APPENDIX B:

Description of the Analysis Process

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APPENDIX B: Description of the Analysis Process

INTRODUCTION

This appendix describes the analysis process the U.S. Forest Service Interdisciplinary Team (ID Team) used for the Land and Resource Management Plan (LRMP) Phase II Amendment. Discussion in this appendix is organized by the three primary analysis tasks for the LRMP Phase II Amendment project: species assessments, treatment estimates, and effects analysis. The methods employed to perform these tasks are discussed in this appendix and include a discussion of data sources, techniques, and assumptions made. References cited in this appendix appear in Appendix F (References) of the final environmental impact statement (Final EIS).

1.0. Assessment Process

The species assessment task consists of identifying emphasis species, migratory birds, demand species, and research natural areas (RNA). The analysis process used to identify each category of species and RNAs is described in the following sections. The alternatives' effects analysis on species is described in Section 3 Effects Analysis.

1.1. Species Viability and Diversity Approach

All alternatives address species viability and diversity. This section describes the approach used by the ID Team to address species viability and diversity for the Phase II Amendment Alternatives. The approach used the following steps:

1. Describe the Ecological Context

An understanding of ecological systems provides a critical foundation for management of species. Because species persistence depends on the state of ecological systems, an understanding of system dynamics, pattern, and process provides critical insights into the design of conservation approaches and sustainable resource management.

Information was gathered on disturbance processes in the Black Hills. Historically, these processes played an important role in shaping the composition and structure of the plant communities in the Black Hills. They continue to play an important role today, along with human activities. Natural disturbance processes are described in Section 3-7 Natural Disturbance Processes in Chapter 3 of this Final EIS.

Information was gathered on ecosystems within the Black Hills. The various ecosystems were described using information from a variety of sources, including scientific literature, the Forest vegetation database, and the information in Section 3-7 Natural Disturbance Processes. Information from Parrish et al. (1996) also provided valuable information for describing the ecological context of forested and riparian ecosystems. The ecosystems are described in Section 3-2 Ecosystems of the Black Hills National Forest and include forested ecosystems, grassland/shrubland ecosystems, riparian and wetland ecosystems, aquatic ecosystems, and cave ecosystems.

2. Identify Species at Risk

Threatened and Endangered Species

The Wyoming and South Dakota State Offices of the USFWS provided to the Forest the names of listed threatened and endangered species for the Phase II Amendment. These species were identified through informal consultation with the USFWS. The most recent list of species from the USFWS WFO was

received on April 7, 2005. The procedure for obtaining a species list from the USFWS SDFO is to obtain a current list from their websites for listed and candidate species by county. On June 13, 2005, an updated species list was obtained from the SDFO website. The list of threatened or endangered species is provided in Chapter 3, Section 3-3.3.1 Threatened and Endangered Species, and also in the Biological Assessment in Appendix C.

Region 2 Sensitive Species

R2 sensitive species included in the LRMP Phase II Amendment consist of those sensitive species the Regional Forester identified that occur on the Forest. The R2 sensitive species list was revised in May 2005 (FSM 2670 supplement 2600-2005-1, May 17, 2005). Region 2 sensitive species that occur on the Forest are listed in Chapter 3, Section 3-3.3.2 Region 2 Sensitive Species.

Species of Local Concern

The R2 Regional Desk Guide defines SOLC as species that failed to meet the criteria for sensitive status. These could include species with declining trends in only a portion of Region 2, or those that are important components of diversity in a local area. The Forest defined the local area as NFS lands within the Black Hills NF (USDA Forest Service 2003b). To facilitate the management of these native and desired non-native plant and animal species, the Forest developed a list of SOLC separate from the regional sensitive species list.

The effort to develop a comprehensive SOLC list was initiated early in the LRMP amendment process. Forest personnel reviewed native and desired non-native species that occur or are likely to occur in the Black Hills Ecoregion (Black Hills) that were not listed as an R2 sensitive species and were not listed as threatened or endangered species under the ESA. The results and the analysis process employed to identify wildlife and plant SOLC on the Forest are described in detail in the technical report entitled *Process for Identifying Wildlife and Plant Species of Local Concern and Results - Black Hills National Forest Phase II Plan Amendment* (Allen et al. 2005).

In general, species were classified based on occurrence, habitat, population size and trend, and vulnerability to management activities. Whether other agencies had identified a species as one of concern was also considered. Each species was assigned to one of three categories: SOLC, species not of local concern, or insufficient information available.

3. Collect Information on Species At Risk

The Black Hills NF completed conservation assessments for several species (see http://www.fs.fed.us/r2/blackhills/projects/planning/index.shtml to view the assessments). Region 2 has also completed conservation assessments for other species. These documents and other scientific literature were collected and summarized for each species. Information on these species is summarized in the affected environment by species in Chapter 3, Section 3-3.3 Fauna, and in the Biological Assessment and Biological Evaluation in Appendix C.

The affected environment includes consideration of the current ecosystem (boundary, structure, composition, and processes), a historical perspective (including disturbance regimes), and the distribution, abundance, habitat requirements, habitat and population trends, and biology of each species. The affected environment serves as the baseline against which proposed changes (associated with each alternative) were compared.

4. Identify Management Indicator Species

The FSM defines MIS as "…plant and animal species, communities, or special habitats selected for emphasis in planning, and which are monitored during Forest Plan implementation in order to assess the

effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent" (USDA Forest Service 1991). The NFMA requires that MIS be selected as part of the LRMP to estimate the effects of planning alternatives on fish and wildlife populations (Hayward et al. 2001). The complete description of the MIS process and rationale for selection/non-selection is documented in the report entitled *Selection of Management Indicator Species Black Hills National Forest Phase II Plan Amendment* (SAIC 2005).

5. Develop Management Approaches

Management approaches were developed for the 81 Phase II Amendment emphasis species to address the long-term viability of species-at-risk. Emphasis species include (1) species listed as threatened or endangered under the Endangered Species Act (ESA), (2) species the Regional Forester listed as sensitive that occur on the Forest, (3) Forest species of local concern, and (4) species proposed as MIS for the Forest. The complete description of the analysis process of management approaches is described in the report entitled *Management Approaches for Emphasis Species and Biological Elements of Viability Concern Black Hills National Forest Phase II Plan Amendment* (SAIC 2003b).

Habitat relationships, distribution, known and potential risks to long-term persistence or viability, and specific management approaches for all emphasis species (organized by taxonomic group) on the Forest were identified through literature review and consultation. Management approaches were developed based on the best available scientific information and to address the risk factors limiting long-term persistence of each species on the Forest.

These management approaches were not intended to be management direction. When alternatives were developed, the management approaches served as a source of information for Forest-wide objectives, standards and guidelines and Management Area direction.

6. Develop Alternatives

As part of the LRMP Phase II Amendment, the management approaches were considered when developing goals, objectives, standards, guidelines, and ultimately the alternatives in the amended LRMP. Input and comments from Forest ID Team members, cooperating agencies, and the public were also considered during alternative development.

The alternatives differ in both the overall ecosystem management direction that is applied, and the species-specific direction that is incorporated. These two components of conservation planning are referred to as the 'ecosystem approach' and the 'species-specific approach' in the effects analysis. Conceptually, the species-specific approach is applied to species for which the ecosystem approach does not provide adequate assurance of maintaining species persistence. Differences in overall ecosystem approach may result in different sets of species needs that must be addressed through the species-specific approach. The overall design of alternatives generally incorporates different applications of the ecosystem approach. For example, some alternatives rely more heavily on reserves, while others put greater emphasis on management that will restore resources to desired conditions across the Forest.

7. Evaluate Effects on Species Viability

The probability of persistence is examined to assess the status of each species. Factors influencing population fluctuations (survival, recruitment, immigration, emigration) are evaluated in the context of management, species natural history, and ecology. By focusing on persistence probabilities one can

compare alternatives and rank the effects more effectively than is possible using the binary classification reached when using viable and not viable. Using an approach focused on probability of persistence does allow one to make a tie back to viability to meet requirements of effects analysis but provides a better assessment of status with a qualitative or quantitative expression of certainty.

The effects analysis consisted of analyzing effects for each species based on how the goals, objectives, standards, and guidelines for each alternative would change the affected environment or current situation. Specifically, expected changes to species' habitats as a result of an alternative's goals, objectives, standards, and guidelines formed the basis of the effects.

Effects were displayed for each species as a result of the information gathered during the pre-field review, field reconnaissance, and effects analysis. Sources of information included Forest records and files, species conservation assessments, South Dakota Natural Heritage Program database, Wyoming Natural Diversity database, South Dakota Department of Game, Fish and Parks, Wyoming Game and Fish Department, and published research. The Forest also used publications based on other parties' fieldwork conducted in the Black Hills.

The basis for each analysis is potential habitat, expected occurrence, distribution, and effects from Forest activities. The habitat requirements and potential limits to persistence for each species were used to determine the effect of relevant objectives and standards on the probability of long-term persistence of each emphasis species. The habitat trends and risks to persistence on the Forest were estimated based on the adequacy of the Forest Plan direction provided under each alternative. The overall conclusions were derived from anticipated trends, probable risks, and degree of uncertainty under each alternative.

The indirect and cumulative effects analysis for species persistence is generally bounded in time as the next 50 years. This temporal scale is based on: a) the planning horizon (usually 50 years for a forest plan), b) the biology of the species (e.g., generation time, response time to changed conditions, recolonization capability), and c) the time needed for the overall ecosystem to respond to proposed management (Liggett et al. 2003).

The spatial scale for cumulative effects analysis of Phase II Amendment alternatives for species generally encompasses the Black Hills Ecoregion as defined by Bailey (1995). This area was chosen because it encompasses similar ecosystem components and species that occur on the Black Hills NF. A larger area would include the surrounding plains, which includes a vastly different suite of species and ecosystem components. The cumulative effects analysis for fish is bounded in space as the fourth level watersheds that encompass the Forest. This equates to the headwaters of the Belle Fourche and Cheyenne rivers, and their associated tributaries, downstream to the Belle Fourche/Cheyenne River confluence. This bounding was determined because effects to water quality and/or quantity from Forest Service activities may extend downstream of the Forest boundary but become negligible at a downstream point due to the underlying Black Hills geology and the overriding effects of other non-Forest activities at an ever-increasing watershed/geographic scale.

8. Monitor

The primary purpose of monitoring species-at-risk and their habitats is to determine whether management actions need to be modified. Monitoring items are described at the end of Appendix D.

1.2. Migratory Birds Identification Process

Migratory birds were identified for consideration in the LRMP Phase II Amendment. The Birds of Conservation Concern 2002 publication partitions North America into 37 bird conservation regions (BCRs). The Black Hills are included in BCR 17 - Badlands and Prairies; migratory birds occurring

within this region and on the Forest were selected for consideration in the LRMP Phase II Amendment. The effects analysis process for migratory birds on the Forest is described in Section 3 of this appendix.

1.3. Demand Species Identification Process

In addition to emphasis species and migratory birds, the following demand species were identified for the LRMP Phase II Amendment: elk, mule deer, trout (brook, brown, and rainbow), and wild turkey (Merriam's). The Forest identified demand species due to the high public interest in these game species for wildlife viewing and for hunting and fishing opportunities. The effects analysis process for demand species is described in Section 3 of this appendix.

1.4. Research Natural Areas Analysis Process

The Region 2 RNA program has two goals (USDA Forest Service 1997a). The first goal is to ensure that selected RNAs represent most elements of the ecological diversity of National Forest and Grasslands within an Ecoregion as described by Bailey (1995). The second goal is to select RNAs in areas where human impacts (since settlement) and conflicts with existing land uses (recreation, mining, livestock grazing, and timber harvest) are limited.

The five main purposes of RNAs are as follows:

1. To provide representative areas of the natural variability of targeted plant series.
2. To serve as baseline or reference areas for management-activity effects analysis; restoration-needs identification; and long-term ecological change measurement.
3. To provide non-manipulative research areas and to serve as controls for manipulative research.
4. To serve educational purposes.
5. To conserve elements of biodiversity such as sensitive species and limited plant community types.

Specific objectives and criteria were developed to evaluate areas for inclusion in the national RNA network listed for the Forest and are specified in SAIC's "Addendum to: Final-Screening and Rationale for Areas Considered for Evaluation as Research Natural Areas" dated January 17, 2003 (SAIC 2003d) and "Screening and Rationale for Areas Considered for Evaluation as Research Natural Areas" revised November 15, 2002 (SAIC 2002a), and in the Summary and Updates of Candidates RNAs Black Hills Phase 2 (USDA Forest Service 2005g) which, includes updated information, site specific public comments, items that are likely to change if designation takes place and the Forest recommendations.

R2 and the Forest targeted the following five plant series for inclusion in the RNA evaluation and screening process (USDA Forest Service 1993):

1. Forest Series: Ponderosa pine and white spruce (R2 targeted).
2. Shrubland Series: Mountain mahogany and skunkbrush (R2 targeted).
3. Wetland and Riparian Series: Montane willow (R2 targeted).
4. Plains Wetland and Riparian Series: Eastern hop-hornbeam, riparian grasslands, and bur oak (R2 targeted).
5. Mountain and Foothills Grassland Series: Montane grasslands (Forest targeted and described in Marriott et al. 1999).

Three criteria initiated selection of these five specific plant series as targeted types within the Forest: their occurrence in the Black Hills; the plant species' unique community associations in the Black Hills; and their natural variability representation found in R2 as well as the ecological diversity found in the Black Hills.

It is important to note that each of the plant series listed above can include numerous plant associations. Though other plant series and associations occur in the Black Hills, a number were not targeted for evaluation under the Forest RNA screening process because they are either better represented or well-represented in other National Forests, National Grasslands, or on other federal or state lands (USDA Forest Service 1993). For example, the plains cottonwood association is represented at the Devils Tower National Monument, Wind Cave National Park, and (Marriott et al. 1999) and at the proposed RNA Antelope Creek in the Thunder Basin National Grassland (USDA Forest Service 2001d). Green ash-elm/wolfberry associations can be found at Custer State Park and at the Devils Tower National Monument (Marriott et al. 1999). Although bur oak in its tree form does occur on the Forest, it is well represented along the Belle Fourche River in the Devils Tower National Monument. Bur oak in its shrub form was selected for representation on the Forest. Paper birch/beaked hazel was not targeted by R2 but is an important plant series in the Black Hills and is already represented at the Upper Pine Creek RNA. Needle-and-thread, little bluestem, and prairie dropseed are found in grassland associations already well-represented at Devils Tower National Monument; Wind Cave National Park; Jewel Cave National Monument (Marriott et al. 1999); proposed RNA sites at Antelope and Rock Creeks; at Wildlife Draw in the Thunder Basin National Grassland; South and Steer Pastures in the Buffalo Gap National Grassland; and at the proposed RNA Mallard South site in the Fort Pierre National Grassland (USDA Forest Service 2001d).

Riparian grasslands occur as emergent wetlands on the Forest. The specific plant associations originally targeted by R2 for this series were updated with the results from a more comprehensive survey and classification completed by Marriott et al. (1999). The salt-flat series was also originally targeted by R2 (USDA Forest Service 1993) for representation on the Forest; however, the plant associations that make up this series primarily occur on the plains and are not found on the Forest. According to Marriott and Faber-Langendoen (2000b), most of the potential habitat for saline grasslands occurs outside of Forest lands.

The process for potential candidate RNA screening and evaluation generally followed two sets of guidelines: Draft Guidelines for RNA Analysis by National Forest within the Rocky Mountain Region (USDA Forest Service 1997b) and Research natural areas: Draft guidelines for RNA selection on the Black Hills National Forest (USDA Forest Service no date[c]) The entire process is detailed in the Screening and Rationale for Areas Considered for Evaluation as Research Natural Areas (SAIC 2002a). The Forest RNA evaluation and screening process used information gathered from available sources, including ranger districts and the forest supervisor's office; R2 and the Rocky Mountain Research Station; Wyoming and South Dakota Natural Heritage Programs; and conservation organizations, academia, and public scoping (SAIC 2002a).

The candidate RNA selection generally consisted of a six-step process with three interim steps (2a, 4a, and 5a) and a final review to recommend the proposed candidates for the Final EIS. In Step 1, all potential candidate RNA areas were identified. Steps 2 and 3 consisted of a conflict analysis using a geographic information system (GIS) database. Potential conflict areas used in screening Steps 2 and 2a included roads; utility corridors; weeds; proximity to private land; size; and proximity to active mining claims. Step 3 displayed and evaluated the potential for conflict with oil-and-gas leasing; grazing allotments; and active mining claims as well as the potential for synergy with research monitoring sites for areas surviving Step 2a screening. Step 4 used Ranger District and Forest Supervisors Office staff local knowledge to

screen out potential candidate RNA sites. Step 4a involved consulting Hollis Marriott, a well-known Black Hills botanist. In Step 5, remaining sites were evaluated in the field for site condition, defensibility, quality, and viability. In Step 5a, the candidate RNAs identified in Step 5 were characterized as to their suitability as RNAs, and the sites' type and quality of the targeted plant communities were evaluated. In Step 6, the Forest reviewed the sites identified in Steps 5 and 5a to optimize site boundaries and review other management considerations. The final review looked at any new and corrected information and worked to alleviate any conflicts (USDA Forest Service 2005g).

In all 121 areas of NFS land, totaling 247,000 acres were carefully reviewed in the elaborate process described above. Nine areas were selected as candidates for additional review in the draft and final environmental impact statements.

1.5. Science Consultation

The Forest conducted a science review of key issues in the Phase II DEIS using a panel of scientists assembled by the US Forest Service Rocky Mountain Research Station. Panel members were asked to review sections of the Draft EIS and address a set of focused questions. The review included the following topics: disturbance ecology, American dipper, American marten, northern goshawk, bloodroot, northern leopard frog, black-backed woodpecker, land snail, mountain sucker, and were invited to review other portions of the analysis to gain a better understanding of the analysis.

The results of the science consultation can be found in the Phase II Administrative Record titled "Science Consistency Consultation – Black Hills National Forest, Phase II Amendment."

2.0. Forest Analysis Process

2.1. Vegetative Activity Estimates By Alternative

A key factor used in the effects analysis is the estimated treatment acres for each of the alternatives. These acres do not represent the decision to be made but reflect a relative comparison of alternatives using the 1997 Forest Plan and Phase II alternative Forest Plan direction (see Appendix D). The estimated treatment acres to implement the given alternative in about a 10-15 year period are as follows:

Table B-1. Estimated Annual Treatment Acres by Alternative to Meet Objectives

Treatment Type	Alternative 1 (No Action 1997 Revised LRMP)	Alternative 2 (No Action Phase I Amendment)	Alternative 3 (Diversity Across the Landscape)	Alternative 4 (Phase I with Additional Mature Forest)	Alternative 6 (Reduced Fire and Insect Hazard)
Annual Estimated Commercial Sale Acres [1]	25,900	15,600	25,900	20,400	25,900
Hardwood Restoration Acres [2]	500	500	5,000	1,000	5,000
Riparian Restoration Acres [3]	50	50	100	50	50
Grassland Restoration Acres [4]	1,040	1,040	1,200	1,040	1,200
Meadow Restoration Acres [5]	10	10	240	10	240
Prescribed Burn Acres [6]	8,000	8,000	4,000	2,000	12,000
Precommercial Thinning Acres [6]	5,400	5,400	15,000	10,000	30,000
Pol Thinning Acres [6, 7]	2,000	1,200	2,000	1,600	2,000
Total	42,900	31,700	53,440	36,200	76,390
Forested Land Treatment [8]	~34,000	~23,000	~41,000	~28,000	~53,000

[1] Commercial harvest acres are based on estimated timber sale volume (see timber volume estimates worksheet) by alternative. Due to the standards and guidelines in Alternatives 2 and 4 less volume is obtained from these Alternatives (see Estimated Timber Volume discussion below)

[2] See Forest-wide Objective 201 in Appendix D

[3] See Forest-wide Objective 214 in Appendix D

[4] See Forest-wide Objective 205 in Appendix D

[5] See Forest-wide Objective 205 in Appendix D

[6] See Forest-wide Objectives 10-01, 10-04, and 10-08 in Appendix D. For Alternative 6, these represent the estimated treatment needed to meet fire hazard and structural stage objectives given existing database information and the AWRP analysis

[7] POL thinning and POL acres treated on the Black Hills NF are a function of sawtimber harvesting, as POL volume is taken as incidental volume as part of sawtimber sales. For Alternatives 1, 3, and 6, POL sale volume is taken from the 1997 Forest Plan timber objective for POL because sawtimber sales are estimated to be at 1997 Forest Plan objectives levels. Estimated sawtimber sale volume for Alternatives 2 and 4 is less than 1997 Forest Plan objectives levels, and POL volume was reduced proportionately to match those estimates

[8] "Forested land treatment" – an estimate of forest-land acreage treated to reduce fire hazard for relative comparison of alternatives and to compare to disturbance that occurred prior to settlement (Final EIS Section 3-7.1.4). Acres = commercial sale acres, hardwood restoration, and one-half the thinning, POL and prescribed burning acres (roughly about half of these treatments are within commercial sale areas and half outside)

Table B-2. Estimated Structural Stages by Alternative

Structural Stages	Ponderosa Pine Acres					
	Existing	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 6
1	120,000	N/A	N/A	59,000	N/A	59,000
2	20,000	N/A	N/A	46,000	N/A	46,000
3A	55,000	N/A	N/A	100,000	N/A	100,000
3B	71,000	N/A	N/A	103,000	N/A	147,000
3C	42,000	N/A	N/A	49,000	N/A	49,000
4A	290,000	N/A	N/A	241,000	N/A	248,000
4B	302,000	N/A	N/A	275,000	N/A	268,000
4C	133,000	N/A	N/A	118,000	133,000	74,000
5	3,000	52,000	52,000	45,000	52,000	45,000
Total	1,036,000			1,036,000		1,036,000
4 (tree size=very large)	72,000	N/A	N/A	N/A	N/A	55,000
Total w/ Large Trees	75,000	52,000	52,000	52,000	52,000	101,000

N/A = No Objective in the alternative for this structural stage
All acreage figures are for ponderosa pine only
Existing acres are Forest-wide acreage, from Forest Rocky Mountain Resource Information (RMRIS) database.
Alternatives 1, 2 and 4 are Forest-wide acreages, based on attaining Objective 207
Alternatives 3 and 6 are acreages in Management Areas 4.1, 5.1, 5.4, 5.43, 5.6 based on attaining Objectives 4.1-203, 5.1-204, 5.4-206, 5.43-204, and 5.6-204. Assumes other management areas will remain similar to existing conditions
Structural stage 4 (tree size=very large) is a subset (10 percent in Alternative 6) of structural stages 4A, 4B and 4C in MA 4.1, 5.1, 5.4, 5.43, and 5.6
Structural stage 4 (tree size=very large) is defined as a stand where the majority of tree stocking based on basal area is in live trees 9-inch diameter and larger, and within that group, the majority of the basal area is in live trees 16-inch and larger in diameter
Total with large trees is the sum of structural stages 4 (tree size=very large) and 5
The time needed to reach the above objectives is dependent on funding and forest growth rates, which are not included in this analysis. As a result, it may take two or more decades to achieve the above objectives

2.1.1. Estimated Timber Volumes for the Phase II Final EIS

For comparison purposes in the economic section of Chapter 3 the effect of alternative direction on timber sale volume was estimated to evaluate the risk to local timber industry from the various Phase II alternatives. Alternative goals, objectives, standards, and guidelines may influence the volume that can eventually be sold in a decade and can affect local jobs and income.

The allowable sale quantity (ASQ) was not analyzed. There is no analysis of land suitability, growth and yield projections, modeling of land management constraints and spatial distribution. ASQ and/or long-term sustained yield would be reviewed for the next forest plan revision.

Therefore, all Phase II Final EIS alternatives have the same ASQ. However, due to the different alternative goals, objectives, standards, and guidelines (alternative forest plan direction) the estimated volume output for each alternative may be different. Alternative timber sale volume was estimated based on the differences in alternative forest plan direction.

Following are estimated sawtimber sale volumes, which could be expected for relative comparison of the alternatives.

Table B-3a. Estimated Sawtimber Sale Volume by Alternative

Estimated	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 6
Annual Sawtimber Sale Volume (MMCF)	18.1	10.9	18.1	14.3	18.1

Table B-3b. Estimated Annual Acres of Sawtimber

Estimated	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 6
Annual Timber Sale Sawtimber Acres	25,900	15,600	25,900	20,400	25,900

The rationale for the different alternative timber sale volume estimates is as follows:

2.1.1.1. Alternative 1

The 1997 Forest Plan Final EIS displayed full funding for this alternative at 18.1 mmcf. Alternative 1 has both green tree retention (see Phase II FEIS Appendix D Forest-wide standard and guideline 3201) and habitat effectiveness index (HABCAP) standards (see Phase II FEIS Appendix D Management area standards and guidelines 3.31-3202, 3.32-3202, 4.1-3201, 5.1-3201, 5.1A-3201, 5.2A-3201, 5.4-3203, 5.4A-3202, 5.43-3202, 5.6-3202, and 8.2-3203). Green tree retention is not a binding constraint in Alternative 1 because the snag standard is only 1.08 snags per acre which the Forest easily meets. In recent years, most of the volume has come from commercial thins (over half). Only about 25 percent has come from shelterwood and only 10 percent of shelterwood volume has come from overstory removal. The resulting 2.5-percent reduction can be made up in other areas of the timber sale program and is not a significant impact on Alternative 1 sale volume. The types of wildlife constraints in Alternative 1 don't constrain thinning and much of the commercial treatments proposed in Alternatives 3 and 6 can also be done in Alternative 1. Therefore, the timber volumes in Alternatives 1, 3 and 6 are estimated to be equal. The 1997 Forest Plan timber sale objectives can be met.

2.1.1.2. Alternative 2

Alternative 2 has both green tree retention and HABCAP. The timber volume in Alternative 2 is estimated to be 40 percent less than in Alternatives 1, 3, and 6. Wildlife constraints preclude overstory removals (about 10 percent of volume), and project reviews have shown an additional 30-percent reduction in volume due to reduced levels of thinning and retention of green trees for snag replacements.

2.1.1.3. Alternative 3

Alternative 3 has an estimated timber sale volume the same as Alternative 1. Alternative 3 has no green tree retention nor HABCAP standards. The vegetation treatment objectives for fire hazard reduction, hardwood restoration, and reductions in structural stage (SS) 4C will result in some sawtimber volume. The 1997 Forest Plan timber sale objectives can be met.

2.1.1.4. Alternative 4

Alternative 4 does not have HABCAP standards but it does have the green tree retention standard that reduces sale volume by 30 percent. Alternative 4 has an objective to manage for a 50 percent low-to-moderate fire hazard around at-risk communities (ARCs). The ARC area is estimated to contain 118,756 acres of which 70 percent is currently in a high fire hazard condition. Twenty percent of the ARC acres would have to be treated to move from a high-to-moderate fire hazard with a timber yield of 700 cf per acre, for an additional 10-year average annual sale volume of 1.7 MMCF.

2.1.1.5. Alternative 6

Alternative 6 has no green tree retention or HABCAP standards that would tend to reduce harvest levels, and it has vegetation treatment objectives for fire-hazard reduction, hardwood restoration, and reductions in SS4C that could tend to increase harvest levels to meet objectives. The 1997 Forest Plan timber sale objectives can be met.

2.1.2. Alternative Estimates for Products Other than Logs

Products other than logs (POL) thinning and POL acres treated on the Black Hills NF are a function of sawtimber harvesting, as POL volume is taken as incidental volume as part of sawtimber sales. For Alternatives 1, 3, and 6, POL volume and acres treated are taken from the 1997 Forest Plan timber objective for POL because sawtimber sales are estimated to be at 1997 Forest Plan objectives levels. Estimated sawtimber sale volume for Alternatives 2 and 4 is less than 1997 Forest Plan objectives levels, and POL volume treated were reduced proportionally to match those estimates. Note: Fiscal Year 2004 POL ~1.7 mmcf (source: PTSAR).

Table B-3c. Estimated Products Other than Logs Volume

Estimated	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 6
Annual Timber POL Volume (MMCF)	2.1	1.3	2.1	1.7	2.1

The alternative volume estimates discussed above were determined from observations of forest inventory, historical volume yields, and growth and yield (Forest Vegetation Simulator - FVS) processing discussed below.

The following discussion was taken from the Executive Summary of the document entitled ***Construction of Vegetation Yield Profiles for the Black Hills National Forest*** (USDA Forest Service 2004d). Forecasting vegetation structure through time had to follow a logical progression of events. A forest land classification was devised to establish stand types for projecting. Stand types are homogeneous land units with respect to their physical, vegetative, and developmental characteristics. Inventory data were assembled to represent the assortment of stand types. Estimates derived from a vegetation simulation model were adjusted in accordance with observed information. Special considerations were made regarding regeneration and mortality components. Silvicultural prescriptions were formulated to represent proposed management strategies. Vegetation yield profiles were prepared for input into the Forest planning model. The FVS, a suite of computer programs that supports vegetation decision efforts, was the principle tool used to develop the yield profiles for the LRMP Phase II Amendment. Stand types were the primary unit for describing the vegetation resource on the Forest. Stand-type attributes were overstory-cover type, size class, multiple vegetation layers, crown density, site productivity, and understory component. In all, 47 different forest strata or stand types were identified. These formed the

basic building blocks for the vegetative yield profiles. Inventory sources to represent the various stand types included data sets assembled for the 1997 Revised LRMP. Additionally, Forest Inventory Analysis (FIA) measurements from 1999 and 2001 were incorporated into the data pool. In all, 647 sample units were used in the analysis. The plot/stand count breakout was as follows:

- 241 plots - 1986 Stage I Inventory
- 182 stands - 1995 Stage II Inventory
- 190 plots - 1999 FIA Measurement
- 34 plots - 2001 FIA Measurement

Use of the *Pre-Suppose* program facilitated data querying of the stand types. *Pre-Suppose* produced links to the FVS model. Model calibration involved a concerted effort to ensure that modeled estimates of stand development closely matched measured values. Baseline trends of the raw inventory data were graphed using the MS-Excel spreadsheet program. Scatter plots for the following y-axis attributes were charted: trees per acre, basal area per acre, cubic-foot volume per acre, and board-foot volume per acre. The x-axis arrayed computed stand age for each inventory sample, allowing upper-capacity stand development over age inferences. FVS projected each plot or stand for a 150-year time period and then overlaid the scatter plots of measured data points. FVS has a self-calibrating feature that captures the individual plot's site characteristics and subsequently modifies the embedded regional growth functions. The ability to develop mean-scale factors for non-calibrating plots also helped refine modeled results. Natural growth runs examined two stand-development elements that still needed to be addressed following FVS model calibration: regeneration inputs and mortality outputs. Regeneration imputation files were constructed for the stand types using the *Repute* program. This application investigates measured values for the seedling/sapling component to imply expected occurrence. These observations can then be input at the proper time to replenish the understory. Mortality effects were also adjusted. FVS does not automatically assume tree mortality at a given age. Tree size is used as a proxy for attainable age. Examination of measured data renders appropriate values. Finally, modeled mortality impacts through the stand profile needed to match measured values. These tendencies were obtained using the FixMort keyword. FVS modeled silvicultural prescriptions. Keyword file sets were constructed for the following systems: natural growth, shelterwood, seed-tree, clear-cut, group selection, aspen preference, oak preference, individual tree selection, WUI, and perpetual thinning. For even-aged silvicultural systems, existing stand types were grown through rotation age. Second growth or regenerated stand profiles were then produced. For uneven-aged treatments, cutting cycles dictated the entry interval. For both even- and uneven-aged prescriptions, the planning period was 150 years. Accounting variables residing in the yield profiles included classic forest metrics such as trees per acre, average diameter, average height, basal area per acre, cubic volume per acre, and board volume per acre. Live tree, harvest tree, and mortality tree components were tracked per these attributes. In addition, several classification variables were computed, including overstory cover type, understory component, habitat structural stage, mountain pine beetle (MPB) hazard, snag counts, and fire hazard.

The *Spray* program produced upwards of 700 vegetative yield profiles containing 300 columns of accounting variables for the LRMP Phase II Amendment. Additionally, the YEP and YIP computer programs were developed to post-process the base-yield profiles to extend coverage of the stand-age range from zero to 300 years. These resultant column delimited files were made available for the FVS to guide vegetation development for management strategies.

2.2. Forest Vegetation

Selected accounting variables from FVS were used to track forest vegetation. The prime variable is habitat structural stage. Fire-and-insect hazard ratings are assigned to structural stages. The habitat-structural-stage-classification scheme is part of the regional database. Reference the 1997 Forest Plan Chapter III and Glossary for definition. Structural stage categorizes the Forest-stand structure into a coding scheme that can be used as a linkage to addressing desired species habitat. The fire-hazard rating used variables that calculate ratings for a torching index and a crowning index. These variables are used in FVS growth and yield software calculating a fire hazard. (Reference *Construction of Vegetative Yield Profiles for the Black Hills National Forest Phase II Amendment* by Don Vandendriesche, Forest Service Washington Office.) Evaluation of selected FVS strata determined a fire-hazard rating based on structural stage. The fire-hazard rating linked to structural stage measured the changes in fire hazard from different treatment types. The insect-hazard rating used variables from the corporate RMRIS database and was supported by research to calculate ratings. These ratings were linked to structural-stage codes. Structural stages for the mature timber categories were divided further into quadratic mean diameter of less than and greater than nine inches diameter at breast height (dbh).

Each alternative started with existing inventory from the year 2004 RMRIS database. See **Table B-4** for vegetation categories.

Table B-4. Forest Vegetation Types

Forest Vegetation Types	Acres
No Cover Type	50
Grassland	110,000
Non Forested	4,000
Shrubland	5,000
Aspen	47,000
Bur Oak	12,000
Douglas Fir	50
Lodgepole Pine	100
Other Hardwoods	1,000
Paper Birch	3,000
Ponderosa Pine	1,036,000
Rocky Mtn Juniper	300
White Spruce	25,000
Water	2,000

All forested polygons have structural stage calculated according to the R2 RMRIS scheme except SS5, which is calculated using FVS. T**able B-5** shows the key variables of structural stage, fire hazard, and insect risk.

Table B-5. Key Variables Of Structural Stage, Fire Hazard And Insect Hazard

Structural Stages	Fire Hazard	Rating	Insect Hazard	Rating
1	Low	1	Low	1
2	Medium	2	Low	1
3A	Medium	2	Low	1
3B	High	3	Medium	3
3C	Very High	4	High	5
4A>9”	Medium	2	Medium	3
4A<9”	Very High	4	Medium	3
4B>9”	High	3	High	5
4B<9”	Very High	4	High	5
4C>9”	Very High	4	High	5
4C<9”	Very High	4	High	5
5	Very High	4	High	5

2.3. At-risk Communities and Wildland-urban Interface

The Phase II Amendment process used the current definition of ARC from the Federal Register (66 FR 43384, August 17, 2001). This list is subject to future revision by the States of Wyoming and South Dakota. The Healthy Forest Restoration Act (HFRA) of 2003 glossary defines wildland-urban interface (WUI) (see Appendix E Glossary). While WUI is expressly defined in the HFRA, for Phase II planning purposes the WUI is assumed to be 1.5 miles from ARCs for all alternatives. Alternative 6 also includes an additional WUI zone of 300 feet from all non-federal lands to partially or wholly include private structures, developments, and other values not currently considered as an ARC and not included within the 1.5-mile WUI. While some non-federal land does not currently contain structural improvements, analysts considered probable building of structures on this land, sometime within the life of the amendment, and that there are other values (e.g., forage, fences, aesthetics, and water) on these lands that warrant protection. The 1.5-mile and 300-foot areas are for Phase II planning purposes only and provide a reasonable geographic representation and acreage for environmental analysis at the Forest level. Actual boundaries will be determined during project planning or in community wildfire protection plans. For Phase II analysis purposes the acres of NFS land within the WUI are listed in **Table B-6a.** The current ARCs and 300-foot WUI map is displayed in Appendix G.

Table B-6a. Estimated Wildland-Urban Interface (WUI) Acres 1

WUI Areas	Estimated Acres Rounded to Nearest 100 Acres
ARC General Acres	108,300
ARC Botanical Area Acres	400
ARC Late-successional Management Area Acres	6,800
ARC Norbeck Management Area Acres	2,100
ARC Peter Norbeck Scenic Byway Management Area Acres	400
ARC Research Natural Area Acres	300
ARC Wilderness Acres	500
Total ARC Acres	118,800
300 Foot WUI General Acres	99,400
300 Foot WUI Botanical Area Acres	300
300 Foot WUI Late Successional Management Area Acres	800
300 Foot WUI Norbeck Management Area Acres	1,100
300 Foot WUI Peter Norbeck Scenic Byway Management Area Acres	100
300 Foot WUI Research Natural Area Acres [2]	0
300 Foot WUI Wilderness Acres	300
Total 300 Foot WUI Acres	102,000
Total WUI Acres	220,800

[1] Source – Administrative record spreadsheet "frq_firehaz_rating.xls"
[2] All acres are within the Canyon City Candidate Research Natural Area.

The itemized acres in **Table B-6a** are important because some management areas will limit how fire-and-insect hazard reduction treatments are conducted, or prevent them altogether. Fire-and-insect hazard reduction management in late-successional management areas (see Management 3.7 direction in Appendix D) must be done while meeting late-successional objectives. Treatments in the Norbeck management areas are legislated to be for purposes other than fire-and-insect hazard (see Management Area 4.2 B, 5.4A in Appendix D), but fire-and-insect hazard reductions may be a secondary management benefit. Botanical area, research natural area, and Wilderness area direction prevent fire-and-insect vegetation management.

Table B-6b. Black Hills Area At-risk Communities*

Aladdin	Doty	New Haven
Alva	Elmore	Newcastle
Argyle	Englewood	Piedmont
Black Buttes	Erskine	Potato Creek
Blackhawk	Ferguson Canyon	Pringle
Boulder Park	Galena	Rapid City
Box Elder	Hayward	Rochford
Breakneck	Hermosa	Rockerville
Buckhorn	Hill City	Sand Creek
Cascade Springs	Hisega	Savoy
Central City	Hot Springs	Silver City
Cheyenne Crossing	Hulett	Spearfish
Custer	Johnson Siding	Sturgis, SD
Custer Highlands	Keystone	Sundance
Deadwood	Lead	Tilford
Deerfield	Maitland	Upton
Devils Tower	Maurice	Whispering Pines
Devils Tower V.C.	Minnekahta	Whitewood
Dewey	Nemo	

*At-risk communities in the Black Hills area (66 FR 43384) as of 7/15/2005. The list is subject to change as communities add or delete themselves from this list.

2.3.1. Fire Hazard Ratings

The Phase II Forest Plan Amendment utilized FVS. Chapter 3 of the Final EIS Affected Environment and Consequences addresses fire.

Fire hazard was estimated using the Fire and Fuels Extension for the Forest Vegetation Simulator (FFE-FVS) and the *torching* (TI) and *crowning* (CI) indices. The TI and CI values obtained from FFE-FVS were used to assign a crown-fire hazard rating of *low, moderate, high, very high or extreme* for each stratum. The fire-hazard rating increases as the amount and continuity of surface and canopy fuels increases. As the amount of fuel on a given landscape increases and fuel profiles become more horizontally and vertically continuous, the intensity of a wildfire in that landscape is expected to increase. Stands with low CI and TI are the least susceptible to crown-fire initiation and spread. Areas with an *extreme* fire-hazard rating (5) have the potential to exhibit more extreme fire behavior with more severe effects than those with a *low* hazard rating (1). Omi and Martinson (2002) found that the correlation between crown-fire hazard and fire severity is generally good.

The Phase II analysis used two crown-fire potential indices that do not rely on extensive climatology as developed by Scott and Reinhardt (2001). The indices use the critical open-wind speeds for crown-fire initiation and active spread as stand (strata) specific indicators of crown-fire hazard. They are the torching and crowning indexes. Although the critical open-wind speeds are used as the indices, the site conditions (surface and canopy fuels, slope, etc.) and not the weather are being rated (Scott and Reinhardt 2001).

The torching index (TI) is the 20-foot wind speed at which crown fire is expected to initiate based on Rothermel's (1972) surface-fire model and Van Wagner's (1977) crown-fire-initiation criteria. The TI is a function of surface-fuel characteristics (fuel model); surface-fuel-moisture contents; foliar-moisture content; canopy-base height; slope steepness; and canopy wind reduction. Lower TI values indicate higher susceptibility to crown-fire initiation.

The CI is the 20-foot wind speed at which active crowning is possible, based on Rothermel's (1991a) crown-fire-spread-rate model and VanWagner's (1977) criterion for active-crown-fire spread. CI is a function of canopy-bulk density, slope steepness, and surface-fuel-moisture content. Lower CI values indicate higher susceptibility to crown-fire spread.

At wind speeds less than TI, a surface fire is expected as indicated in **Table B-7**. If the wind speed is greater than TI but less than CI, analysts expect a passive crown fire. Finally, wind speeds greater than CI result in active crown fire.

Table B-7. Classification of Fire Types Using Torching and Crowning Indices in FFE-FVS (Reinhardt and Crookston 2003)

	TI < Wind Speed	TI > Wind Speed
CI > Wind Speed	Passive crown fire	Surface fire
CI < Wind Speed	Active crown Fire	

The Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) (Reinhardt and Crookston 2003) was used to simulate stand vegetation and fuel dynamics and the effects of treatment regimes, calculate the canopy-fuel-profile characteristic, and then simulate fire behavior to assess the relative fire potential in the strata through time. Outputs produced included TI and CI. The fire behavior was simulated with very dry fuel conditions and moderate winds, which are an approximation of severe fire-weather conditions.

The TI and CI values obtained from FFE-FVS were used to assess the relative fire hazard between stands/strata using the model depicted in Figure B-1 (Langowski and Twombley 2000). The model provides a crown-fire-hazard rating for each stratum. Stands/strata with low CI and TI are the most susceptible to crown-fire initiation and spread. The Fire Hazard ratings from representative FVS strata were used in the analysis to predict relative hazard by alternative. (Refer to Construction of Vegetative Yield Profiles for the Black Hills National Forest Phase II Amendment February 2004 by D.Vandendriesche – Washington Office.)

Figure B-1. Relative Fire Hazard

TI / CI	Low (0-15 mph)	Moderate (16-39 mph)	High (40+ mph)
Low (0-15 mph)	Extreme (5)	Very High (4)	Moderate (2)
Moderate (16-39 mph)	Very High (4)	High (3)	Moderate (2)
High (40+ mph)	High (3)	Moderate (2)	Low (1)

The fire-hazard rating increases as the amount and continuity of surface and canopy fuels increase. As fuel amounts on a given landscape increase and fuel profiles become more horizontally and vertically continuous, wildfire intensity in that landscape is expected to increase. Areas with a high fire-hazard rating (Extreme – 5) have the potential to exhibit more extreme fire behavior with more severe effects than those with a low-hazard rating (Low – 1). Omi and Martinson (2002) found that the correlation between crown-fire hazard and fire severity is generally good.

2.3.2. PROBACRE

2.3.2.1. Acres Burned by Wildfire

Calculating an exact number of acres burned by wildfire in the future is difficult to predict. This is primarily due to annual variation in ignition sources and the flammability of fuels, which in part is a function of climate.

In an effort to predict the number of acres that will be burned in the future, over a decade; the fire probability analysis program *PROBACRE* (Wiitala, 1999a) was utilized. This program will assess the risk of catastrophic consequences from a single or series of wildfire events. *PROBACRE* calculates the probability of a major single event, or multiple fire events, and the long-term probability that a combination of fire events, both large and small, would result in a total burned area in excess of a particular (user specified) number. All probabilities are calculated from information on annual frequency of fires by size class.

For a given area *PROBACRE* computes the probability that burned acres will exceed some threshold over a period of time based on both annual fire frequency and average acres burned by fire-size class. Frequencies are expressed relative to the entire protection area being considered. Threshold probabilities are derived from the Poisson probability model. For the requested period, probabilities are computed and summed for all combinations of fires by size and number that are less than or equal to the threshold. This aggregate probability is subtracted from one to give the probability of exceeding the acreage threshold.

There are two cautions within which the analysis should be viewed (Wiitala, 1999b):

1. The degree to which historic frequency and size data will represent conditions in the future, and
2. Severity, duration and magnitude of events are not reflected in the analysis and the results cannot be used to assess the risk of adverse outcomes other than in a qualitative/relative manner.

2.3.2.2. PROBACRE Inputs

The inputs require an analysis of the historical fire records to determine annual fire probability by size class. The historical fire records (Forest Service 5100-29 Fire Report) are obtained from the National Interagency Fire Management Information Database stored on the web server at the USDA National Information Technology Center (NITC). Fire records are processed in PCHA (Personal Computer Historic Analysis) and spreadsheet (BKF_fire_occurrence_1970-2003.xls).

User defined inputs for *PROBACRE* are:

- Number of fire-size classes
- Mean fire size for each class
- Annual fire occurrence for each class
- Analysis projection period
- Acreage thresholds

Table B-8. Black Hills NF Historical Fire Occurrence

Analysis Period: 1970-2003					
Class	**Size (acres)**	**Annual Number of Fires**	**Annual Number of Acres**	**Percent of Fires**	**Percent of Acres**
A	0 - 0.25	85.59	9.15	62.4	0.1
B	0.25 - 10	46.76	77.21	34.1	0.9
C	10.0 - 99	3.41	108.26	2.5	1.3
D	100 - 299	0.50	89.82	0.4	1.1
E	300 - 999	0.32	215.24	0.2	2.6
F	1000 - 4999	0.29	719.38	0.2	8.7
G	5000+	0.38	7,055.50	0.3	85.3
Total/Mean		137.26	8,274.56		

Mean fire size was calculated and is used as the fire size for the class for the analysis. Fire Size Classes A, B and C were combined for the analysis as these small fires usually are not the major events of significance and software limitations (processing capabilities).

Table B-9. Fire Size Class for Analysis

PROBACRE Analysis Classes	1	2	3	4	5
Size	0-99	100-299	300-999	1,000-4999	5,000+
Number of Fires	4,616	17	11	10	13
Number of Acres	6,617	3,054	7,318	24,459	239,887
Mean Fire	1.43	179.65	665.27	2,445.90	18,452.85
Annual Number of Fires	135.76	0.50	0.32	0.29	0.38
Annual Number of Acres	194.62	89.82	215.24	719.38	7,055.50

Table B-10. Summary Fire Size and Frequency Inputs

FMZ ALL	Forest Totals Analysis Period: 1970 to 2003				
Class	Class Limit	Mean Size	Annual Number of Fires	Annual Number of Acres	Size Class
1	0 – 99	1.43	135.76	194.62	A, B, C
2	100 – 299	179.65	0.50	89.82	D
3	300 – 999	665.27	0.32	215.24	E
4	1,000 – 4,999	2,445.90	0.29	719.38	F
5	5,000 +	18452.85	0.38	7,055.50	G
Total			137.25	8,274.56	

The PROBACRE analysis period selected was 10 years, which corresponds with the displays of vegetation change in the Draft EIS. The cumulative burned acreage threshold levels established for the analysis are shown in the table below. The probability analysis was completed for the Forest as a whole. Output from the analysis is summarized below.

2.3.2.3. PROBACRE Results

As indicated in **Table B-11**, during a 10-year period within the Forest, the probability that cumulatively fires will burn more than 25,000 acres is almost 100 percent. The probability of burning more than 50,000 acres is approximately 78 percent. For a threshold greater than 100,000 acres the probability is about 30 percent, and for fires to cumulatively exceed 150,000 acres, the probability is less than 5 percent. The probability of fires burning more than 200,000 acres is less than 1 percentage.

Table B-11. FMZ All Forest Total

Size Class	Fire Frequency		Probability Of Number Of Fires Per Period					
	Annual	Period	None	1	2	3	4	>4
0 - 99	135.76	1,357.60	0.000000	0.000000	0.000000	0.000000	0.000000	1.0000
100 – 299	0.50	5.00	0.006738	0.033690	0.084224	0.140374	0.175467	0.5595
300 – 999	0.32	3.20	0.040762	0.130439	0.208702	0.222616	0.178093	0.2194
1000 – 4999	0.29	2.90	0.055023	0.159567	0.231373	0.223660	0.162154	0.1682
5000 +	0.38	3.80	0.022371	0.085009	0.161517	0.204588	0.194359	0.3322

Probability of Acres Burned Exceeding Thresholds in Decade 1					
Probability Of Exceeding	5,000	Acre Threshold In	10	Years Is	0.99893
Probability Of Exceeding	10,000	Acre Threshold In	10	Years Is	0.99110
Probability Of Exceeding	25,000	Acre Threshold In	10	Years Is	0.96725
Probability Of Exceeding	50,000	Acre Threshold In	10	Years Is	0.78454
Probability Of Exceeding	100,000	Acre Threshold In	10	Years Is	0.30358
Probability Of Exceeding	150,000	Acre Threshold In	10	Years Is	0.04240
Probability Of Exceeding	200,000	Acre Threshold In	10	Years Is	0.00362
Probability Of Exceeding	250,000	Acre Threshold In	10	Years Is	0.00113

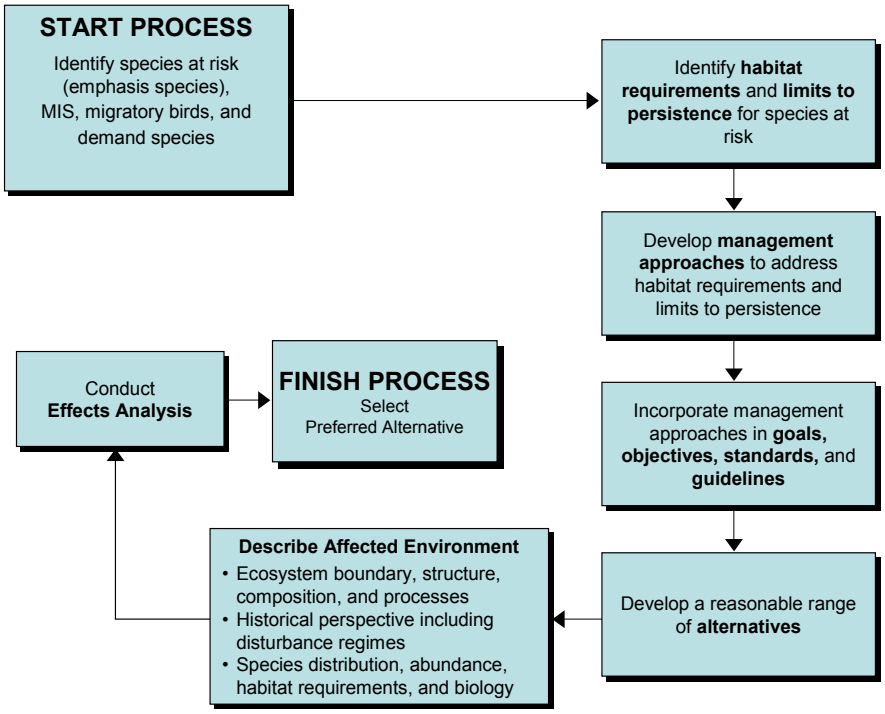
3.0. Effects Analysis

The effects of alternatives on the environment are described in Chapter 3 of the Final EIS as Environmental Consequences. This section of Appendix B includes a description of the analysis process used to determine effects to species viability and diversity and to social and economic resources.

3.1. Species Viability and Diversity Analysis Process

The effects analysis for species viability and diversity is based on the affected environment, alternatives and associated goals, objectives, standards, and guidelines. This section of Appendix B describes the overall process for addressing the requirement to maintain viable populations of all native and desired non-native vertebrate and plant species on the Forest. The specific effects analysis process used for determining effects to the four categories of emphasis species, migratory birds, and demand species is also described. The analysis process began by identifying species at risk (e.g., emphasis species) as well as migratory birds and demand species for the Forest. The habitat requirements, distributions, and potential limits to persistence for species at risk were then identified based on the best available scientific information including published conservation assessments. Management approaches were then developed to address the risk factors potentially limiting long-term persistence of each species on the Forest.

Figure B-2. Analysis Process for Addressing Species Viability and Diversity



As part of the LRMP Phase II Amendment, management approaches were considered when developing goals, objectives, standards, and guidelines as part of the Phase II Amendment process. Habitat requirements for migratory birds and demand species on the Forest were also considered in the development of goals, objectives, standards, and guidelines.

Working with cooperating agencies and using public involvement input from the scoping process, the Forest developed a reasonable range of alternatives for detailed analysis in the EIS. The linkage of goals, objectives, standards, and guidelines of alternatives to species is shown in **Figure B-2.**

Once a reasonable range of alternatives was developed, the affected environment was described. The affected environment includes consideration of the current ecosystem (boundary, structure, composition, and processes), a historical perspective (including disturbance regimes), and the distribution, abundance, habitat requirements, habitat and population trends, and biology of each species. The affected environment serves as the baseline against which proposed changes (associated with each alternative) were compared.

The effects analysis consisted of analyzing effects for each species based on how the goals, objectives, standards, and guidelines for each alternative would change the affected environment. Specifically, expected changes to species' habitats as a result of an alternative's goals, objectives, standards, and guidelines formed the basis of the effects.

Effects were displayed for each species as a result of the information gathered during the pre-field review, field reconnaissance, and effects analysis. Sources of information included Forest records and files, species conservation assessments, South Dakota Natural Heritage Program database, Wyoming

Natural Diversity database, South Dakota Department of Game, Fish and Parks, Wyoming Game and Fish Department, and published research. The Forest also used publications based on other parties' fieldwork conducted in the Black Hills.

The basis for each analysis is potential habitat, expected occurrence, distribution, and effects from Forest activities. The habitat requirements and potential limits to persistence for each species were used to determine the effect of relevant objectives and standards on the probability of long-term persistence of each emphasis species. The habitat trends and risks to persistence on the Forest were estimated based on the adequacy of the Forest Plan direction provided under each alternative. The overall conclusions were derived from anticipated trends, probable risks, and degree of uncertainty under each alternative.

There were three categories for determination for threatened, endangered, and sensitive species:

1. Threatened and Endangered Species: no effect; may affect, beneficial effect; may affect, not likely to adversely affect; or may affect, likely to adversely affect.
2. Region 2 Sensitive Species: no impact; beneficial impact; may adversely impact individuals, but not likely to result in a loss of viability in the Planning Area, nor cause a trend toward federal listing; or likely to result in a loss of viability in the Planning Area, or in a trend toward federal listing.

For threatened and endangered, and sensitive species, a high level of confidence was necessary to make a no impact/no effect determination. Determination of beneficial effect/impact required that the effect be wholly beneficial.

The effects determination for SOLC were based on viability concerns, available data and information, and professional judgment as to whether or not the species was likely to persist on the Forest.

3.1.1. Alternative 1, an Alternative Maintaining Viable Populations

The 1999 Appeal Decision found that Alternative 1 (Revised Forest Plan) did not establish a sufficient standard for snag density and that the use of 10-inch diameter and 15-feet minimum height standard does not meet the needs for those species requiring a larger diameter or taller snags. This finding was based on information on the Revised Forest Plan (Alternative 1) that some species need larger and taller snags or higher densities of snags. In the Phase II Final EIS, the analysis in Chapter 3 and Appendix C acknowledges that some species need larger and taller snags and higher density of snags. There is little evidence that managing for the above snag size and density will "likely lead to a loss of viability on the Planning Area". Certainly, managing for these conditions presents an increased risk to snag-dependant species, and a higher level of uncertainty as to whether the species will persist on the Forest. This is noted for Alternative 1 for specific species in Chapter 3 and in Appendix C.

The 1999 Appeal Decision found that there were no specific soft snag retention guides in the Revised Forest Plan (Alternative 1). However, Guideline 2305 says "all soft snags should be retained unless they are a safety hazard".

The 1999 Appeal Decision found that the standards and guidelines in the Revised Forest Plan for maintaining viability of northern goshawks were inadequate and that the viability determination for goshawks was not supported in the record. This finding was based on statements that post-fledging family areas were not defined, Guideline 3110 does not prohibit activities which would reduce the compositional and structural integrity of active and alternate nest stands, and an apparent loss of habitat capability on the southern third of the Forest. However, in the Phase II analysis (Alternative 1), these items do not provide enough evidence that activities will be "likely to lead to a loss of viability". Post-fledging family areas are easily defined using Reynolds et al. (1992) and applied to Guideline 3114. If new scientific information becomes available that highlights a different definition, that definition can be used also. Guideline 3110

does not prohibit activities, but certainly discourages activities within goshawk nest stands. The loss of habitat capability in the Revised Plan Final EIS was based on the HABCAP model. The analysis in the Phase II Amendment focused on the individual habitat features of goshawks and did not use HABCAP as an analysis tool. These features of Alternative 1 present an increased risk to goshawks, and a higher level of uncertainty as to whether the species will persist on the Forest, and this is noted for Alternative 1 in Appendix C.

The 1999 Appeal Decision found that Guideline 3201 in the Revised Forest Plan was not supportable. This guideline allows for a continuous decline in habitat capability, with no minimum level identified. However, other standards and guidelines (e.g., 3205, 2414, 2306, 5.1-3201) would likely keep this from happening. This guideline presents an increased risk and a higher level of uncertainty for species persistence.

3.2. Phase II Amendment Economic Analysis

Several models and data sources have been used in the alternatives economic analysis. Individual resource specialists provided resource outputs; specific analyses are highlighted in each resource section. The Washington Office and Forest specialists provided additional activity values and inputs. IMPLAN is an input-output model the Forest Service uses to estimate job and income impacts and alternative cumulative effects. Present-net-values for financial and economic efficiency were estimated using the Forest *QuickSilver* model and regionally defined values for outputs and activities.

3.2.1. Purpose

This section provides interested parties with additional details regarding the economic analysis used in the Phase II Amendment process.

3.2.2. Forest Contribution and Economic Impact Analyses

Impact analysis describes what happens when a change in final sales (e.g., in exports or residents) occurs for goods and services in the model region. Changes in final sales are the result of multiplying production data (timber sales volume (CCF)) by sales price.

Impacts to the local economy are measured in two ways: employment and labor income. Employment is expressed in jobs contributed by the Black Hills NF as a result of timber sales and expenditures for programs and activities affected by the Phase II amendment. A job can be seasonal or year-round and full-time or part-time. Jobs represent the annual average of 12 monthly estimates with no seasonality in the measure.

The income-measure used was labor income expressed in 1,000-dollar increments. Labor income includes both employee compensation (pay plus benefits) and proprietors (i.e., self-employed income).

Economic impacts were assumed to predominantly affect the seven-county area adjacent to the Black Hills NF, specifically Crook and Weston Counties in Wyoming, and Custer, Fall River, Lawrence, Meade, and Pennington counties in South Dakota.

Lower Brule, Cheyenne River, Standing Rock, Rosebud, and Pine Ridge Indian reservations were examined, based on available county level data, to determine if the Black Hills NF had significant economic impact links to them. Because Indian Reservations are sovereign nations, they are not subject to the same reporting requirements as businesses outside reservations. The counties within which the reservations are located were examined to see if they had economic sectors related to production of Black Hills NF goods and services and if it was reasonable to conclude some type of economic activity was occurring between the two. Only the Rosebud Sioux Tribe was found to have some forest product industry. They have an active forest management program and operate a sawmill, RST Forest Products Inc. In 2004 they employed four people at the mill. While operation of the mill has been erratic over the last five years, they have a firewood harvesting program that has operated consistently for many years providing firewood to people living on the reservation.

There are four additional Indian Reservations in South Dakota: Crow Creek, Flandreau Santee, Sisseton-Wahpeton, and Yankton. Crow Creek is next to Lower Brule, and the others are a greater distance away in the eastern part of the state. These reservations are smaller and analysis of the counties within would include economic information outside the reservation. But it is unlikely these reservations would have significant economic ties to the Forest due to the distance from the reservation to the Forest resources.

3.2.3. Economic Model

Economic effects to the seven counties surrounding the Forest (Custer, Fall River, Lawrence, Meade, and Pennington Counties in South Dakota, and Crook and Weston Counties in Wyoming) were estimated using an economic input-output model developed with *IMPLAN* Professional 2.0 (MIG, 2002). IMPLAN is a software package for personal computers that uses the latest national Bureau of Economic Analysis input-output tables; secondary economic data at the county level from a variety of public sources; and proprietary procedures to develop an input-output model for a study area. The Forest originally developed the software that the Minnesota IMPLAN Group, Inc. (MIG) now maintains. The most recent data available from MIG, year 2002, was used in the Phase II Amendment analysis (note that MIG 1999 data was used for economic impact modeling in Phase II amendment analysis for the Draft EIS). Impact results are converted to 2004 dollars.

The only impacts captured by economic modeling for the Final EIS are employment and income attributable to timber sales and Black Hills forest expenditures on programs and activities affected by the Phase II Amendment. Those programs and activities include: (1) commercial timber program, (2) thinning and mechanical fuels treatment, (3) vegetation management/Restoration, and (4) fire/fuels (excluding fire suppression). As such, all employment and labor income results in Chapter 3 are attributable to these programs and activities only.

3.2.4. Data Sources

The planning area model was used to determine total consequences of dollar, employment, and income changes in selected sectors. Because input-output models are linear, multipliers or response coefficients need only be calculated once per model and then applied to the direct change in final demand. A specially developed spreadsheet, FEAST (Forest Economic Analysis Spreadsheet Tool) (USDA Forest Service 2004j), was used to apply the model results to the current situation and each alternative.

3.2.4.1. Timber

Revenues per Acre

Specific information concerning cost and revenue estimates is discussed in the Vegetation/Timber section of the Final EIS and Appendix B. The following values were used in the final analysis:

Commercial timber revenues: $56.48/ccf Adjusted base price for sawtimber (Transaction Evidence Bulletin, June, 2005)

Timber volumes under current conditions are assumed to be 10-year average Black Hills sales volumes (1994-2003). Volumes under alternatives are provided in timber resource sections in Chapter 3 and Appendix B. Information about production levels and percents of inputs from the Black Hills NF and other sources (private, state) for primary and secondary producers (Teasley 2004, Forest Wood Products Market Survey 2002) is used to establish assumptions regarding allocation of harvest among industry sectors within FEAST.

Use of the Model

The capacity of surrounding mills and their production and supply figures were estimated through a separate survey effort. The Lumber Market Analysis is described in the Final EIS and Appendix B.

The model showed that for every $1 million (2002$) of logging production in the seven-county area, an additional $545,231 is generated in total impacts to the study-area economy. The direct impact of every $1 million of logging accounts for almost 6 direct jobs, and the indirect and induced effect account for another 5 jobs. Sawmill production of $1 million created an additional $864,000 within the study area and 5.5 direct jobs, with indirect and induced effects accounting for 7.5 more jobs. Reconstituted wood products contributed an additional $685,000 for every $1 million in production and an associated 4 direct jobs and 5.5 more indirect and induced opportunities. These relationships were used to estimate current contribution to the economy through FEAST.

3.2.4.2. Grazing

The grazing sector is not included in impact modeling (IMPLAN, FEAST) for the Final EIS, but retained in efficiency analysis. See Section 3.2.4.8 for discussion of efficiency analysis assumptions.

Use of the Model

No changes to available head months are expected in any alternative or over time. If allotment management were to change, specific analysis of that individual area would need to be completed. But at the level of the LRMP, no changes over time or between alternatives were modeled.

3.2.4.3. Recreation/Tourism/Wildlife/Fish

The recreation, tourism, wildlife, and fish sectors are not included in impact modeling (IMPLAN, FEAST) for the Final EIS, but retained in efficiency analysis. See Section 3.2.4.8 for discussion of efficiency analysis assumptions.

Use of the Model

Based on information and recreation-staff assumptions, none of the recreation activities are expected to change by alternative. Therefore, for the recreation analysis, no changes were modeled among the alternatives.

3.2.4.4. Mining/Oil/Gas

The recreation, tourism, wildlife, and fish sectors are not included in impact modeling (IMPLAN, FEAST) for the Final EIS, but retained in efficiency analysis. See Section 3.2.4.8 for discussion of efficiency analysis assumptions. The best available data for mineral prices was taken from the United States Geological Survey (USGS) annual mineral reports by state. Output was provided by annual Forest Plan monitoring reports. Output and prices were included for mica, feldspar, crushed sand and gravel, and dimensional stone.

Use of the Model

No changes to current mineral outputs are expected in any alternative. Mineral management by alternative will change, increasing miner-operation costs but not necessarily available output. At the Forest Plan scale, no changes over time or between alternatives were modeled.

3.2.4.5. Federal Expenditures and Employment

Expenditure Data

For impact modeling (*IMPLAN*, FEAST), only forest expenditures for those programs affected by the Phase II Amendment are included in the analysis. Programs or activities affected are (see Section 3-11.1.3 Black Hills NF Budget):

Commercial timber program	$500/acre
Thinning and mechanical fuels treatment	$277 to $318/acre
Vegetation management/restoration	$46 to $ 5,048/acre
Fire/fuels (excluding fire suppression)	$476/acre

Total expenditures for these programs/activities under current conditions are assumed to be 3-year average expenditures (2002-2004), and estimated total expenditures for these programs/activities under each alternative are provided in the Final EIS section regarding final budgets (Section 3-11) and discussed in Section 3.2.4.8 of Appendix B.

For economic and financial analysis, expenditures for all forest programs (i.e., recreation, range, minerals) are included in the analysis. For programs/activities expenditures that do not change across alternatives, 3-year average (2002-2004) expenses are assumed (see Final Budget spreadsheet in administrative record (USDA Forest Service 2005l).

Use of the Model

To obtain an estimate of total impacts from U.S. Forest Service spending, salaried and non-salaried portions of the impact were handled separately. Non-salaried expenditures were determined by using the budget object code information. This profile was run through the model for non-salaried expenditures per $1 million: the results multiplied by total Forest non-salary expenditures. FEAST was again used to make

the calculations. Local sales to the federal government are treated in the same manner as exports.

Salary impacts result from Forest employees spending a portion of their salaries locally. *IMPLAN* includes a profile of personal consumption expenditures for several income categories; the average compensation for an employee on the Forest fell in the $30,000 to $39,000 range.

3.2.4.6. Revenue Sharing – 25-Percent Fund Payments

Expenditure Data

Until September 30, 2001, federal law required that 25 percent Fund Payments be used for only schools or roads or both. A split of 50 percent for schools and 50 percent for roads was used. One profile of expenditures was developed from within the seven-county model for the highway construction sector and for local educational institutions. Because counties can now choose to continue payments under this formula, traditional payments were analyzed. All counties in the study area have selected secure or full payments under the new law; these impacts would not vary by alternative. Counties may elect to change back to 25-percent payments or stay with secure payments every 5 years. The impact for the study area was calculated using the traditional 25-percent fund based on revenues by alternative. Based on information presented in Section 3-12.4 of the Final EIS, total payments are stabilized at $4.12 million (i.e., 2002 levels); allocation of payments is based on majority distribution to education and roads.

Use of the Model

The national expenditure profile for state/local government education and local model estimates for road construction are provided within IMPLAN. An impact of $1 million of each profile was used to obtain a response coefficient for these U.S. Forest Service payments to the study-area counties. Sales to local government are treated in the same manner as exports.

3.2.4.7. Output Levels

Output contributed by Black Hills NF timber sales and expenditures on programs/activities affected by the Phase II Amendment can be viewed in FEAST spreadsheet files contained in the administrative record. Employment and labor income results are located in Section 3-11 of the Final EIS.

3.2.4.8. Financial and Economic Efficiency Analysis

Financial efficiency is defined as how well the dollars invested in each alternative produce revenues to the agency. Economic efficiency is defined as how well the dollars invested in each alternative produce benefits to society. Present Net Value (PNV) is used as an indicator of financial and economic efficiency.

The Model

QuickSilver is a public domain Windows-based program used to calculate PNV over a 50-year period (USDA Forest Service 2004e). A 4-percent discount rate was used, and inflation was not considered. *Quicksilver* spreadsheet files are contained in the administrative record.

Data Sources

Revenues to the U.S. Forest Service for resource outputs are set by law as in grazing fees or by associated policies for timber harvest, special-use permits, or minerals. Economic values were based on either actual revenues or on a willingness-to-pay evaluation. These economic values were developed by the Strategic

Planning Resource Act staff of the Washington D.C. Office and updated to 2002 values using Gross Domestic Product inflation factors. As discussed in the Final EIS, willingness-to-pay estimates for non-use values (scenery, existence values, bequest values, etc.) have not been established by the agency and are therefore excluded from this analysis. All output values are in 2004 dollars.

Table B-12 displays the economic values per unit of production used for each resource. Average gross receipts (2002 to 2004) for the Black Hills NF are used to measure benefits (returns) to the Forest (see USDA Forest Service 2005l for receipts). Quantities for timber and minerals are discussed in the relevant resource sections of Chapter 3 of the Final EIS that address Use of the Forest. For recreation quantities (e.g., RVDs) in *Quicksilver*, the proportional distribution of recreation visitor days (RVD) associated with each activity as listed in *The State of the Forest – Fiscal Year 2003 – Black Hills National Forest* are multiplied by the total number of site visits (1,684,855) reported in the National Visitor Use Monitoring Results for June, 2004 – Black Hills National Forest (USDA Forest Service 2004k).

Forest Service expenditures that did not change by alternative developed for this analysis were based on experienced budget (3-year average of past budgets, 2000 to 2002). Only commercial timber program, thinning, fuels/fire (excluding fire suppression), and vegetation management/restoration costs varied by alternative and are based on experienced treatment costs. Estimated alternative vegetation management treatment acres are found in **Table B-1.** Total expenditures are estimated by multiplying acres by costs in Section 3.2.4.5 of Appendix B.

Table B-12. Economic Benefits and Financial Revenue Values Information

Activity	Unit	Economic Benefit	Financial Value
Timber	CCF	See Timber, Appendix B	See Timber, Appendix B
Grazing	Head Months	$10.24	Avg Receipts (2002-2004)
Developed recreation	RVDs	$11.60	Avg Receipts (2002-2004)
Mechanized travel	RVDs	$12.04	Avg Receipts (2002-2004)
Hiking/Horseback/Water travel	RVDs	$13.83	Avg Receipts (2002-2004)
Winter sports	RVDs	$57.03	Avg Receipts (2002-2004)
Cabins/Camps	RVDs	$23.47	Avg Receipts (2002-2004)
Other recreation	RVDs	$16.98	Avg Receipts (2002-2004)
Fishing	RVDs	$78.95	Avg Receipts (2002-2004)
Hunting	RVDs	$61.89	Avg Receipts (2002-2004)
Wildlife viewing	RVDs	$61.77	Avg Receipts (2002-2004)

Source: Economic Benefits: Resource Planning Act (RPA) values are market-clearing prices (1989) (USDA Forest Service, 1990) for region 2, converted to 2003$ (USDA Forest Service, 2004); Financial Values (USDA Forest Service, 2004k).

3.3. Timber Market Assessment and Effects Analysis

The Bridges Corporation conducted a market study of the Black Hills region. (Refer to Forest Product Industry Market Study, Teasley (2004).) The study addressed the status of the Black Hills region forest-product industry.

Refer to Section 3-9 Social Environment and Sections 3-11.2.2 and 3-11.2.3 for results and summary.

Changes in average number of 8-hour shift capacities for large sawmills are estimated using 2003 annual production and 8-hour shift capacities (Random Lengths 2003), as well as percent of timber supply from Black Hills NF versus non-Black Hills NF (State, private) sources (Forest Wood Products Market Survey - Teasley 2004) for the three largest sawmills (process majority of timber from Black Hills NF).

3.4. Analysis Assumptions

The analysis of alternatives considered in detail assumed the following:

1. This Final EIS analyzes the general effects of programmatic decisions, and none of the alternatives would result in any ground-disturbing activities or direct changes to the environment. Subsequent project-specific actions/activities that may occur as part of LRMP implementation will be preceded by site-specific environmental analysis, as appropriate, and will comply with LRMP direction by this decision associated with this Final EIS.
2. Information from third-party sources including species conservation assessments, other scientific literature, referenced websites, Forest Service data, states of South Dakota and Wyoming, and other sources represents the best available scientific information.
3. The Forest Service uses the most current and complete data available. GIS data and product accuracy may vary. They may be developed from sources of differing accuracy, accurate only at certain scales, based on modeling or interpretation, incomplete while being created or revised, etc. Using GIS products for purposes other than for which they were created may yield inaccurate or misleading results. The Forest reserves the right to correct, update, modify, or replace GIS products without notification.
4. Species-viability projection contains a level of certainty when information was known for a particular species.
5. The Forest model used the best available scientific information to forecast outputs with a degree of certainty sufficient for programmatic-decision effects analysis.
6. The effects analysis assumes experienced budget levels will continue with respect to implementation of the LRMP Phase II Amendment.
7. Proposed resource conservation measures will be implemented for the associated alternatives.
8. The codes and definitions for Wyoming Plant and Animal Species of Concern considered for the effects analysis follow Kenneth et al. 2003.
9. The Forest planning area is defined as the NFS boundary for the Black Hills NF.

The percent change in acreage for ponderosa pine structural stages by alternative is based on analysis in the Forest vegetation spreadsheet. The current acreage for ponderosa pine structural stages reflects RMRIS 2004. Because ponderosa pine comprises 92 percent of total forested acreage, the difference in calculated versus model output values is generally within 10 percent. Despite these differences in absolute values, the relative percent change in values between alternatives is correct. Moreover, the calculated percent-change values rather than absolute values were used in the effects analysis.

3.5. Metric Conversion Table

Table B-13. Metric Conversion Table

Common Measure to Metric Measure				Metric Measure to Common Measure		
Multiply	**By**	**To Obtain**		**Multiply**	**By**	**To Obtain**
Inches	25.4	Millimeters		Millimeters (mm)	0.03937	Inches
Inches	2.54	Centimeters		Centimeters (cm)	0.3937	Inches
Feet (ft)	0.3048	Meters		Meters (m)	3.281	Feet
Fathoms	1.829	Meters		Meters (m)	0.5468	Fathoms
Statute miles (ml)	1.609	Kilometers		Kilometers (km)	0.6214	Statute miles
Nautical miles (nmi)	1.852	Kilometers		Kilometers (km)	0.5396	Nautical miles
Square feet (ft^2)	0.0929	Square meters		Square meters (m^2)	10.76	Square feet
Square miles (mi^2)	2.59	Square kilometers		Square kilometers (km^2)	0.3861	Square miles
Acres	0.4047	Hectares		Hectares (ha)	2.471	Acres

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