access for collecting special forest products?

The majority of collecting special forest products such as mushrooms, recreational rock collections, ferns, transplants, medicinal plants, Christmas trees, transplants, firewood and others is done manually, and as such is tied closely to the road system. Most of this collecting is done off of maintenance level 1 and 2 roads. The current maintenance level 3, 4, and 5 road system provides adequate access to the lower maintenance road system for this seasonal collecting. If road closure or seasonal closure is considered in a project, access for special forest products are considered.

Administrative (AU)

AU(1): How does the road system affect access needed for research, inventory and monitoring?

Two Research Natural Areas (RNAs) exist on the Bighorn National Forest, Bull Elk Park and Shell Canyon. The 1985 Forest Plan's standards and guidelines preclude road construction in the 10A, RNA, management area. The Shell Canyon RNA is located within a few hundred yards of US Highway 14, so research access is extremely easy. On the other hand, human access is relatively easy, although the topography generally precludes much human use. The trail to Bull Elk Park is non-motorized and the motorized closure is considered to be effective, primarily because of the remoteness of the RNA itself. The trail allows for reasonable access for any research activities.

Concerning general Forest Plan inventory and monitoring, most activities that are monitored are along the road system. However, inventory and monitoring activities, including range utilization, forest inventories and water quality monitoring, just to name a few, have occurred in unroaded areas. People access these areas on foot, horseback, and, on occasion, by helicopter. The road system is considered to have very little affect concerning access needed for research, inventory and monitoring, except for the cost.

AU(2): How does the road system affect investigative or enforcement activities?

The level 3, 4, and 5 road system on the Bighorn National Forest generally provides good access for investigative and law enforcement activities. These roads provide access to developed and dispersed recreation sites where many common violations occur. These roads also provide access to the trailhead-parking areas that provide backcountry access. While the road system provides access to perform investigative and enforcement activities, it also provides access for increasing public use of National Forest System lands, which increases the possibility of criminal activities.

The road system itself, and travel management in general, creates additional law enforcement needs because of violations of Forest travel regulations. Off-road motorized travel, primarily ATV use, is the most common travel management violation, and the level 3, 4, and 5 road system provides the access for these vehicles. The demand for ATV opportunities is increasing dramatically. There is a large public demand for more designated ATV trails. People driving around closed gates and carsonite closure signs is another frequent travel management violation.

Theft of forest products is also usually directly attributable to the level 3, 4, and 5 road system. These violations mostly involve the theft of firewood, transplants, or Christmas trees. Occasional commercial level thefts also occur.

Protection (PT)

PT(1): How does the road system affect fuels management?

This question will be answered by addressing forest fuel types, as road access is quite different between the major fuel types, and then some general considerations on fuels management and roads will be addressed.

Fuel Types:

- Ponderosa Pine types: Historically occurred as multiple-aged stands in small even-aged cohorts, with limited under story because of the short fire intervals of 20 to 50 years with low intensity fires that burned out the under story vegetation and accumulated ground fuels. Most of this fuel type is now in Condition Class III[3], where a wildfire now would be uncharacteristically intense, compared to the typical historic fire. This is due to both human fire suppression and weather patterns that made fire suppression successful for much of this century. Most of these fuel types on National Forest System land are found on the face of the Bighorn Mountains, in areas of very rugged, steep topography. In

[3] Condition Class Definitions, from Hann and Bunnell (2001)

Class	Departure from Historic Range of Variability	Description
Condition Class 1	None, Minimal, Low	Vegetation composition, structure and fuels are similar to those of the historic regime and do not predispose the system to risk of loss of key ecosystem components. Wild land fires are characteristic of the historical fire regime behavior, severity and patterns.
Condition Class 2	Moderate	Vegetation composition, structure and fuels have moderate departure from the historic regime and predispose the system to risk of loss of key ecosystem components. Wildland fires are moderately uncharacteristic compared to the historical fire regime behaviors, severity and patterns.
Condition Class 3	High	Vegetation composition, structure and fuels have high departure from the historic regime and predispose the system to high risk of loss of key ecosystem components. Wildland fires are highly uncharacteristic compared to the historical fire regime behaviors, severity and patterns.

general, levels 3-5 roads only access a small portion of this fuel type. It is unlikely given the resource values involved and the difficulty and cost of road construction that much additional road construction will occur.

- Limber Pine/Douglas-fir types: These types are considered to have had a "mixed severity" historic fire regime, in that fires were a mix of stand replacing fire and creeping, under story fire. Intervals are thought to have varied widely, on the scale of the Bighorn National Forest, because of the range of elevations and aspects that these forests occur. This fuel type currently has a mix of Condition Class II and III[4] stand conditions, for the same reasons as stated for Ponderosa types. Also like Ponderosa, these fuel types occur in areas of rugged, steep topography, and levels 3-5 roads only access a small portion of this fuel type.

- Sub alpine types (lodgepole pine, Engelmann spruce, and sub alpine fir): This type covers 52%[2] of the Bighorn National Forest. Historic fires in this fuel type were generally long interval (100 to 500+ year intervals) and were stand replacing crown fires. Research has shown that the majority of the acres burned occur after warm, dry periods are followed by strong cold fronts accompanied by strong winds that "drive" these fires (Bessie and Johnson, 1995). Since the average fire return interval is longer in this type than the time humans have been suppressing fires, the majority of these forests are in condition class I, where fires would play their "natural" role in the system, and the existing fuel conditions are not out of "balance" with their natural conditions.

Concerning access:

a. Much of the sub alpine fuel type has a level 3-5 road system. This fuel type is generally relatively gentle with steep draws interspersed. It is on the more gentle slopes of these fuel types where much of the logging has occurred on the forest. Within this area, there are "pockets" of up to several thousand acres with difficult to non-existent road access, but the size of these areas is less than the size of many historic fires. That is, these several thousand acre areas, even if burned catastrophically, would not create larger patches that would have occurred naturally.

b. The large sub alpine forest areas on the Bighorn National Forest that major road systems (levels 3-5) do not serve are: the area between Paintrock Lakes and Battle Park, the Piney/Rock Creek area, Little Bighorn river, Walker Prairie, and Hunt mountain. This will make access and management of fuels and wildland fire suppression more difficult logistically.

The effects of the road system upon fuel management is difficult to characterize, for several reasons:

a. 55% of the fires on the Bighorn NF between 1910 and 1999 were human caused[3] ; increased road access, especially in to the two large sub alpine expanses (Piney/Rock and Paintrock Creek) could create additional opportunity for ignitions.

b. On the other hand, as mentioned above, wildland fire suppression and preventative fuels treatments would be facilitated by a road system. This is especially true for initial attack, where the access provided by a road system could allow firefighters the time to "catch" the fire at a small stage.

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[2] From Forest Wide Assessment, IRI database.

3 Kurth, Jay. 2002. Existing Condition Assessment for Fire on the Bighorn National Forest. Report on file at Forest Supervisor's Office, Sheridan, WY.

c. On the other hand, it is not clear that a well developed road system, combined with fuels treatments, will actually lessen the severity of the largest, most catastrophic wildfires. Weather conditions are the primary "drivers" of these events (Bessie and Johnson, 1995). This was borne out on the Hayman fire in the summer of 2002 on the Front Range in Colorado, when extreme climatic conditions combined with extreme fire weather conditions caused the fire to burn through pre-treated areas with about the same effect as untreated areas. Another example of the potential difficulty with assuming that a road network and prior fuels treatments can lessen the severity in the most extreme conditions is the 2001 Jasper fire in the Black Hills National Forest. This 85,000-acre burn was in a Ponderosa pine system that was extensively roaded, logged and thinned.

The Forest Plan revision effects analysis will spend more time and detail at exploring the relationship between the road system and fuels management.

PT(2): How does the road system affect the capacity of the Forest Service and cooperators to suppress wildfires?

Much of the answer to this question is answered above, because the relationship between the road system and fuels management is so similar to the considerations between the road system and wildfire suppression.

The issues for cooperators is the National Forest – other ownership interface, and in access to the National Forest. Concerning the interface, the Bighorn National Forest has less of an issue with this than probably any other National Forest. This is due to two factors: there are very few lands of other ownership within the proclaimed boundary of the National Forest; and, the National Forest boundary primarily follows natural ecosystem, topographic boundaries, where the fuel continuity changes abruptly. Concerning access to the National Forest itself, for resources such as the lodges, there are relatively few entry points. There are five all weather entry points, two each on US Highways 14 and 16, and one on US Highway 14A, the latter of which is closed from November to May. Road access to the Piney Creek area (Penrose Park – FSR 320 and Willow Park Reservoir – FSR 319) is complicated by the necessity of traveling across private land. For fire emergencies, the Forest Service has permission from the landowners to use those roads without prior permission, although notification calls are made as soon as possible.

PT(3): How does the road system affect risk to firefighters and to public safety?

The R2 Roads Analysis supplement to FS-643 identifies this question as being more appropriately responded to at the project-level scale. However, the discussion above on access to the Penrose Park area is worth mentioning. The slightly slower response times, due to potential access issues, could create a slightly higher risk to firefighters and public safety. The longer it takes firefighters to respond to a reported fire, the greater the chances that the fire will become larger and more difficult to suppress.

PT(4): How does the road system contribute to airborne dust emission resulting in reduced visibility and human health concerns?

Air quality impacts from the Forest road system are associated with vehicle emissions and dust from traffic on unpaved roads. These effects are typically localized and temporary, and their extent depends on the amount of traffic. Dust from unpaved roads increases with dryness. Forest roads are usually unpaved and are used primarily for recreational purposes (such as passenger car and four-wheel drive vehicle use). Lesser amounts of use are from resource management purposes related to timber harvest and livestock production. Dust abatement requirements can be included in contracts where use is expected to be particularly heavy. However, dust abatement measures have only infrequently been used on the Bighorn NF.

Specifying the type of dust abatement product, method, and frequency of use is not a programmatic issue. This is expensive, and depends on intensity of use. Dust abatement should be considered as mitigation for high volume traffic volumes resulting from commercial activities and special use permits. It is particularly appropriate on arterials and major collectors, and when traffic is expected near high-user density sites, such as developed recreation sites.

Passive-use Values (PV)

The R2 Roads Analysis guidance combined PV 1-4 into the following question:

PV(3): Who currently holds passive use values and what will be the potential effect, positive and negative, of building, closing or decommissioning roads on passive-use values?

This forest scale Roads Analysis is an inventory and assessment of road uses and conditions, not a plan for specific road entry or road closures. It is programmatic, and will not result in site-specific management actions in and of itself.

Passive use value is a value or benefit people receive from the existence of a specific place, condition, or thing, independent of any intention, hope, or expectation of their active use. When the affected resources are unique or rare, such as threatened or endangered species, spectacular scenic views, pristine wilderness, unusual geologic or natural conditions, or unique cultural heritage resources, passive use values can be greater than the value produced from the same place by active recreational use or commodity production.

Passive use values cover a broad spectrum of desires for many diverse populations. On a national scale, many who hold passive use values for National Forest System lands live in urban areas. Some may never visit a National Forest but value knowing there are diverse resource opportunities on their public lands. Locally, there is a wide diversity of values associated with the Forest and access to resources. In almost all cases, there will be people interested in maintaining an area as roadless, and there will be other people interested in having roaded access to the same area. Forest Service managers, who work for the citizens of the United States, work to manage and protect National Forest System resources, and are mindful of this balance of public values.

There are people who hold high passive use values for areas of future road entry and closure. These areas vary across the Forest as do the passive use values people hold for them. Subforest scale roads analysis interdisciplinary teams have been, and will, explore and highlight passive use values when they perform project analyses tiered to this Forest-wide assessment.

The Bighorn National Forest is moderately roaded compared to the other Region 2 National Forests in Wyoming, see table PV1 (Baker and Knight, 2000).

Table PV1. Roads in Region 2 National Forests as of 1997. Data from the US Forest Service R2TF database. Road densities are for entire national forest, including roadless areas, and would be higher in only the roaded portions of these forests.

National Forest	Total Length (miles)	Density (mile/mile**2**)
Shoshone	1604	0.42
Pike-San Isabel	2458	0.71
White River	2200	0.72
Grand Mesa, Uncompahgre, Gunnison	3484	0.75
Arapaho-Roosevelt	2287	0.80
Rio Grande-San Juan	5150	0.88
Bighorn	1619	0.94
Routt-Medicine Bow	4466	1.29
Black Hills	4620	2.37

At the geographic area scale, the density of roads on the Bighorn varies dramatically, see table PV2. The most densely roaded areas are where logging has occurred. Some of the highest density areas, Crazy Woman Creek and South Tongue River, having been managed for timber resources for 100 years or more.

Table PV2. Road Densities by Geographic Area on the Bighorn National Forest.

Geographic Area	Density (mile/mile2) – All Forest System Roads	Density (mile/mile2) – Open Forest System Roads
Clear/Crazy Woman	2.22	1.33
Tensleep	1.67	1.28
Paintrock	1.45	0.75
Shell	1.31	0.93
Devil's Canyon	1.36	0.81
Little Bighorn	1.15	0.52
Tongue	1.36	0.73
Goose	1.16	0.90
Piney/Rock	0.22	0.21
Forest Wide Average	1.27	1.08

The most active local groups of roadless passive use proponents on the Bighorn National Forest are the Sierra Club and the Bighorn Forest Users Coalition (BHFUC). The Sierra Club has offices in Sheridan, and most active members of the BHFUC are from Sheridan County. Many of the same people are involved in these groups. Biodiversity Associates, Laramie, WY, have become more involved recently. The Sierra Club and BHFUC are involved with all aspects of forest- and project-level planning on the Bighorn National Forest. They comment and actively participate in nearly all National Environmental Policy Act projects, and they have been actively filing appeals and litigation on numerous forest projects, especially those such as timber sales that would impact their passive use values. While the people actively involved in these groups on the Bighorn are local, they represent the viewpoints of people from across the United States.

Although considerably less vocal and less actively involved that these groups, there are individuals, tribes and other organized user groups that hold traditional, cultural and religious values for the Bighorn NF. The Crow, Northern Cheyenne, Arapaho, and Shoshone tribes are historic users of the Bighorn Mountains, and are consulted on forest and project analyses. These tribes have strong cultural and traditional ties to numerous specific locations in the Bighorn Mountains. The most important categories of sites that Bighorn NF personnel are aware of include historic trails and travelways, quarry sites, vision quest sites, and the Medicine Wheel. Tribal members and leaders annually participate in Medicine Wheel monitoring and implementation of the Historic Preservation Plan.

Groups that hold symbolic and cultural values for projects that require road construction are mostly commodity advocates such as logging proponents and industry members, ranchers, and motorized recreationists. Some descendants of the early tie hackers and loggers on the Forest enjoy historic tie hack areas as an opportunity to revisit their cultural heritage. One of the groups that most believe their passive use values are being substantially affected by roads closures or decommissioning is motorized recreationists. Many people are proponents for maintaining or increasing current levels of motorized road and trail opportunities and maintaining roads for future forest management activity. These users feel that their values are threatened by proposals to close Forest roads and trails to motorized use.

Many of the grazing permittees on the Forest also enjoy passive use values when they are working their livestock. Permittees use horses and ATVs as part of their livestock management. Many of the permittees believe motorized use conflicts with their management (gates left open, people moving livestock to the wrong places), and believe they benefit from fewer open roads. However, others are more dependent on the road system for their management. One of the passive use values enjoyed by grazing permittees is the historic way of life, of being able to hand down the "operation" from generation to generation. Many of the current Bighorn National Forest permittees are fourth generation ranchers.

There are many passive use values to consider in forest management. Several have been highlighted in this discussion, but will be explored in more detail when during project-specific roads analyses.

Social Issues, Civil Rights, and Environmental Justice

SI(1): What are peoples perceived needs and values for roads? How does road management affect people's dependence on, need for, and desire for roads?

Human needs and values for roads and access on the Bighorn NF is the most important issue to local residents. All of the users of the Bighorn National Forest access the resource using roads, even those driving to a trailhead to use as a jumping off spot for non-motorized recreation.

People in Wyoming are used to driving to their destinations because people and places in the state are so far apart. Roads are used to transport goods, access recreation, and for commercial opportunities. Well maintained roads facilitate recreation and other experiences; poorly maintained roads make them unpleasant, difficult or impossible to travel. Roads are not always viewed as beneficial. Many people feel the National Forests have too many roads and no further road construction, and decommissioning of existing roads, is necessary. Others view roads as beneficial to their experience and for forest management.

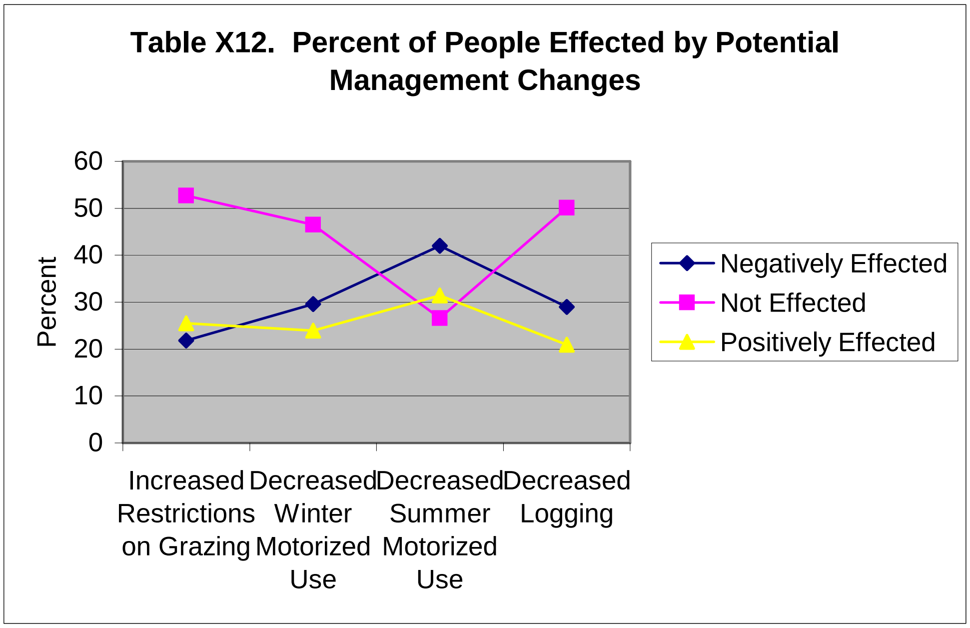
SI(2): What are people's perceived needs and values for access? How does road management affect people's dependence on, need for, and desire for access?

This question is very similar to SI(1) because many people perceive roads and access to be the same thing. Access methods that are in addition to roads include motorized and non-motorized trails, but the use on these systems are much less than what occurs on roads. As stated above, Human needs and values for roads and access on the Bighorn NF is the most important issue to local residents.

The major travel arteries across the Bighorn NF, the US highways, were constructed to provide access between the Powder River and Big Horn Basins, and that remains the primary need and value of those routes.

Most of the road construction on the Bighorn NF was done to provide access to timber resources, although providing recreational access was a secondary rationale for many of the roads. Once the road was constructed, the need and value for recreational access usually superceded the need and value for timber harvest, at least as measured by the preference and desires of the majority of local residents. This creates an interesting dilemma, as once a road is built and open for public access, the visual quality objective is increased to provide for high quality public, recreational enjoyment, which leads to limitations and restrictions upon further future timber harvests.

The Bighorn NF social assessment (Blevins and Jensen, 2002) showed that people are more affected by travel management decisions than about other commodity decisions, such as grazing or logging, see table SI1. That is, the majority of people are not affected by changes to grazing (53% not effected) or logging (50% not effected). However, more people are affected positively (31%) or negatively (42%) than are not effected (28%) by decreased summer motorized use.



According to the Bighorn NF social assessment (Blevins and Jensen, 2002), the population in the communities around the forest is aging. This creates a higher demand of roaded recreational access and a demand for more developed facilities, as opposed to unroaded, primitive recreation opportunities.

SI(3): How does the road system affect access to paleontological, archaeological, and historical sites?

FSR 12 (maintenance level 3) provides access to the Medicine Wheel. While the road remains open to "pass through" users, people visiting the Medicine Wheel itself are asked to park at the interpretive center and walk the last mile to the Wheel. This management was defined in the collaboratively developed Historic Preservation Plan.

Other sites along maintenance level 3, 4, and 5 roads have been recorded. Some of the historic resources along the roads have been interpreted for visitors with interpretive signs, such as the Tie Dams along FSR 26 (Big Goose Road) and FSR 23 (Sourdough Road).

U.S. highways 14, 16, and 14A cut through sedimentary layers, and common variety fossils are found and collected.

SI(4): How does the road system affect cultural and traditional uses (such as plant gathering, and access to traditional and cultural sites), and American Indian Treaty Rights?

SI(9): What are the traditional uses of animal and plant species in the area of analysis?

In response to the facets of this question, traditional use is interpreted as defined by the National Register Bulletin 38 (traditional use is defined as a critical practice that is essential for the continuation of a community's culture, and the practice is depended on a specific locality), and is not the same as historic use (i.e. deer hunting is not limited to one or two specific localities versus traditional eagle catching pits that are limited to a few specific localities). At the programmatic level, roads are not an issue. Specific discussions on questions are:

a. At present, Native Americans have identified only one specific plant gathering area. The presence of roads in the area has not been voiced as a concern. Plants gathered in the area are common, and can be found across the Forest and on adjacent non-Forest Service lands. The importance of the one identified gathering area is primarily due to its proximity to a large and complex traditional cultural property, and not due, for example, the rarity of the plant or plants in nature. Therefore, there is no data to suggest that roads, on a Forest wide context, detracts or enhances traditional use.

b. Easy access to stands of lodge pole pines for tepee pole collection has been noted as an issue, but concerns relate to practical vehicle access, such as four-wheel drive versus two wheel drive and/or a concern about whether or not access is blocked by snow in early spring.

c. On a Forest level, no clear determination on how or if the road system affects traditional cultural properties, such as vision quest areas, is documented. Verbally, Native Americans have expressed that they like roads so they can access such sites. Their main issue is that if they are using a site, that the road be temporarily closed, so they would not be disturbed.

d. No treaty rights exist on the Forest. Therefore, the portion of the above question on treaty rights is non-applicable.

e. In response to SI(9), no traditional uses related to animals have been documented, and as noted in (a.) above, only one plant gathering area has been identified. Based on discussion, plants gathered in the area are of common varieties, but the specific plant types are held in confidence.

SI(5): How does road management affect historic roads?

The vast majority of the Forest's roads are located on the same alignment of earlier historic roads ways. Therefore, affects have been adverse and occurred primarily during the early and mid portion of the modern period (1951 – present) from the 1960s to the early 1980s. To a large extent road building/management is based on the actions taken pre-1985 resulting in affects that have already occurred and separated by time and distance from the present analysis.

Historic roads and/or portions of roadways that are still present survived because they were abandoned before the modern period, or as segments adjacent to the present roadways from re-routes previous to or during the modern period. No roads under scenario 1 have been significantly affected since implementation of the 1985 Forest Plan. Segments created by re-route under scenario 2 have been impacted from road maintenance. For example, by cutting out ditches for drainage. However, the impacts over all have been considered non-significant.

SI(6): How may local community social and economic health be affected, positively and negatively, by road management (for example, lifestyles, businesses, wood products, tourism industry, infrastructure maintenance)?

There are some resource uses of the Bighorn National Forest that are completely dependant upon road management, such as roaded recreation and timber. All of the communities surrounding the Bighorn NF derive social and economic benefits from roaded recreation. Local people use the roads for recreation, and benefit from the tourism income generated as people pass through the area in their vehicles.

Concerning the timber industry, there are small sawmills located in many of the local communities that get some raw material from the Bighorn NF, including Buffalo, Tensleep, Worland, Lovell, Cody, and Manderson. The largest local purchaser of Bighorn NF timber has historically been Wyoming Sawmills in Sheridan. The Wyoming Timber Market Analysis (Rideout and Hesseln, 2000) describes in detail the relationship between the timber industry in Wyoming and the sources of raw material. Specific to Wyoming Sawmills and the Bighorn NF, the sawmill was largely dependant upon Bighorn NF timber until about 1990, when the Bighorn NF timber output dropped from an average of about 10-15 million board feet from 1964 to 1990 to about 2 million board feet since 1992. While there are many factors that will contribute to the continued viability of this entity (including international and national timber demand, international trade policies, technology and product innovation, availabilities of non-Bighorn NF timber supplies, etc.), it is clear that these particular businesses are dependant upon road management and timber management policies on the Bighorn NF.

SI(7): What is the perceived social and economic dependency of a community on an unroaded area versus the value of that unroaded area for its intrinsic existence and symbolic values?

or SI(7): For communities adjacent to the Forest with industries dependent upon the Forest – related resources (wood products, minerals, grazing, tourism), what are the local values of currently unroaded areas surrounding the communities? These may include the value of roading the area for continued access to resources, expanded roaded opportunities, or maintaining unroaded areas and opportunities?

This is an extremely difficult question, and the thoughts here will only brush the surface an issue that is very value laden. This question is difficult because many of the values found in unroaded areas (solitude; primitive recreation; contiguous, unfragmented habitat blocks) are not traded in the market place, so they are extremely difficult to value economically. On the other hand, the value of wood products and to some degree, the value of motorized, developed recreation, is easier to quantify and display. Finally, some of the "trade-off" considerations, such as risks and outcomes of wildland fire, are probabilistic, and may not occur for several decades or may occur next year.

The following considerations pertain to the Bighorn NF:

a. Many unroaded areas on the Bighorn are unroaded because of difficult topography, usually associated with the steep face country separating the National Forest from the surrounding basins. These areas are likely to continue to remain unroaded because of the natural, physical terrain.

b. Many grazing permittees do not see unroaded areas as an impediment; in fact, many feel stock management is easier because they do not have to contend with people leaving gates between pastures open or people inadvertently (usually) moving stock around.
c. Minerals are very nearly a non-factor in this issue, because of the paucity of this resource on the Bighorn NF.
d. It is unclear as to whether roading these areas would have much effect on tourism economic benefits, because most of the non-local tourists are traveling through the Bighorn NF between the Black Hills and Yellowstone.
e. Concerning timber resources, the largest forested unroaded land base on the Bighorn is the Piney/Rock Creek area. The social, economic and resource tradeoffs between maintaining the "unroaded" character of this area versus the value of roading, timbering and managing the fire/fuels resource in this area will be considered in depth during revision. One issue that will be analyzed is the economic value of the timber resource in this area as opposed to the cost of constructing the road. The Piney/Rock Creek area (and many of the other unroaded areas on the Bighorn NF) burned in the late 1800's, regenerated to relatively dense lodgepole pine, and are currently pole size, stagnant, stands that will not pay for the roads to access the area.
f. The existing condition social assessment revealed some preferences for unroaded areas, wilderness, and commodity uses. Table SI2 indicates the number of people responding "yes" to various desired future conditions for the Bighorn NF. The ordinal ranking of the ranked percent is shown in parenthesis with highest checked ranked 1. The desired future conditions relating to unroaded areas are bolded. "Continue commodity uses of forest" was the 3rd most desired condition. On the other hand, the desire for unroaded areas also ranked highly, with "Open areas for recreation that are neither wilderness or roaded (motorized)" was ranked 4th, and "create separate recreation areas for motorized and non-motorized use" was ranked as the 5th most popular desired future condition by survey respondents. Setting aside land for wilderness was the least favored desired future condition, so it can be inferred that local people desire unroaded areas for their unroaded character, not for their wilderness potential.

Table SI2: Percent of Respondent Responding "Yes" to Future Desired Conditions on the Bighorn National Forest

Desired Condition	**Big Horn**	**Johnson**	**Sheridan**	**Washakie**	**Total**
Set aside land for wilderness	11.9 (14)	21.3 (13)	27.2 (11)	13.3 (14)	21.1 (14)
Modern facilities for recreation	29.1 (9)	19.1 (14)	22.4 (13)	30.0 (10)	24.4 (12)
Plants and animals as a high priority	47.6 (3)	64.5 (1)	65.8 (1)	46.7 (3)	59.0 (1)
Provide more roads for access	35.2 (7)	22.4 (12)	22.2 (14)	35.6 (6)	26.9 (10)
Consider forest appearance in making decisions	49.3 (2)	63.9 (2)	59.1 (2)	50.0 (2)	56.5 (2)
Allow lightning-caused fire to burn	19.8	24.6	25.6	21.1	23.6

	(11)	(9)	(12)	(11)	(13)
Continue commodity uses of forest	55.1 (1)	51.9 (3)	46.4 (6)	61.1 (1)	51.3 (3)
Open areas for recreation that are neither wilderness or roaded (motorized)	41.0 (6)	44.5 (4)	46.6 (5)	42.6 (5)	44.6 (4)
Create designated ATV trails	43.2 (4)	33.5 (8)	38.4 (8)	46.1 (4)	39.8 (71/2)
Created separate recreation areas for motorized and non-motorized use	42.7 (5)	40.7 (6)	47.0 (4)	33.9 (8)	43.1 (5)
Designate Wild and Scenic river areas	18.9 (12)	23.6 (10)	36.5 (9)	18.3 (121/2)	28.1 (9)
Set aside Research Natural Areas	16.7 (13)	23.1 (11)	31.1 (10)	18.3 (121/2)	25.0 (11)
Close some dispersed recreation sites	28.6 (10)	43.2 (5)	47.7 (3)	31.1 (9)	40.6 (6)
Limit camping to designated sites in heavily used areas	33.9 (8)	39.3 (7)	44.0 (7)	34.4 (7)	39.8 (71/2)

During the open interview session, one person's opinion revealed that many people are in favor of both unroaded/wilderness and roaded motorized opportunities, saying, "I like limits, rules, referees. I ride my motorcycle to the wilderness boundary; then I hike in where I won't hear motorcycles."

g. Finally, the Bighorn has been managed for over 100 years, and is extensively roaded in the areas that had the resources and topography that made roading worthwhile. While some of the remaining unroaded areas may have values or resources that make roading worthwhile, it may be surmised that many of the remaining unroaded areas remain in that condition for a topographic, economic, or resource value reasons.

SI(8): How does road management affect wilderness attributes, including natural integrity, natural appearance, opportunities for solitude and opportunities for primitive recreation?

The Cloud Peak Wilderness makes up about 17% of the highest elevation area of the Bighorn National Forest. Geographically, the wilderness is located in the south-central portion of the forest. Roads facilitate wilderness users experience by providing access to developed trailheads. Table SI8 shows the formal trailheads (shown on Bighorn NF visitor map and facilities) for the Cloud Peak Wilderness area. All of these except Coffeen Park are accessed by Maintenance Level 3 and 4 roads. A complete set of trailhead use data for the Cloud Peak Wilderness for 1987 through 2001 is at Appendix 1.

Table SI8. Formal Trailheads for the Cloud Peak Wilderness

Trailhead Name	FSR #	Maintenance Level	% of Total Cloud Peak Wilderness Use Originating from Trailhead, 2001
West Tensleep Lake	27	4	29.9

Battle Park	24	3	9.5
Paintrock Lakes	17	4	3.5
Adelaide Lake/Ranger Creek Trailhead	17	4	2.0
Coney Creek	26	4	2.5
Coffeen Park	293	2	7.7
Hunter Corrals	19	4	17.8
Circle Park	20	3	10.5

Three items can be considered for this question:

a. Dust: On most of the access roads to the Cloud Peak Wilderness, dust is an extremely minor consideration, experienced only on the driest days when following the preceding user too closely. On a few roads, such as the West Tensleep Lake road, use is high enough that dust remains suspended in the air on certain days. This use is due to Wilderness and non-wilderness users. Even on these roads, the dust is dispersed prior to reaching the wilderness, so wilderness users' experience is not noticeably affected.

b. Unauthorized motorized use facilitated by the road system: One area where ATVs have been able to access the wilderness is from FSR 491 (Maintenance level 2) in Sourdough Creek. There are no maintenance level 3, 4, or 5 roads that directly contribute to unauthorized summer motorized use in the wilderness. Winter snowmobile intrusions into the wilderness are not considered here, as that is not a function of the road system. Winter snowmobile access into the Cloud Peak Wilderness is a function of where topography, vegetation, and trails to the wilderness create snowmobile opportunities.

c. Maintenance level of road affects the number of users: West Tensleep Lake road is a maintenance level 4 road: an all-weather, two-lane, gravel road. This contributes, at least in part, to the high levels of use experienced from that trailhead. The other factor leading to use is a relatively short hike to 2 very spectacular areas, Lake Helen – Mistymoon Lakes and Lost Twin – Mirror Lakes. Hunter Corrals and Circle Park are two other trailheads that are easily accessible via the US highways and Forest Service Roads. Other trailheads providing similar experiences in the wilderness are not as crowded, at least in part because of the inconvenience or difficulty of the access roads.

SI(9): What are the traditional uses of animal and plant species in the area of analysis?

Answer: In response to the facets of this question, traditional is interpreted as define by the National Register Bulletin 38 (traditional use is define as a critical practice that is essential for the continuation of a community's culture, and the practice is depended on a specific locality), and is not the same as historic use (i.e. deer hunting is not limited to one or two specific localities versus traditional eagle catching pits that are limited to a few specific localities). At the programmatic level, roads are not an issue. Specific discussions on questions are:

1. At present, Native Americans have identified only one specific plant gathering area. The presence of roads in the area has not been voiced as a concern. Plants gathered in the area are common, and can be found across the Forest and on adjacent non-Forest Service lands. The importance of the one identified gathering area is primarily due to its proximity to a large and complex traditional cultural property, and not due, for example, the rarity of the plant or plants in nature. Therefore, there

is no data to suggest that roads, on a Forest wide context, detracts or enhances traditional use.

2. Easy access to stands of lodge pole pines for tepee pole collection has been noted as an issue, but concerns relate to practical vehicle access, such as four-wheel drive versus two wheel drive and/or a concern about whether or not access is block by snow in early spring.
3. On a Forest level, no clear determination on how or if the road system affects traditional cultural properties, such as vision quest areas, is documented. Verbally, Native Americans have express that they like roads so they can access such sites. Their main issue is that if they are using a site, that the road be temporarily close, so they would not be disturbed.
4. No treaty rights exist on the Forest. Therefore, the portion of the above question on treaty rights is non-applicable.
5. No traditional uses related to animals have been documented, and as noted in (a.) above, only one plant gathering area has been identified. Based on discussion, plants gathered in the area are of common varieties, but the specific plant types are held in confidence.

SI(10): How does road management affect people's sense of place?

People's sense of place is directly tied to the aspects of an area, including the area within a road corridor, that invoke a special feeling or attachment to the area. Factors include the area's vegetation, the amount of sunlight available, the views, the solitude, the opportunities that make it a destination, and the overall familiarity. The road itself facilitates a person's enjoyment of the area by providing for driving comfort, the amount and type of use, and any number of aesthetic attributes visible alongside the road. These attributes are directly related to road management. Any change in road management or the development of a road will create a change in the current user's sense of place.

For example, if a road is managed as a level 3 and a decision is made to upgrade it, more and different users might begin to use the area. This will change the character for users who consider the area to be special for what it was; it will change their experience and may displace current users to other areas for their recreation. It is likely that use would increase, creating a higher density of use and associated changes, like hardened facilities, increased litter, etc. Likewise, if that same level 3 road is downgraded, the experience change from being able to travel the road in a sedan to a 4-wheel drive or ATV will change the sense of place for the people currently using the road.

CR(1): How does the road system, or its management, affect certain groups of people (minority, ethnic, cultural, racial, disabled, and low-income groups)?

The road system is used by all groups of people. Changes in road management, including closing or decommissioning of any roads would have the same effect on all groups of people, including minorities and different cultures.

At the Bighorn NF roadless meetings, some people pointed out that elderly or disabled people should be allowed to use ATVs or other motorized vehicles on roads closed to others. Society has decided that it is appropriate to have certain areas that provide challenges, or are even inaccessible to certain people, such as Wilderness. Lessening the restriction in this case fundamentally changes the recreation experience of the non-motorized users.

Range Management (RM)

RM(1): How does the road system affect access to range allotments?

The network of roads across the Forest has positive direct effects and both positive and negative indirect effects on rangelands and the administration of the grazing program.

Livestock are trailed to and from Forest Grazing allotments along roads. Historic sheep driveways cross the Forest and access allotments along roads. Roads are used to transport sheep and cattle to and from mountain allotments. Permit holders access cow camps and various pastures of each allotment along the Forest travel ways.

Grazing permittees may experience lowered operating costs by having motorized access to allotments on open roads. In many cases, permittees are issued limited short-term 'off-road vehicle' permits to allow them to use motorized vehicles on closed roads, or in areas where there are no roads.

The road network sometimes increases the efficiency of Forest Service employees in administering grazing permits. Administratively, the road network allows Forest Service rangeland management specialists to access allotments quickly by using motorized vehicles rather than foot travel or horses.

While roads improve efficiency of permittee and Forest Service administration, they also allow more public access for recreation purposes such as hunting, fishing, camping, ATV use, etc. The increase in public use of an area provides additional opportunities for conflicts between users such as gates being left open, livestock being disturbed, cow camps or other range improvements being vandalized, etc.

General Public Transportation (GT)

GT(1): How does the road system connect to public roads and provide primary access to communities?

National Forest system roads connect numerous public roads managed and operated by the state of Wyoming, county governments, Bureau of Land Management (BLM), and local or private landowners. However, few Forest roads serve as the primary through-routes that connect communities. Communities are, generally, connected via US Highways 14, 14A, or 16. Of greater importance is how the county roads, state highways, BLM roads, and private roads give communities, tourists, and industries access to the National Forest. These roads connect to arterial, collector, and some local roads at the Forest boundary where traffic is dispersed into the Forest for a variety of uses. Some county and state highways traverse into or through the National Forest. The following table lists public roads identified as important to linking the National Forest to public roads and the local communities:

Table GT_1-1 – Public roads under county, state, or BLM jurisdiction that access the National Forest

Public Road Number / Name	Termini
Sheridan County:	
26 / Big Goose	Forest Boundary / US Hwy 14
Johnson County:	
3 / Hazelton	US Hwy 16 / Forest Boundary
466 / Billy Creek (BLM maintenance only)	County Rd. 3 / Forest Boundary
Washakie County:	
18 / Old Highway 16	MP 6.6 / US Hwy 16
State Highways:	
14	Forest Boundary / Forest Boundary
14A	US 14 / Forest Boundary
16	Forest Boundary / Forest Boundary

There are numerous other roads that fall under State, BLM, county, and private jurisdiction that access the national forest. However, these other roads are either maintenance level 1 or level 2 roads, and were not considered in this analysis, but will be considered in a sub-forest analysis.

The Bighorn National Forest road system does not provide any primary access routes to or between communities other than US Highways 14, 14A, and 16. However, these communities use several Forest roads for recreation and commercial access to the National Forest.

The following table lists major population centers and public and Forest System roads used for primary access to the National Forest:

Table GT_1-2 – Primary county, state, BLM, Local, and forest roads providing access to and through the Forest

Community, Town, or City	Public Road	National Forest System Roads
Sheridan / Bighorn	County Road 26 26,	Big Goose
		293, Coffeen Park
		16, Black Mountain
	US Hwy 14	16, Black Mountain
		15, Burgess
		26, Big Goose
		10, Hunt Mountain
		17, Paintrock
Lovell	US 14A	12, Medicine Wheel
		13, Porcupine
		14, Devil's Canyon
		15, Burgess
		10, Hunt Mountain
Greybull / Basin	US Hwy 14	17, Paintrock
		10, Hunt Mountain
		26, Big Goose
		15, Burgess
Worland / Tensleep	US Hwy 16	18, Old Highway 16
		27, West Tensleep
		24, Battle Park
		432, Sitting Bull
		437, Lake Point
		429, High Park
		422, Upper Dump
		25, Canyon Creek
		29, North Fork Powder River
Buffalo / Gillette	US Hwy 16	19, Hunter
		20, Circle Park
		21, Tie Hack
		22, Elgin Park
		23, Sourdough
		31, Pole Creek
		33, Crazy Woman Canyon
		3, Hazelton
		28 Sheep Mountain
	Johnson County 14	33 Crazy Woman Canyon

These roads and others are important to and used by smaller communities around the Forest. Many people in these communities rely on access to the Forest for their livelihood as well as for recreation. The Forest is important to people in these smaller communities for mining, timber, ranching, and tourism. Some of these communities are listed below in the following table:

Table GT_1-3 – Small residential communities near the Bighorn National Forest

County	Main communities
Sheridan	Dayton, Ranchester, Acme, Arvada, Leiter, Ucross, Wyarno, Claremont, Parkman, Beckton, Wolf, Bighorn, Story, Banner
Johnson	Kaycee, Sussex, Barnum, Mayoworth, Linch
Washakie	Tensleep, Big Trails
Big Horn	Hyattville, Manderson, Basin, Shell, Cowley

GT(2): How does the road system connect large blocks of land in other ownership to public roads (ad hoc communities, subdivisions, inholdings and so on)?

The amount and dispersion of private and other ownership lands vary across the forest. Most of these lands are very isolated and are accessed by remote local or collector roads. However, there are a few instances where private lands are located adjacent to one of the 3 US highways traversing the Forest, or by higher-standard arterial or collector roads. Individual access needs to in-holdings and lands adjacent to the Forest are addressed on an individual basis as requests are received. Forest Service policy is to require the landowners create an association or some type of consolidated organization to represent all of the landowner interests. This eliminates the need for the Forest to enter into road use or special use permits with each individual landowner. Access is normally limited to summer or non-snow periods, but on occasion permits are issued for snow plowing during the winter months. Responsibilities for improvements and maintenance should be determined through a commensurate share process. If access is being provided by a public road agency, such as the county or state, then the Forest Service may not be obligated to provide any additional access over federal lands. When larger developments or subdivisions occur, and in holding traffic is expected to exceed that generated by the users of the National Forest, agency policy is to pursue turning jurisdiction of the Forest road over to another public road authority, such as the county or state.

There are very few private or other ownership lands located on the south end of the Forest. The main blocks of private land are located on the east end of the southern half of the forest, adjacent to US 16 and FSR 19. The primary non-forest lands on the southern half of the Forest are located along Johnson County Road 3, or Hazelton Road. The remaining areas of non-Forest land on the south half of the forest are accessed via various four-wheel drive roads.

On the northern half of the Forest, the main sections of non-Forest lands are located adjacent to US 14. One portion of this land is located near Burgess Junction, and is home to the Bighorn Mountain Lodge. The other portion in this area consists of approximately 3 sections of state land, located adjacent to US 14 between FSR 16 and Steamboat Rock. The much of the remaining main portions of non-Forest land on the northern half of the Forest are accessed via FSR 26, Big Goose Road, and FSR 293, Coffeen Park Road. These lands are primarily lands set aside for impounding water for off-Forest irrigation.

These impoundments include Dome Lake, Crescent Lake, Heart Lake, Bighorn Reservoir, and a few other impoundments located on land adjacent to the Forest in the same area. The remaining portions of private and state land located within or adjacent to the northern half of the Forest are accessed with low standard, 4-wheel drive roads or with various motorized and non-motorized trails.

Generally, the largest blocks of non-Forest land are connected with the 3 US Highways on the Forest, US 14, 14A, and 16. The Forest Service is currently identifying a portion of its road system for public designation, or Public Forest System Roads (PFSR's). These roads will be open and available to the traveling public on a regular and consistent basis. PFSR's will be maintained for passenger car access and will provide unrestricted access to and through the National Forest. Coordination with county officials and the Federal Highway Administration is currently ongoing, and no roads have yet been designated.

GT(3): How does the road system affect managing roads with shared ownership or with limited jurisdiction? (RS 2477, cost-share, prescriptive rights, FLPMA easements, FRTA easements, DOT easements)?

Several roads traversing the National Forest fall under the jurisdiction of agencies other than the Forest Service. Where desirable, cooperative agreements should be established to share road improvement and maintenance responsibilities when all partners can benefit. Currently the Bighorn National Forest has a cooperative maintenance agreement with Bighorn, Johnson, and Sheridan County. Paintrock Road, Hazelton Road, and Big Goose Road, respectively, are the roads that have maintenance that is cooperated by the respective counties. There do exist opportunities to enhance and maximize cooperative maintenance on certain roads. As an example, Big Horn County is willing to pursue taking over the majority of maintenance on all of the roads within their county. This option is currently being explored. There are also opportunities to share some maintenance with the BLM in the Cold Springs area, on the Medicine Wheel / Paintrock District in Big Horn County.

There are currently no cost-share agreements with private or public landowners on the Forest. The diversity of ownership and lack of any sizable in-holdings doesn't indicate a need to pursue agreements of this type. However, there are a notable number of permitted summer homes and summer home groups located throughout the Forest. It is currently being investigated by Forest personnel how mutual cost sharing can be maximized on these road segments

Rights of access by law, reciprocal rights, or easements are recorded in Forest files and county courthouse documents. The Forest recognizes these rights and works with the owners to preserve3 access while protecting the natural resources and facilities on adjacent National Forest Lands. There is also an understanding by the Forest Service that individuals or entities may have established valid rights, unknown to the Forest Service at this time, to occupy and use National Forest lands and roads. The courts have established that such valid outstanding rights may be subject to some federal regulation. See *Sierra Club v. Hodel*, 848 F 2d. 1068 (10th Circuit 1988). This analysis recognizes that such valid outstanding rights exist and the Forest Service will certainly honor such rights when it is subsequently determined that the specific facts surrounding any claim to such rights meet the criteria set forth in any respective statute granting such occupancy and use (see *Washington County v. The United States*, 903 F. Supp. 40 [D. Utah, 1955]).

GT(4): How does the road system address the safety of road users?

In 1975, the Forest Service developed a Memorandum of Understanding (MOU) with the Federal Highway Administration that required the Forest Service to apply the requirements of the national highway safety program, established by the Highway Safety Act, to all roads open to public travel. In 1982, this agreement was modified to define "open to public travel" as "those roads passable by four-wheeled standard passenger cars and open to general public use without restrictive gates, prohibitive signs…" Most roads maintained at the level 3, 4, and 5 meet this definition. Design, maintenance, and traffic control on these roads emphasizes user safety and economic efficiency.

The largest proportion of road maintenance and improvement funds allocated to the Forest is spent on these higher standard roads. Safety work such as surface maintenance, roadside clearing and installation and maintenance of warning and regulatory signs are performed on an annual basis. During the winter, these roads are not plowed open and some are subject to seasonal restrictions to prevent road damage during the early spring when the roads are drying out. Traffic control signing follows standards set forth in the Manual of Uniform Traffic Control Devices (MUTCD). Exceptions are permitted where state or county practice in those situations where use of MUTCD guidelines would be confusing to the motorist.

When accidents occur on Forest roads, often the Forest Service is not immediately informed unless an employee is involved. Accidents involving only public motorists are reported to the local sheriff or state patrol, if reported at all. When the Forest does become aware of an accident, an investigation is initiated to attempt to identify the cause. If a feature of the road is found to be unsafe, addressing the condition becomes a high priority. Presently, there is no comprehensive program on the Bighorn National Forest for identifying accident locations and for maintaining surveillance of those locations having a high accident rate or losses as is required by the Highway Safety Act. The Forest needs to address this area of non-compliance.

Road condition surveys conducted in 1999 and 2000 reveal a backlog of over $1.2 MM in deferred health and safety work items on level 3-5 roads in the analysis area. A large portion of this backlog is a result of deteriorated road surfacing on aggregate-surfaced roads. In the past, when logging was at its peak, road-resurfacing projects were planned as part of commercial timber sale activities. The decline of this program has thus reduced the Forest's ability to fund this work. Many arterials and collectors do not meet standards for alignment or roadbed width. Built originally for commercial use, design considerations did not emphasize the high volumes of public recreational traffic that the roads are experiencing today. Many roads are lacking sight distance, turnouts, and adequate lane width needed for the higher volume and speed of traffic now occurring. Another high-cost item is roadside brushing. Level 3, 4, and 5 roads need to be placed on a recurring schedule to maintain sight distance and a safe clear zone. While this work has been part of the annual maintenance program, it is often dropped in years when budget allocations are down. Finally, warning and regulatory signing contributes significantly to the backlog. Engineering studies are currently being conducted to determine the actual warning sign needs on the higher standard roads. As funding levels permit, these signs are being installed. Sign maintenance after installation is part of the annual maintenance program of work.

Maintenance level 1 and 2 roads that intersect the higher standard roads need to be clearly distinguishable from those that are managed for passenger car use. This can be accomplished in a variety of ways. The surface type and condition of the lower standard road should convey the impression that a high clearance vehicle is needed. The route marker used to identify the road should be placed back from the intersection so it does not readily attract attention to the road. The closure device on roads that are maintained at level 1 should be visible from the intersection or have a clear warning sign for traffic approaching the closure. During watershed and project-scale analysis, Forest officials should give high priority to recommending decommissioning those roads that pose the greatest risk to public safety.

Travel management regulations are posted on the ground and described on the Forest Visitor's map. These regulations have been established by the Forest to enable safe motorized travel while protecting natural resources and minimizing conflicts between users. A recent Forest Supervisor decision ended all unrestricted off-road travel by motorized vehicles on the Bighorn National Forest. Off-road recreational vehicles such as trail motorcycles and ATVs are discouraged on higher standard arterial and collector roads but not prohibited. Wyoming state law governs operation of off-road vehicles. Wyoming Statute 31-1-101 allows off-road vehicle owners to title and register their vehicles. These licensed vehicles can then be operated on public roads, including Forest Service roads. Vehicles not licensed may be operated only off-road or on designated motorized trails. This statute also applies to out-of-state visitors.

SU (1) How does the road system affect managing special use permit sites (concessionaire, communication sites, utility corridors and so on)?

The existing road system is adequate to accommodate the majority of recreation special uses. Safe and efficient access to areas under Special Use Authorization has a direct effect on the economics of an operation, either through quantity of customers, and/or operation and maintenance costs. Most recreation special use proposals and/or authorizations are designed around the existing road system. Analysis for specific projects that affect road systems need to also evaluate special use permits that may be affected by the decision.

Many of the non-recreation Special Uses Authorizations rely on the existing road infrastructure or utility corridors to accommodate construction, operation and maintenance.

Prior to any changes in road access or road closures consideration needs to be made as to whether the road is used for any permitted special use authorization. This will require coordination with Districts, recreation and lands departments and various related departments.

UR & RR (1) Is there now or will there be in the future excess supply or excess demand for unroaded recreation opportunities? Is there now or will there be in the future excess supply or excess demand for roaded recreation.

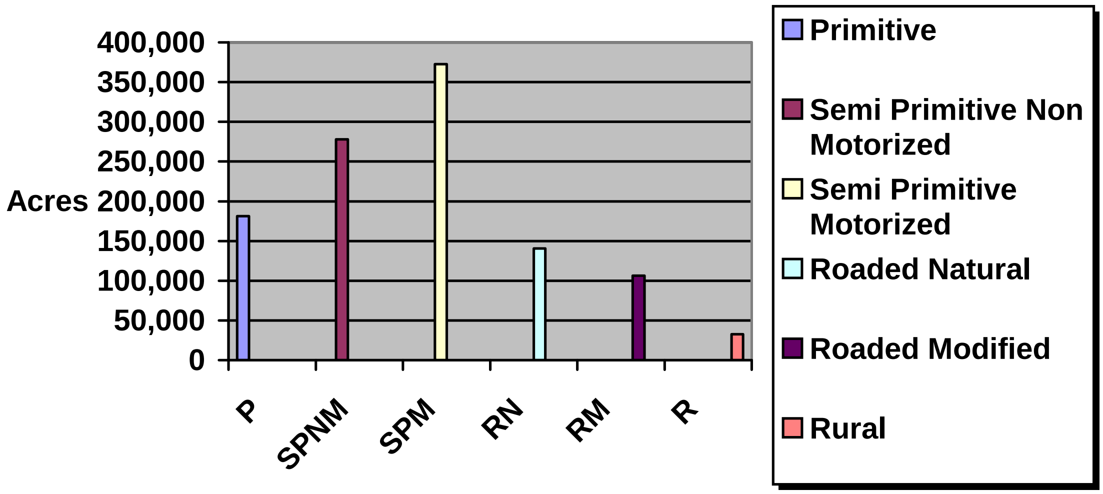
Recreation use on the Bighorn National Forest is steadily increasing. Not only is the number of visits increasing, the complexity of uses and user expectations are greater than ever. The Bighorn National Forest Social Assessment indicates both a demand for unroaded and roaded recreation opportunities.

Roads are the current instruments in providing and accessing recreation opportunities on the National Forest. The majority of roads on the Forest were originally constructed for natural resource extraction and this has resulted in a lower standard road system. Overtime, recreation use of the National Forest has increased thus, the necessity of roads suited for transporting the public safely across and into the forest has amplified. Due to budget constraints, maintenance activities are nominal and user comfort has decreased. These factors may contribute to users choosing the higher maintained roads, which may increase the pressure on those roads and the surrounding areas.

Both the Recreation Opportunity Spectrum (ROS) and the roadless inventory were evaluated. These methods utilize different criteria, the roadless inventory assesses the condition of the landscape and ROS describes the condition of the resource in relation to the needs of the recreationists.

Recreation Opportunity Spectrum (ROS)

ROS is used to describe the recreation opportunities available on the landscape. It defines recreation areas based on different settings that provide different experiences. The presence of roads and the distance from roads are two criteria for determining the ROS of an area. The following graph depicts the number of acres in each ROS classification on the Bighorn National Forest.



Fifty-nine (59) percent of the forest is considered roaded, ROS classifications of Rural, Roaded Modified, Roaded Natural and Semi-Primitive Motorized, however not all roads are for recreation use. Ten percent (10%) of the Forest is in a Roaded Modified (RM) class. RM areas are not managed for recreation but are heavily managed for other activities including timber harvesting. The Semi Primitive Non Motorized (SPNM) class is important for non-motorized recreation in an unroaded setting. All non-motorized activities are generally allowed in a SPNM, ROS setting, however, a trail network may be needed.

The Social Assessment conducted in conjunction with the Forest Plan Revision identified a high desire for "Open areas for recreation that are neither wilderness or roaded (Motorized)". Additionally there is a identified need to create separate recreation areas for motorized and non-motorized use. Conversely, the need for providing more roads for access was not rated as high. The following table depicts the results regarding the Percent Respondent Responding "Yes" to Future Desired Conditions on the Bighorn National Forest. A ranking of one (1) indicates the highest desired condition.

Desired Condition	Total Ranking
Plants and animals as highest priority	1
Consider forest appearance in making decisions	2
Continue commodity uses of the forest	3
Open area for recreation that are neither wilderness or roaded (motorized)	4
Create separate recreation areas for motorized and non-motorized use	5
Close some dispersed recreation sites	6
Limit camping to designated sites in heavily used areas	7.5
Create designated ATV trails	7.5
Designate Wild & Scenic river areas	9
Provide more roads for access	10
Set aside Research Natural Areas	11
Modern facilities for recreation	12
Allow lightning caused fire to burn	13
Set aside land for wilderness	14

It is important to understand that not all roaded and unroaded recreation requirements are the same. Multiple trail uses can occur on both roads and trails. Motorized riding, mountain biking, hiking, wildlife viewing and hunting are not solely dependent on the trails but rather each of these activities requires varying degrees of challenge, trail length, loop opportunities and scenery.

Non-motorized recreation opportunities include mountain biking. Mountain biking has increased dramatically since the late 1980's. Nationwide, an increase of 60% or an average of 1.2% per year over the next 50 years is expected. (Bowker et al. 1999) Mountain bikers utilize roads where there is a lack of trail opportunities. Trail users prefer a variety of opportunities while utilizing the trail; therefore it is important to consider the ROS and preferred experiences when identifying roads for trail uses. In decommissioning level 1 and 2 roads, thought should be given to the experiential changes in recreation opportunities. Opportunities for non-motorized trail experiences could be made if it fits into the theme and concept of that area.

Horseback riding and hiking are probably the most compatible trail and road activities. In fact, many areas otherwise inaccessible by vehicles or mountain bikes are very accessible by horseback or on foot. Participation rates for both activities are expected to increase over the next 50 years: 60% increase in horseback riding and 59% in hiking. This is an increase of more than 1% per year, with an equal increase in trips taken and days spent (ibid).

Motorized users and mountain bikers can travel further than most hikers, but mountain bikers would travel shorter distances than motorized users on the same corridor. These distance factors need to be considered when converting roads to trails for recreational use. Motorcycle trails are narrow and riders prefer not to ride on old roads unless the roads are converted to single track. Motorized recreation is a fast way to get through the backcountry, but users need to have a destination, loop opportunities and/or varying degrees of challenge. Destinations such as a fishing hole or a variety of scenic vistas are preferable to riding though clear cuts and stands of trees and then back again. Many motorized users spend time in favorite areas, especially where they are familiar with the road system and other nearby opportunities. The semi primitive motorized (SPM) classification offers access on level 1 and 2 roads and no facilities in a backcountry setting.

Approximately 718 miles of trail are open to motorized use and there are approximately 1306 miles of level 1 and 2 roads, most of which do not restrict ORV use or any other type of trail use. The State of Wyoming passed a Wyoming Off Road Recreational Vehicles (ORV) Statute in 2001. This State managed program requires ORV's to display a state ORV registration sticker to legally travel enrolled routes. Proceeds from the state program will become available to develop and maintain route opportunities as well as facilities. This program is similar to the State snowmobile program. Currently the Bighorn National Forest has enrolled the majority of their roads into the State program, trail enrollment will be forthcoming. There is a need to designate trails specifically for ORV use, preferably where loop opportunities are available. ORV and 4-wheel drive users prefer the SPM setting for their riding opportunities as well as for utilizing the machines to access fishing and hunting opportunities. The Social Assessment identified fishing as the number one (1) "most favorite thing to do" and hunting is the number four (4)"most favorite thing to do" on the Bighorn National Forest. There have been numerous public comments regarding fewer restrictions on motorized use for game retrieval.

A Roaded Natural (RN) ROS class describes an area with level 3 and 4 roads, which provide easier access to other, less developed areas (arterials). Sightseeing in level 4 roads generally occurs in the RN and Rural (R) ROS settings, however these opportunities are declining as maintenance decreases and as logged areas, which once provided opening for viewing are filled in with new growth. Days spent sightseeing are expected to increase 75% by 2050, an average of 1.5% per year, with the number of trips taken increasing by 90% in that same period. (Bowker et. al. 1999) The Social Assessment identified "Enjoyed the scenery" as the number three (3) "most favorite thing to do" on the Bighorn National Forest. Wildlife viewing was the number one (1) "recreational activity" and sightseeing/scenery viewing was the number two (2) "recreational activity".

Developed facilities provide a higher level of visitor comfort. The majority of campgrounds on the Forest were constructed in the 1960's. The standard to which they were constructed in the 60's are no longer conducive to the space requirements of today. The Bighorn National Forest has been slowly but steadily reconstructing the existing developed recreation sites, developing them to today's standards and correcting health, safety and wellness items.

Developed Facilities

Guidelines for reconstruction of a campground:

- Consider re-designing some of the spurs into pull-through loops that provide for at least 60' of vehicle off the main road.
- Consider barrier free standards when designing the width of spurs as well as the campground road system.
- Clear trees where they obstruct the turning radius required by longer vehicles.

- When changing campground road systems, consider alternative resurfacing material.

Nonmotorized Trails

Guidelines for opening and signing level 1 and 2 roads for mountain biking, horseback riding, and hiking:

- Look for opportunities to provide loop trails (long and short). Consider enhancing the opportunity with a view or a variety of terrain.
- Enlist the help of these trail users when designing for these opportunities.
- Develop at minimum a pullout parking lot and sign with a map at the trailhead.
- Mountain bike and horseback trails should be slightly longer (by 2/3) than hiking trails.

Motorized Trails

Guidelines for designing a motorized trail system out of the level 1 and 2 roads:

- Consider the users and their preference for features along the trail and at the end of the trail.
- Consider motorcycle riders preferences for single-track trails.
- Develop adjacent trail systems so users aren't loading and unloading multiple times during one day.
- Consider the width requirements for developing ORV trails.

UR2 and RR2: Is developing new roads into unroaded areas, decommissioning of existing roads, or changing the maintenance of existing roads causing substantial changes in the quantity, quality, or type of unroaded (or roaded) recreation opportunities?

When reviewing the total capacities, the quality of the recreation experience as well as the potential offering of a variety of non-motorized and motorized recreation experiences must be analyzed. Capacities can simply be raised by altering the users expectations of the type of experience that they may have in a particular area.

Reductions in level 3,4 and 5 roads may appear to increase the capacity of recreational experience in a non-motorized setting. However, the constrained vehicular access may also limit the capacity of users to effectively access non-motorized areas, thus shifting use from one area to another area without actually adding to the useable non-motorized capacity.

There may be more capacity presented in a roaded natural ROS setting as opposed to a semi primitive motorized setting. However, the user will have to accept more resource development and less solitude in the roaded natural setting. Closing level 3,4, and/or 5 roadways will likely increase the more semi primitive, non-motorized recreation experience. However, this may lead to a concentrated area not fulfilling the user expectation.

Few roads have been built in unroaded areas since 1985 nor have many level 3, 4, or 5 roads been decommissioned or obliterated during this time. Due to a lack of funds and resources, many roads haven't been maintained regularly. Over time, increasing or decreasing regular maintenance can change the frequency and patterns of use.

Decreasing maintenance due to funding shortfalls means the intended comfort level may no longer be experienced on these roads, and over time, they might become unusable for passenger vehicles. Increasing maintenance efforts on level 3 roads changes the use and increases user access and use levels. The potential to increase opportunities for roaded and unroaded recreation is dependent on funding and public input. Traditionally roads have been paid for and built to access timber sales, range allotments or mining activities. If the public no longer supports these management activities, funding for road construction would have to come from another source—recreation, for example. In other cases, existing road systems can be rehabilitated to help facilitate recreation by providing loop opportunities or access to trailheads.

UR3 and RR3: What are the effects of noise and other disturbances caused by developing, using, and maintaining roads on the quantity, quality and type of unroaded (and roaded) recreation opportunities? What are the adverse effects of noise and other disturbances caused by constructing, using and maintaining roads on the quantity, quality, or type of roaded recreation opportunities?

The noise from constructing new roads would carry into the forest and could affect a recreationist's sense of remoteness. However, construction activities are short in duration. The sound from road maintenance activities could carry into the forest, but are also of short duration. Road use from standard vehicles does not carry far into the forest because of the low speeds involved, whereas off-road vehicle use does carry far across the landscape and could affect a sense of remoteness.

The significance of this noise depends primarily on the location of the road and the management emphasis of surrounding lands. The Recreation Opportunity Spectrum is one tool used to define objectives for an area. This system provides a means to categorize lands according to the type of recreational opportunity a person could expect to achieve within a given area. Ranked from Primitive to Urban, this system defines the level of development, noise, crowding etc that one should expect in the area. Roads adjacent to land that should be managed as primitive or semi-primitive would have a greater negative effect than if adjacent to lands managed as roaded natural, rural or urban. In the more developed areas, there should be a higher expectation of noise than in the more primitive end of the spectrum.

Because of the low level of roadwork on the Bighorn National Forest, there is very little negative effect on unroaded recreation from road management activities on Level 3, 4 and 5 roads. Work on lower level roads, especially in more remote areas may have greater negative effect since the areas are more likely to have ROS objectives that are closer to the Primitive end of the spectrum.

There are no adverse effects created by new road construction activities, as this activity is not occurring. Potential adverse effects of maintenance would include displacement/detours, inconvenience and travel delays. The maintenance of roads would displace some recreationists while that road activity is occurring. This disturbance would be temporary and users would return when the road activity was completed. The degree of inconvenience would vary by circumstance. If a visitor were on their only trip to the Bighorn National Forest, perhaps at a picnic site and encountered constant noise or other construction disturbances during their one visit, it would likely have a high negative impact. Contract clauses may be placed to limit the roadwork to specified times or weekdays during which operations would be allowed, thus limiting the impact on visitors.

UR4 and RR4: Who participates in unroaded (and roaded) recreation in the areas affected by constructing, maintaining, and decommissioning roads?

UR5 and RR5: What are those participant's attachments to the area, how strong are their feelings, and are alternative opportunities and locations available?

Note: UR4, RR4, UR5, and RR5 have been combined under advisement of the Regional team.

The primary recreation users of unroaded areas are hikers, skiers, equestrian users and other non-motorized recreationists. At particular times of year there may also be use by hunters, anglers and numerous other activities.

All Forest users travel the arterial/collector roads (level 3-5 maintenance levels). Level 2 roads, provide dispersed recreationists access into otherwise inaccessible areas. Many bicyclists and horseback riders, for instance, use these roads for riding. Road decommissioning would be contentious for these users, depending on the road and the area. By the same token, some users would not welcome a road into their favorite roadless area.

The National Visitor Use Monitoring (NVUM) project was implemented as a response to the need to better understand the use of, importance of and satisfaction with national forest system recreation opportunities. The Bighorn National Forest participated in the NVUM project from October 2000 through September 2001. This study identified the primary activities of visitors. Included were activities that were both road-based and those that required a more primitive, un-roaded setting. Wilderness users, day hikers, campers, skiers, casual forest users passing through the Bighorn forest were all interviewed. The following discussion uses total visitor activities, whether road-based recreation or not.

The average Bighorn National Forest visitor went to 1.3 sites during their national forest visit. The average length of stay on Bighorn National Forest for a national forest visit was 16.4 hours. Twenty-one percent of visitors stayed overnight on the forest. Forest visitors sometimes go to just one national forest site or area during their visit. For example, downhill skiers may just go the ski area and nowhere else. Fifty-three percent of visitors went only to the site at which they were interviewed. During their visit to Bighorn National Forest the top five recreation activities of the visitors were viewing natural features, viewing wildlife, relaxing, hiking/walking and driving for pleasure. Each visitor also picked one of these activities as their primary activity for their current recreation visit to this forest. The top primary activities were viewing natural features, fishing, hunting, relaxing and hiking/walking. The results of the NVUM activity analysis do not identify the types of activities visitors would like to have offered on the national forests. It also does not tell us about displaced forest visitors, those who no longer visit the forest because the activities they desire are not offered.

Chapter 5 Describing opportunities and setting priorities

Problems and Risks Posed by the Current Road System

Introduction

To assess the problems and risks posed by the current road system, the IDT evaluated the current maintenance level 3, 4, and 5 road system on the Bighorn National Forest using the following tools: a GIS assessment, a road matrix, and a road management graph. There were some inherent limitations in the data used. The available GIS data for each resource area wasn't complete. However, the watershed and aquatics databases were more complete and were adequate for a GIS-based analysis. These were also the resources at most risk from road-related impacts.

GIS Assessment: The effect of roads on the watershed and aquatic resources was analyzed using GIS computer technology combined with the Forest transportation inventory and cartographic feature files. This analysis was not limited to the effects of level 3 through 5 roads. All classified and unclassified roads currently inventoried on the National Forest were included in the analysis. Areas with high road densities were identified and assessed for potential risk to the water and aquatics resources.

The Road Matrix lists every maintenance level 3, 4, and 5 road on the Forest, assigns low, moderate, or high values to resources, and includes annual and deferred maintenance costs. This is a broad assessment, so the detail and accuracy for road risk and values contain a degree of subjectivity and potential for inaccuracies. However, this road matrix provides road-specific information that will help define the potential minimum road system, identify roads that pose high risk to other resources, and prioritize subforest scale projects. As more information becomes available, the road matrix information should be validated and updated.

The Road Risk-Value Graph was developed to display the information in the road matrix. It categorizes the values and risks of the current road system and helps identify opportunities for managing the road system and prioritizing expenditures of Forest road maintenance and improvement funds. This graph is only a management guide; it is not firm direction as it combines many of the road matrix risk and value variables.

Resource Risks versus Road Use Values

The risks and values from the road matrix and the road management graph are defined below.

Road-related Risks

Watersheds and Aquatic Risks: Watershed and aquatic resources were determined to be the resources at greatest risk from road-related impacts. In a given watershed basin, aquatic health depends on watershed health. The GIS assessment compiled the following information by 6th-level watershed. This information was then used to determine watershed risk (see accompanying watershed risk table in Appendix A).

Geologic hazards	Road densities
Soil types	Road proximities to streams
Slopes	Numbers of road crossings of USGS blue-line streams

Each 6th-level watershed was assigned a low, moderate, high, or extreme risk rating. This was intended to guide subforest scale analysis. In a separate analysis, we evaluated the potential effects of level 3-5 roads on watershed and aquatic resources, and the roads were assigned a risk rating.

Wildlife Risks: Many scientific studies have documented impacts to wildlife, including direct mortality, habitat fragmentation, edge effects, viability and sustainability, and nesting and rearing disturbances. The IDT utilized these studies as well as the Forest's annual monitoring reports to evaluate wildlife risks. The monitoring reports clearly demonstrated that the current road system has minimal effects on the management indicator species listed in the Plan. Most of the wildlife risk values assigned to each road on the Forest were low, a few were moderate, and none were in the high category.

More information about road impacts to wildlife on the Bighorn NF can be found in the TW section of this report.

Financial Risks: Annual maintenance and deferred maintenance costs were included in the risk/value categories for the road management graph. These costs were included to reflect the Forest's financial commitment to maintain the road system and to identify the link between maintenance and resource protection. If basic annual road maintenance (e.g., drainage maintenance) is not performed, roads have an increased potential for loss of investment and environmental damage. The same is true for deferred maintenance, such as replacing major culverts in perennial streams at the end of their design life. A catastrophic drainage failure will have a direct negative impact on the associated watershed and aquatic health.

Road-related Values

Value was determined by looking at resource management use and recreation use.

Resource Management Values: This value was based on two factors: road length and variety of land and resource management access needs provided by the road. Initially, each road was given a default value rating based on its length. Level 3, 4, and 5 roads, 10 miles in length or greater, received a high value rating. Roads from 1 to 9.9 miles in length were given a moderate value. Roads less than 1 mile long were rated low. For the second step, the following criteria were used on a road-by-road basis to adjust the default values up or down:

- Access to suitable timber base.
- Access to private land.
- Existing or potential legal right-of-way to NFS lands.
- Access to high-density urban interface areas (fire suppression) or to known fuel reduction projects.
- Access to key administrative facilities.
- Access to water production or storage facilities.

These criteria were used either alone**,** in cases where one use was very important for management of that resource**,** or in combination where the road served two or more access needs.

Recreation Use Values: The value of recreation use of the road system was rated separately. High values were assigned to roads that provided direct access to developed recreation sites or were key recreation access roads to the Forest. Moderate to high values were assigned to dispersed recreation areas along roads with heavy summer and fall use. Low values were often assigned to roads that provided only seasonal dispersed recreation use.

Road System Modification Options

After performing a road-by-road rating of risk and value based on the established criteria, the following road management categories and graph were developed to display the information and present opportunities for road management. *The matrix and watershed assessment provide a basis for subforest scale roads analyses.* The graph helps identify roads that make up the potential minimum road system, roads that may need additional investment to protect the resources, and roads that could have their maintenance level reduced.

Road Management Categories and Graph

The following 4 categories of roads were identified based on value and risk. Within each category, there are possible management options for the roads.

Category 1: High Value and Low Risk – Ideal Situation

Options:

- Focus road maintenance funds on these roads to keep them in this category.
- High priority for the Public Forest Service Road designation.
- These roads form part of the potential minimum road system for the Forest.

Category 2 – High Value and High Risk – Priorities for Capital Improvements

Options:

- High priority for subforest scale roads analysis to identify high risk reduction needs.
- High priority for capital improvement funding, such as: PFSR designation, road improvement, road relocation, funding, capital improvement program, etc.
- Shift road maintenance funds to these roads to keep their resource risks from increasing.
- These roads are the remainder of the potential minimum road system for the Forest.

Category 3 – Low Value and High Risk – Priorities for Risk Analysis

Options:

- High priority for subforest scale roads analysis to identify high-risk reduction needs and confirm use value.
- Potential for reducing maintenance level.
- High potential for decommissioning.

Category 4 – Low Value and Low Risk – Priorities for reducing Maintenance Level

Options:

- Lowest priority for expending annual road maintenance funding.

- Moderate potential for decommissioning or reducing maintenance level.
- Where there is a recreational demand, convert these roads to trails.

The Road Risk-Value Graph (page 87) was the tool used to identify roads for the above road management categories. Several factors need to be understood to correctly interpret this graph and the identification of roads in the different categories:

Roads with a value of more than 4 (left side of the vertical axis) represent those roads that constitute the Potential Minimum Road System for management and use of the Bighorn NF. Those roads with a value of 4 or less are those roads that are potentially not needed for the Forest, at least possibly not needed at their current maintenance level. The situation is similar for the horizontal axis. Those roads with a risk rating of 7 or more represent those roads that may be causing unacceptable resource impacts, while those with a rating of less than 7 are not as much of a resource impact concern.

Of special note, it needs to be emphasized that just because a road falls below the horizontal axis does not mean it is not causing resource impacts. The risk values are a sum of the wildlife, watershed, annual maintenance and deferred maintenance costs. Low costs and higher resource risks could still result in an overall value of less than 7, low risk, on the graph. The road matrix needs to be used with the graph to identify the actual risks that have been assessed through this analysis.

Road Maintenance Costs – Identification of the Potential Minimum Road System

One purpose of a roads analysis is to identify ways to more efficiently spend the limited road maintenance dollars allocated to the forests. One approach is to reduce or eliminate expenditures on roads that are not needed or not needed at their current maintenance level. The process described above identifies the Potential Minimum (Level 3, 4, and 5) Road System.

Some conclusions can be made by comparing annual road maintenance funding needed for each road to the road maintenance graph on the following page. If all of the roads to the right of the vertical axis were to be decommissioned, the needed annual road maintenance funding for just the level 3, 4, and 5 roads on the Forest would be reduced, approximately, from $1,722,468 to $1,343,551. The actual allocated road maintenance funding for the entire Bighorn National has been around $800,000/year. More road maintenance funding is needed to support the road system infrastructure.

Decommissioning Guidelines

Discussion

Road decommissioning results in the removal of a road from the road system. The impacts of the road on the environment are eliminated or reduced to an acceptable level. To accomplish this, a number of techniques can be used, such as posting the road closed and installing waterbars, posting and installing barriers and barricades, ripping and seeding, converting the road to a trail, and full reclamation by restoring the original topography. There is a different cost associated with each of these techniques and their effectiveness for deterring unauthorized motorized vehicle use varies as well. Road decommissioning employs site-specific techniques, which are most conducive to achieving minimal impacts to the resources.

Decommissioning level 1 and 2 roads can consist of removing any culverts, ripping and seeding, posting closed with signs, and installing waterbars to discourage unauthorized motorized vehicle use and ensure proper drainage occurs over time.

Decommissioning level 3, 4, and 5 roads is more expensive than decommissioning most level 1 and 2 roads. When choosing a technique for road decommissioning, the objective is to eliminate the need for future road maintenance.

Level 3, 4 and 5 roads are usually wider than level 1 and 2 roads, have culverts installed at designed intervals to cross drain the road, are ditched, have better sight distances designed on horizontal and vertical curve, have larger cuts and fills, may have bridges or large culverts, and are designed through the topography rather than with the topography. It is much more expensive to decommission these roads than level 1 and 2 roads. Given the cost, it may be cheaper to maintain level 3, 4, and 5 roads than to decommission them. However, future maintenance costs may not be the only factor to consider; other resource considerations may outweigh the cost. For a particular road (level 3, 4, or 5), high deferred maintenance costs may exceed the costs of decommissioning.

Guidelines:

- Balance cost with resource risk and effectiveness of the treatment when selecting methods for decommissioning roads.

- Convert roads to trails as a decommissioning method when analysis of recreation demand indicates a need to expand, connect or improve the existing trail system in the area. Provide adequate trailhead parking as part of this treatment method (See UR1 and RR1 discussion in Chapter 4).

- Decommission by restoring the road to original contours when mitigating visual impacts is required by the Forest Plan or when necessary to assure the elimination of vehicular traffic.

Road Risk-Value Graph

High Potential for Investment

Low Potential for Investment

Risk

9

Category 2
High Value/High Risk

Priority for investment
(CIP, PFSR, etc.)
Focus on resource concerns

190 miles
$2,247877 deferred mtce
$1,220,795 annual mtce

Category 3
Low Value/High

Priority for risk analysis
Consider reducing maintenance level
Consider decommissioning
Focus on resource concerns

26 miles
$232,145 deferred mtce
$168,408 annual mtce

6 ***(4,6)*** ***2*** ***Value***

Category 1
High Value/Low Risk

Ideal condition
Maintain to standard
Review for potential resource concerns

55 miles
$446,725 deferred mtce
$361,445 annual mtce

Category 4
Low Value/Low Risk

Consider reducing maintenance level
Consider decommissioning
Review for potential resource concerns
Opportunity for development

32 miles
$263,458 deferred mtce
$208,303 annual mtce

3

Note: Not to scale.
Value = Recreation value + Resource mgmt value (max = 6).
Risk = Watershed/aquatic risk + Wildlife risk + (Road Maintenance Average of Deferred and Annual Maintenance) (max=9).
Horizontal axis: Value of 4 or less = low potential for investment (low value).
Value > 4 = high potential for investment (high value).
Vertical axis: < 6 = low risk. 7 or greater = high risk.

Minimum Transportation System

This analysis revealed that approximately 277 miles of level 3, 4, or 5 road on the forest either have a high value associated with them, or have a low risk, or both. 26 miles have neither. It is therefore recommended that these 26 miles be removed from the rest of the transportation system for the minimum system. It is proposed to retain the remaining 277 miles of road as the minimum system, as there is some sort of desirable character associated with these roads. The majority of the road miles analyzed fell into the high risk, high value category. It was identified after further analysis that these roads must remain as a portion of the minimum transportation system. In addition, the high value, low risk roads were felt were the ideal condition, and should remain, as well. The roads in the low value, low risk category seemed to be 'on the bubble.' Meaning that the roads may not be needed from the value standpoint, but could remain on the system as 'opportunities' to mitigate the loss of roads in the high risk, low value areas.

Capital Improvement Guidelines

Discussion

This analysis revealed that 47% of the road miles scheduled for construction and reconstruction in the 1985 Forest Plan were accomplished. Revision of the Plan will reassess the need for previously identified level 3, 4, and 5 road construction.

This analysis does show there is a need to reconstruct existing roads to correct deferred maintenance work items or to improve some roads to meet the increasing use and traffic requirements. Funding limitations require prioritization of reconstruction work. The Road Risk-Value Graph provides a starting point for developing priorities. The following guidelines are to be used in conjunction with the graph when selecting, prioritizing and implementing road reconstruction and construction projects.

Guidelines

- Conduct road location reviews prior to all new construction and road relocations. Assure the location meets public and agency needs while mitigating environmental impacts identified in the analysis. Responsible line officers and resource and engineering specialists should participate in the review.
- Establish a traffic counting program to identify high use roads and traffic patterns.
- Roads with seasonal average daily traffic volumes exceeding 400 vehicles per day should be considered for reconstruction to two lanes.
- Use motor vehicle accident safety investigations and reports to help identify road safety hazards.
- Use the following categories to prioritize road investments planned to reduce deferred maintenance backlog on roads: 1 – Critical Health and Safety; 2 – Critical Resource Protection; 3 – Critical Forest Mission. Data for these work items can be found in the INRASTRUCTURE database.
- Coordinate reconstruction and construction work with other agencies whenever possible. Utilize interagency agreements to develop investment and maintenance partnerships.

Road Management Guidelines

- If a road's maintenance condition has decreased, consider the need for the road and the historic use, as well as alternative roads in the area before permanently changing the maintenance level.

- Reduce the maintenance level on identified low value level 3, 4, and 5 roads being analyzed in subforest scale roads analyses. This can be a cost effective alternative. Reduced maintenance of these roads should not result in any increased watershed risks from these roads as the most basic road maintenance will focus on maintaining road drainage. The reduced maintenance should only result in reduced user comfort, and hence, reduced use over time will further reduce the potential for road related watershed risks.
- It is important for travelers to have the sort of information necessary to make a decision about the road on which they're about to travel. When appropriate, utilize entrance treatments, warning signs, route markers, and information bulletin boards to advise travelers of conditions ahead.
- Do not post speed limit and other regulatory signs on roads under Forest Service jurisdiction without a Forest Supervisor's order and a law enforcement plan.
- Consider prohibiting ATV use on Forest system roads when one or more of the following conditions exist:
    - The road is maintained at level 3, 4 or 5 and connects to a state, county or other public agency road that is similarly regulated.
    - Traffic volumes exceed 100 vehicles per day, seasonal average daily traffic (SADT) on single lane roads.
    - Average traffic speed on the road exceeds 25 mph.
- To reduce annual maintenance costs, implement seasonal travel restrictions on roads susceptible to damage during wet or thawing conditions.
- Collect road maintenance and surface rock replacement deposits as appropriate on all road use permits and special use permits.

General Guidelines

The following are general road related guidelines:

- Require authorized, permitted operations utilizing NFS roads to pay or perform their fair share of road maintenance costs.
- Consider road decommissioning when planning projects that involve the construction and use of short term, single resource roads: for example, roads planned for mineral projects that undergo exploration, development, and abandonment phases. By incorporating decisions to decommission the single resource roads at the end of the project, rather than not addressing this issue up front, the Forest will better demonstrate a commitment to managing its road system toward the minimum road system needed. Document planned decommissioning in road management objectives.
- Develop an annual maintenance plan to prevent deferred maintenance costs from accruing on High Value rated roads
- Update the road system databases and keep them current.
- Use an interdisciplinary process to develop, update, and implement road management objectives for all system roads. Assure that information in the transportation atlas and inventory conforms to approved road management objectives.
- At appropriate intervals, update the data contained in the Road Matrix. Analyze the changes to determine new opportunities that may have developed as new information is collected.

- Incorporate yearly Forest road changes into the annual Forest Plan Monitoring Report (via the forest plan revision process). These road changes can include miles of roads decommissioned (classified and unclassified), miles of roads converted to trail (MV and Non-MV), miles roads reconstructed (by maintenance level), and miles of roads constructed (also by maintenance level).
- Require the use of this Bighorn NF Roads Analysis for all subforest scale roads analysis through a Forest supplement to the 7700 Manual.
- Annually, perform road condition surveys on all level 3, 4, and 5 roads.

Assessment of Building Roads in a Currently Unroaded Area

For this assessment, unroaded areas include inventoried roadless areas and other areas that do not contain roads.

National direction addressing road building in inventoried roadless areas is needed to help resolve some of these conflicts. Even with such direction, road building in unroaded areas or inventoried roadless areas will most likely result in social opposition and conflict.

Some inventoried roadless and unroaded areas are not conducive to road building due to physical constraints (steep slopes, unstable soils, wetlands). However, in other areas, roads can be constructed after proper project planning, analysis, road design, and mitigation.

This issue will be decided in forest plan revision. It is addressed in specific resource sections in Chapter 4.

Opportunities for Addressing Problems and Risks

Travel Management: For roads in the Low Value rating, either decommission or consider ways to raise this value: for example, by providing recreation opportunities along the road. Overall recreation use on the Forest is increasing and road related opportunities exist to better disperse this use and lessen recreation impacts that are occurring elsewhere. An example of increasing recreation use on a low value road would be to develop a trailhead and trail system at the end of the road. There are many opportunities on the Forest to convert the unclassified and level 1 and 2 roads to motorized and non-motorized trails.

Watershed: The watershed assessment identifies potential effects of roads which can impact watershed condition. Watersheds, and associated aquatic resources, that are at greatest road related resource risk could be prioritized for separate watershed analyses to better identify specific areas of concern that may need repair.

The following table identifies extreme and high risk watersheds by geographic area.

Table 14. Extreme and high risk watersheds on the Bighorn National Forest.

Geographic Area	% of area with severely erodible soils	# of 6th level HUC with v. high or extreme road stream crossing densities	# of 6th level HUC with a high, very high or extreme density of roads within 200 feet of stream courses	# of 6th level HUC with a high, very high or extreme road densities
Little Bighorn	13%	3	1	0
Tongue River	9%	2	1	1
Devil's Canyon	13%	2	0	1
Shell Creek	2%	4	0	1
Goose Creek	4%	0	0	0
Piney/Rock	1%	0	0	0
Paintrock	3%	3	0	3
Clear-Crazy	> 1%	6	0	5
Tensleep	5%	4	3	3

Aquatic: the following opportunities address roads impacts on specific aquatic situations, e.g., surface/subsurface hydrology, surface erosion, etc.

The following is a list of opportunities/recommendations to consider if roads are likely to modify surface and subsurface hydrology:

- Design roads to minimize interception, concentration, and diversion potential.
- Design measures to reintroduce intercepted water back into slow subsurface pathways.
- Use outsloping and drainage structures to disconnect road ditches from stream channels rather than delivering water in road ditches directly to stream channels.
- Evaluate and eliminate diversion potential at stream crossings.

The primary opportunities to reduce surface erosion identified in a subforest scale roads analysis include:

- Increasing the number and effectiveness of drainage structures.
- Improving the road surface by either gravelling, or adding a binding material to those roads that have native surfaces with no inherent binder.

Opportunities to address existing roads in areas with high mass wasting potential include:

- Road relocation to an area with more stable soils.
- Relocation of drainage structures so that the outlets are on less sensitive areas which may include flatter slopes and better-drained soils.

Opportunities to improve local channels at road-stream crossings include:

- Designing crossings to pass all potential products including sediment and woody debris, not just water.
- Realign crossings that are not consistent with the channel pattern.
- Change the type of crossing to better fit the situation; for example, consider bridges or hardened crossings on streams with floodplains, and consider bottomless arch culverts in place of round pipe culverts.
- Add cross-drains near road-stream crossings to reduce the connected disturbed area.
- Reduce the number of road-stream crossings to minimize the potential for adverse effects.

Opportunities to reduce the effects of the road system on wetlands include the following:

- Relocate roads out of wetland areas.
- Where relocation is not an option, use measures to restore the hydrology of the wetland. Examples include raised prisms with diffuse drainage such as french drains.
- Set road crossing bottoms at natural levels of wet meadow surfaces.

Opportunities to address road-stream crossings that restrict migration and movement of aquatic organisms include:

- Reset the culvert to eliminate the limiting factor.
- Replace the culvert with an alternative crossing such as bridge, hardened low-water ford, or bottomless arch culvert.

Opportunities to address roads that affect riparian plant communities include:

- Relocate roads out of riparian areas.
- Restore the hydrology in riparian areas that have been dewatered by the road system.

Fuel Reduction: Initiative funding anticipated for the next several years is another opportunity to address growing urban interface wildfire risks. The IDT placed a high resource management values on many of the level 3, 4, and 5 roads that provide primary access to areas around and within the Forest that have high densities of cabins, homes, and other structures. These roads may be important access routes for fuel reduction projects, especially any commercial projects that could involve log hauling, and provide important access for wildfire suppression access and evacuation egress. The IDTs for these fuel reduction planning projects can use the road matrix to begin identifying the existing access/egress situation to help define the road related project proposals.

Deferred maintenance backlog: This Bighorn NF Roads Analysis clearly demonstrated that annual maintenance funding is inadequate to maintain the road system on the Forest. Over time, these roads will continue to incur additional deferred maintenance costs and degrade unless significant road reconstruction funding becomes available. The agency is addressing this issue nationally by proposing a new funding category for the 2004 federal highway transportation funding authorization called Public Forest Service Roads (PFSR). A challenge for this Forest is determining how to prioritize these roads for the PFSR funding. The Road Matrix Table revealed that some currently submitted PFSR project proposals are for roads that received a low value rating. This table can be used as a prioritization tool for these proposals.

This roads analysis has identified an opportunity to improve road related dialogue with the respective counties. The Forest should continue to pursue formal road maintenance agreements with the counties interested in sharing maintenance to more efficiently use taxpayer funds.

NEPA analysis needs

This forest scale roads analysis is intended to be used as an assessment for the revision of the Bighorn Forest Plan. This roads analysis does not need any NEPA analysis as it provides information and opportunities for the plan revision, as well as for subforest scale roads analyses. The forest plan revision will be analyzed through the EIS process. Any decisions resulting from subforest scale roads analyses will be required to be supported by the appropriate level of NEPA.

Chapter 6 Key Findings

Forest Scale Issues

- **Shared maintenance is not occurring on key access roads.**
- The Forest should continue to pursue formal road maintenance agreements with the counties interested in sharing maintenance to more efficiently use taxpayer funds.
- The Category 1 and 2 roads (from the Road Risk-Value Graph) are the most obvious candidates for Road Maintenance Agreements with the counties. In some cases, the Category 2 roads might need federal capital improvements first before the counties would consider shared maintenance responsibilities.

Some roads are not under appropriate jurisdictions.

- We don't know the extent of this problem. A preliminary review of the database shows several roads listed under questionable jurisdiction. However, this was based on data that had not been updated as the Forest acquired legal jurisdiction on roads. During their research for this analysis, the Forest lands staff reviewed and updated some of the jurisdiction information in the database. Efforts to update and correct the data files should continue.

Road maintenance funding is not adequate to maintain and sign roads to standard.

- The road matrix developed for this roads analysis contains the annual and deferred maintenance costs for each level 3, 4, and 5 road on the Forest. Even with the focus on potential minimum road system, our current budgets don't cover road maintenance costs. The Bighorn National Forest currently receives approximately $800,000 per year for all road maintenance. To maintain the level 3, 4, and 5 road system to standard would cost approximately $2.8 million.
- Using the subforest level roads analysis process could result in continued reductions of the Forest road maintenance obligations through decommissioning of level 1 and 2 roads. However, these reductions will be minor compared to the overall road maintenance needs on the Forest.

Road access may not be adequate for future management needs.

- Arterial and collector roads are not being maintained to the standards specified in the 1985 Forest Plan. The road system will continue to degrade, and this will compromise future access on existing roads.
- Comparing the 1985 Forest Plan with the existing road system revealed that approximately 15 miles of new road construction and over 30 miles of road reconstruction projected to meet land management purposes did not occur. Most of these road improvements were intended to meet timber stand vegetative treatment needs. On the Bighorn NF, the timber program still has additional road access needs to meet the 1985 Forest Plan and may very well have additional road needs under the revised plan. Subforest scale roads analyses should focus on road-related watershed improvement opportunities, decommissioning of unneeded level 1 and 2 roads and upgrading roads to meet current and future management needs.

There are potential environmental impacts from the road system that need to be prioritized and evaluated for future analyses at a subforest level scale.

- This roads analysis process identified individual roads that represented high potential for environmental risks. Categories 2 and 3 from the Road Risk-Value Graph identified approximately 216 miles of these roads. The analysis also identified watershed that are at risk. The process used watershed health assessments as the indicator of aquatic health. The watershed risk tables (see above in Chapter 4, AQ sections) also identify those watersheds most at risk. Future subforest scale roads analyses should reference this appendix for risk rating and baseline watershed information.
- Chapter 4 provides more information in response to this issue.

High road densities in some areas of the Forest are causing impacts to resources and users.

- By itself, the level 3, 4, and 5 road system was not a road density concern.
- The watershed assessment considered areas of relatively high road densities[5] as one component of the overall watershed risk ratings. Most of these high road density areas are areas where there are many unclassified roads and level 1 and 2 roads. These areas of high road densities often correlate with high risk ratings. These areas are also opportunities for identifying road conversions into trails to enhance recreation opportunities. Such areas include areas that are open to off road vehicular travel. These areas are to be assessed to limit off road travel as part of the forest plan revision.

The public was concerned about road-related decisions being made without public involvement.

- The public was concerned that decisions about reducing or reconfiguring the Forest's transportation system might be made without the benefit of public involvement. The roads analysis process doesn't make any road-related decisions. Decisions that will change the existing system will occur through public involvement and a site-specific analysis that considers effects on existing roads or roads proposed for addition, deletion, or reconstruction in the future.

Products of the Bighorn National Forest forest-wide roads analysis

Products produced from this analysis includes maps that are described below with discussion items:

An inventory and map of all classified (3, 4, and 5 level) roads and a description of how those roads are to be managed.

- The first map is of the existing inventoried level 3, 4 and 5 road system, with the road numbers. It also includes the inventoried level 1 and 2 roads without their respective road numbers. The level 3, 4, and 5 roads from the road matrix are displayed on the maps.
- The second map is of the Potential Minimum Level 3, 4, and 5 Road System. These maps display the high value level 3, 4, and 5 roads. The maps, matrix, and graph show management opportunities for the level 3, 4, and 5 roads. In subforest scale analysis, specific road management decisions will be made using this information.

[5] High road densities are defined as 2 or more miles per square mile for the watershed assessment.

Guidelines for addressing road management issues and priorities related to construction, reconstruction, maintenance, and decommissioning.

- Chapter 5 of this report contains guidelines and opportunities for addressing road management issues and priorities related to construction, reconstruction, and decommissioning.
- Aquatic questions in Chapter 4 identify opportunities for addressing aquatic resource concerns.

Significant social and environmental issues, concerns, and opportunities to be addressed in project level decisions.

- Contacts with the other counties resulted in a mix of potential opportunities. Most of these are the varying interest of these counties to work with the Forest in developing Road Maintenance Agreements for shared road maintenance and eligibility of county roads for federally funded road improvements. Many details remain to be coordinated and agreed to with these counties and the Forest.
- The environmental issues that surfaced are concerns about the health and condition of some watersheds as a result of road impacts, silvicultural concerns about the current and future health of the forest, and road access for fuel reduction projects and fire suppression, especially in the urban interface areas.

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