APPENDIX B

DESCRIPTION OF THE ANALYSIS PROCESS

INTRODUCTION

The planning problem is a very complex one. This complexity stems from the need to address a variety of interrelated and often conflicting issues by allocating land and scheduling activities in a cost-efficient manner for the entire Forest over a long period of time. This appendix describes some of the analytical tools used to reduce the process to manageable proportions. It is divided into the following sections:

1. Framework of the Planning Process
2. Inventory Data for Information Collection
3. Recreation Information Evaluation Process
4. Biological Diversity Evaluation Process
5. Watershed Assessment and Yields
6. Range Capability and Suitability for Livestock Grazing
7. Social and Economic Impact Analysis
8. The Forest Planning Model (FORPLAN)
9. Analysis Prior to Development of Alternatives
10. Formulation of Alternatives

SECTION 1 - FRAMEWORK OF THE PLANNING PROCESS

The planning and environmental analysis process for the revision allows a new approach to National Forest land management, principally because·

(1) processes formerly used to make individual resource decisions are now combined to help make integrated resource management decisions, and
(2) new information is available to determine the greatest benefit and the most cost efficient pattern of land management

The 10-step Forest planning process is discussed in the NFMA regulations (36 CFR 219 12) This section describes 10 steps, which lead from the completion of a Forest Plan to the completion of a revised Forest Plan

Step 10. (Step 10 of the Initial Planning Process) Monitoring and Evaluation

The last step of the initial Forest Plan process is the first step in revising a Forest Plan. Annual monitoring and evaluation has been done since the first Forest Plan for the Arapaho and Roosevelt National Forests (ARNF) and Pawnee National Grassland (PNG) was released in 1984. A mid-course evaluation, the Five Year Evaluation, was completed in December 1990.

Essentially, this evaluation looked at: planned objectives for FY 86-90 and compared them with actual accomplishments; and, Plan management goals and direction for each resource area The Forest evaluated what was done and how well it worked; options for improving management actions, and, discussed major management situation changes since adoption of the *Forest Plan* The Five Year Evaluation report helped the Forest Supervisor identify several reasons to revise the *Forest Plan.*

Step 1. Identify Public Issues, Concerns, and Opportunities (ICOs)

In this step, the need for changes in the Plan were identified After the Forest Supervisor determined that a revision was needed, a series of public forums and open houses were organized from May through October of 1990 Local government officials were also involved at this stage The Interdisciplinary Team (IDT) then identified and evaluated the public issues, management concerns, and resource use and development opportunities.

Step 2. Develop Planning Criteria

Criteria were designed to guide the collection and use of inventory data and information, the analysis of the management situation, and the design, formulation, and evaluation of alternatives This step set the guidelines for accomplishing the next five steps.

Step 3. Collect Data and Information

Based on information of step 2, the data were collected and assembled in a manner meaningful for addressing the ICOs identified in step 1 The primary source of data used during the revision process was the Rocky Mountain Resource Information System (RMRIS), which is described later in this appendix.

Step 4. Analysis of the Management Situation

This step determined the ability of the planning area to supply goods and services in response to society's demands This information provided a basis for formulating a broad range of reasonable alternatives The June 1993 Analysis of the Management Situation (AMS) document focused on the revision topics, and several of the models described in this appendix were initially developed during this step

Step 5. Formulation of Alternatives

Some initial ideas for alternatives were developed and discussed in the AMS. These were further formulated by the IDT according to NEPA procedures. Broad themes were developed to respond to the revision topics (ICOs).

The alternatives were presented to the public at a series of open houses in March 1994 Comments from the public and local government officials were solicited. After reviewing the comments, the alternatives were further refined into the set that appears in this *FEIS*

Step 6. Estimated Effects of Alternatives

The physical, biological, economic, and social effects of implementing each alternative considered in detail were estimated and compared according to NEPA procedures.

Step 7. Evaluation of Alternatives.

Significant physical, biological, economic, and social effects of implementing alternatives were evaluated.

Step 8. Preferred Alternative Recommendation

The Forest Supervisor reviewed the IDT's evaluation and recommended a preferred alternative to the Regional Forester The Regional Forester selected the preferred alternative, Alternative B, displayed in this document

Step 9. Plan Approval and Implementation

The Regional Forester will review the *Forest Plan* and *Final Environmental Impact Statement* (*FEIS*) for a final decision

SECTION 2 - INVENTORY DATA FOR INFORMATION COLLECTION

This section describes the collection and use of data. The Forest planning process requires the collection of data for numerous resources Data were used by the IDT to predict and analyze the effects of alternatives and to analyze the management situation. The data collected were used to address the ICOs, determine resource potential and limitations, and quantify outputs. For a more detailed description of data sources, the reader is referred to the planning record.

Vegetation was identified by species, size, and condition to determine, for example, wildlife habitat capability, and the volume and value of existing timber Specific resource information, such as roadless area boundaries, big game winter range, travel system, Recreation Opportunity Spectrum (ROS) class, administrative boundaries, including Ranger Districts and Wilderness areas, were identified. Much of this data were collected and developed from existing resource inventories, such as the Forest's RMRIS (Rocky Mountain Resource Information System) or R2TF (Region 2 Transportation Features) databases. A more detailed discussion of existing data sources is found in Section titled "Existing Data Sources "

Most of the collected resource information was assembled on maps and entered into a Geographic Information System (GIS). The spatial display data is stored in ARC/INFO[1] with the

[1] ARC/INFO is a product of the Environmental Systems Research Institute (ESRI)

corresponding data attributes stored in ORACLE[2]. The ORACLE database contains over 65,000 records, each record representing a unique combination of attributes and range in size from 1 to 500 acres The databases were used to stratify and aggregate capability areas to form analysis areas.

Analysis Areas. The basic resource information contained in the databases were used to divide the Forest into analysis areas Analysis areas are tracts of land assumed to be homogeneous in terms of outputs and effects being analyzed The composition of an analysis area is important because it defines the range of prescriptions that could be applied to achieve multiple use objectives The Sections titled "The Forest Planning Model" and "FORPLAN Structure" contain more information on the development of analysis areas and level identifiers.

FORPLAN normally uses up to six levels of identifiers to define the land component of the model (analysis areas) and additional identifiers to define prescriptions which include management emphasis and intensity The level identifiers represent the key characteristics of the analysis areas and are used to provide spatial definition or to identify differences in management costs and effects. The level identifiers were also used for constraining and reporting activities, outputs, and environmental effects.

The IDT and Ranger Districts assigned prescriptions to analysis areas by alternative. Analysis areas are constructed using RMRIS data. Modeling limitations in FORPLAN require grouping or condensing the number of analysis areas into a manageable number.

Tentatively suited timber lands were mapped to identify acres most appropriate for timber production The mapping effort identifies the best timber lands as appropriate for timber production. Other tentatively suited timber lands were identified as not as appropriate for timber production with the reason why

The analysis areas were stratified according to the FORPLAN level identifiers The IDT may change the analysis area identifiers during the analysis process to better address the ICOs.

Production Coefficients. The IDT developed coefficients (yields) for timber, wildlife, fisheries, recreation, sediment, road/trail construction and reconstruction, road/trail maintenance, range, and water augmentation Other coefficients were used in other analyses. Some of these coefficients were included in the FORPLAN model while other resources may use outputs from FORPLAN to measure impacts of various management activities

Cost estimates were based on recent experiences. Most costs are dependent upon the level of production of a given resource, while others are assumed to be fixed for a given alternative Variable timber costs are dependent upon the level of timber production. Other costs not related to variable timber management levels were assumed to be fixed for all benchmarks and alternatives Only those costs related to timber management were accounted for in the analysis

[2]ORACLE is a product of the Oracle Corporation

The following is a list of coefficients developed and their source.

- Timber· Timber yields expressed in cubic feet and developed from Forest inventory
- Range· Measure of present AUM's per acre; potential AUM's resulting from various management activities. Developed based on productivity of usable range, grazing system, compatibility with other uses.
- Recreation, Dispersed Measure of RVDs for capacity based on the level of dispersed development, use densities for various ROS class, historical use
- Recreation, Developed: Measure of RVDs for capacity based on types of existing and potential developed sites and their Persons at One Time (PAOT) capacities, using data from Recreation Information Management (RIM).
- Recreation, Downhill Skiing: Measure of skier days/year and skiers at one time (SAOTS) for capacity based on existing capacities, predicted potential development capacities, and historical use.
- Wildlife and Fish User Days: WFUD's calculated based on wildlife habitat capabilities.
- Habitat Capability: Based on cover type and structural stage for various species
- Water Yields Measure of Acre Feet increases in water runoff due to planned management activities. Yields predicted based on coefficient from research data, existing yield records, professional judgement
- Roads/Trails Miles based on existing and predicted road/trail densities.
- Fuels Treatment: Total acres treated based on the allocation and schedule of activities
- Fuelwood Expressed in cubic feet and derived from historical data associated with fuelwood and timber sales.
- Recreation Opportunity: Acres of ROS class over time based on the existing physical setting, scheduled management activities

Lands Tentatively Suited For Timber Production. According to the NFMA Regulations, timber production and commercial harvesting generally may take place only on lands classified as suited lands (36 CFR 219 14). The process for determining lands suited for timber production is one of eliminating lands from the forested base, i e. it starts with all forested lands in public ownership, then begins eliminating lands for various reasons. The process is described in the Forest Service Timber Resource Planning Handbook FSH 2409.13, Chapter 20.

The elimination of lands occurred in two different steps:

1) those lands **not** considered tentatively **suited**, and
2) those lands considered **not appropriate** for timber production The number of acres considered not appropriate can vary according to the alternative being considered

Lands were not considered tentatively suited if

1) The land is not forest land as defined in NFMA.
2) Technology is not available to ensure timber production without irreversible damage to soil productivity or watershed condition.
3) Reasonable assurance that such lands can be adequately restocked as provided in NFMA is not present.
4) The land has been withdrawn from timber production by an Act of Congress, the Secretary of Agriculture, or the Forest Service Chief

The Forest identified lands in all four of the above categories. Information was gathered from the Forest's RMRIS database. The Ranger Districts identified timber lands as tentatively suited for timber production using the RMRIS Handbook (See Forest Service Handbook-FSH 6609 21) During the process of mapping appropriate timber lands, the tentatively suited land base was found to include acres not tentatively suited for timber production. The tentatively suited timber base was then adjusted to remove those acres not considered tentatively suited for timber production Refer to the following section on "Lands not Appropriate for Timber Production "

The identification of suitable and suitable but not allocated was identified during the analysis of alternatives. The determination of tentatively suited timber lands on the Forest was based on the timber inventory and the mapping of appropriate timber lands.

Lands Not Appropriate for Timber Production. Timber lands not appropriate for timber production are determined indirectly through the determination of suited timber lands by alternative. For each alternative considered in detail, there were lands identified as suited for timber production in order to meet the objectives of each alternative These lands were taken from those lands identified as "tentatively" suited during the first stage of the analysis In the final alternative, the "tentatively" suited acres which are not identified as "suited" in the final stage of the analysis were considered "not appropriate" for timber production

According to 36 CFR 219.14(c), lands considered **not appropriate** for timber production fall into one of three classifications. 1) lands where minimum management requirements could not be met if timber activities occurred on them, 2) lands where, based on multiple-use objectives, the land is proposed for resource uses that preclude timber production, and 3) lands not cost-efficient over the planning horizon, in meeting forest objectives, which include timber production

The tentatively suited lands were mapped on overlays using 7.5' topographic base quadrangle maps. Then, Ranger District personnel, having **on-the-ground** knowledge, identified lands **not appropriate** for timber production for the reasons (appropriateness category) displayed below The acres of lands both appropriate and not appropriate by analysis area were calculated, by Ranger District. The acres were further delineated by either conifer or aspen types as well as the corresponding category that caused an area to be considered not appropriate

The planning records contain the appropriateness category maps and overlays Many areas were considered **not appropriate** for more than one reason The predominant reason is indicated on the overlays

Rock. The areas identified as not appropriate because of "Rock" are lands where surface rock is present in sufficient size and quantity (over 50% ground coverage) to make logging impractical due to timber breakage during felling and severe limitations on skidding abilities

Low Productivity The areas identified as not appropriate because of "Low Productivity" are lands where the forested stands were either isolated and/or marginal because of small size (dry, low productivity sites)

Steep Slope/Access The areas identified as not appropriate because of "Steep Slope/Access" have slopes over 40% and sites where the timber stands are not reasonably accessible due to either high road construction costs through steep adjacent terrain or because of excessive road construction mileage.

Irreversible Damage· These are lands where "Irreversible Damage" would likely occur if timber management and associated road building activities are to occur The "Irreversible Damage" lands are primarily on highly unstable soils. The RMRIS database is one source of information.

Other Uses. These are lands where other uses have a higher value than timber and timber management activities (on a sustained yield basis) are not compatible.

Appropriate Those remaining tentatively suited timber lands not classified under the above categories are considered "appropriate lands" in the discussions throughout the analysis.

The results of the mapping efforts of lands considered not appropriate for timber production are displayed in tabular form in the *FEIS* The results of the map analysis were incorporated into the FORPLAN analysis of alternatives.

Allocation and Scheduling Alternatives Alternatives were developed to meet specific resource objectives. The basic use of inventory data in this step was to accurately reflect the land base and provide the basis for scheduling activities, estimating outputs, costs, and effects for each alternative. Inventories of potential land allocations or management areas were used as a basis for assigning prescriptions in each alternative. The Forest's database facilitates the tack of identifying these areas and determining which prescriptions could be applied This process is described more fully in the Forest Planning Model and Formulation of Alternatives sections of this appendix

The schedule of activities was also tied to and influenced by the analysis area identifiers. The existing condition and potential of the land, given other resource needs, was key to determining the timing, intensity, and amount of activities The resulting activity schedules and land allocations provides the basis for Plan implementation and monitoring

Implementation and Monitoring. The databases provides biological and physical data that helped develop subsequent programs for Plan implementation As more resource data becomes available, the databases will be updated and improved.

At intervals established in the Forest Plan, management practices are evaluated to determine how well objectives have been met, the accuracy of cost and yield estimates, and how closely management standards and guidelines are being applied The results of monitoring and evaluation may be used to analyze the management situation during review of the Forest Plan

Existing Data Sources. Existing inventories and databases were used unless found to be inadequate. The Forest planning effort did not create a planning database. Instead, District databases were used and archived to complete the Plan Analysis information and decisions essential to implementation of the Plan were stored in each District database.

To be useful in the revision, most inventories and information needed to be organized in an integrated database. Some of the currently existing data was not in an integrated database Other data was on maps in each District office, or on maps and files (paper and computer) in various specialists offices. Databases that needed to be assembled into a common integrated database were defined.

Existing data sources used during the revision included

- RMRIS Database
- R2TF Roads Inventory
- Stage II timber survey
- CFF (Cartographic Feature Files)
- IMPLAN economic sectors data
- 1990 census data
- Management Practice Cost Tables

Existing data from RMRIS and R2TF was used in the revision process, where appropriate. Additional data was collected to help answer new issues (such as ecosystem stewardship, roadless/wilderness, travel management, and oil and gas leasing) and to update and improve existing information

Existing databases used during the revision included·

- RMRIS - Land and resource characteristics about sites
- R2TF - Characteristics about roads and trail management
- COMMENT - List of public and internal comments and categories used in developing the revised plan.
- CONTACTS - List of public contacts involved in the revision.

RMRIS Rocky Mountain Resource Information System - Database with information on areas (5-20 acres) of land Sites are delineated on locatable features and where characteristics change some management activity Sites include all acres on the Forest. This database is linked to other databases through GIS The RMRIS is the standard data base for the Rocky Mountain Region for information Forest Service Handbook-FSH 6609 21 displays information and coding structure for the Forest's database RMRIS provides specific resource information for each of the more than 65,000 land units (sites) on the Forest. RMRIS is used for determining acreage, identifying analysis area (AA), initially determining land not appropriate for timber production, for determining lands available for oil and gas leasing, effects analysis, and monitoring

R2TF—Region 2 Transportation Features System Database with segments of roads and trails Includes all roads and trails on the Forest This database is linked to RMRIS through electronic map layers Example characteristics include management status, mode of use, condition, safety, closures, road or trail names, etc R2TF is used for travel management analysis and mapping, road densities and travel distances

COMMENT: The Comments database records all public and internal comments This database was used to make a listing of all comments organized by subject or by geographic area.

CONTACTS: The Contacts database records all persons, external and internal, interested in the revision This database records affiliation, mailing address and interest in Forest mailings

The following are other sources of data used during the revision

Timber Several updates to the Stage I, Timber Suitability Analysis have occurred since it was originally completed The latest update occurred in 1989/1990. Information from STAGE II timber inventory, 1980-1992, was used along with timber sale cruise volumes for 1980-1990 found in sale folders in Forest Supervisor's office Colorado State University Timber Demand Study, 1992, identifies short term (5-10 year) demand for commercial forest products

Economics Benefit values for recreation and wildlife are taken from the 1990 Forest and Rangeland Renewable Resources Planning Act (RPA) Assessment. Benefit values for timber are the five year rolling average used for TSPIRS. All costs were derived on the Forest using the most current budget data.

Social and economic Information came from the US Bureau of Census population statistics and Colorado Legislative Council Staff Reports for Economic and Revenue Forecast.

Recreation: Recreation Information Management (RIM) data is compiled annually by each Ranger District and consolidated information is provided on recreational use estimates, facilities, and conditions. Recreation Visitor Day (RVD) coefficients were based on RIM statistics. Recreation supply (capacity) for dispersed and developed recreation was based on the ROS coefficients of RVDs/acre/year. Information from the Colorado Division of Parks and Outdoor Recreation, Colorado State University, and the Colorado Division of Wildlife was also used to determine demand and user preferences.

Protection The National Fire Management Analysis System (NFMAS) is used to analyze the economic efficiency of different fire protection organizations

Land Status: Land status information was taken from the Forest Landownership Status System The information was updated in 1991 to incorporate current ownership status.

SECTION 3 - RECREATION INFORMATION EVALUATION PROCESS

The recreation information evaluation process was a six step process that integrated RIM information, SO Recreation Staff inputs, and the field experience of district specialists The steps are as follows

1 Information Gathering. RIM information on use and resource capability by ROS land classes and uses with specific resource requirements were assembled and entered into a standard spread

sheet (Quattro Pro). This facilitated the evaluation of trends, projecting use to the future, and facilitated comparison of future use with resource capabilities.

2 Projection of Recreation Use to the Year 2010. This was accomplished by developing simple average annual increments of change in use between 1985 and 1993. Given the variability of RIM information, different formulas were used to determine average use changes for each of the Districts Once a reasonable average annual increment of use was determined, five year increments were built into a spreadsheet so use projections could be completed

3 Resource and Facility Capability Assessment. This was completed by using the current Forest Plan standards and guidelines for recreation use by management areas and ROS classes, data entered into and outputted through the ARNF GIS center, and recreation coefficients from FS design and Colorado Division of Parks and Outdoor Recreation information. Recreation use coefficients were applied to acres, developed facilities for the appropriate season length to arrive at a capability determination This information was also built into the spread sheet to allow comparison (to the extent possible) between use projections and facility and resource capability

4 Comparison of Recreation Use with Facility and Resource Capability. Current and future recreation use (to 2010) were compared with appropriate facility and resource area (ROS land classes) to estimate if and when there may be a shortfall in recreation opportunities and/or settings (ROS) Comparisons were limited to recreation management and use situations where there are current and/or predicted issues or problems

5. Supplemental Recreation Use Information This information, provided by several state agencies and Colorado State University, was reviewed and included to further substantiate RIM information to allow direct comparison with RIM use information.

6 Summary Outputs Summary outputs have been provided on both a forest wide and district breakdown. Outputs include the following

a) Use estimates to the year 2010 (where the ARNF, Districts need to concentrate their limited resources plus management strategies to insure quality recreation opportunities)
b) Supplemental recreation use and user preference information from other resource management agencies, Colorado State University.
c) Recreation Opportunities in "short supply" between 1995 and 2010, or where significant recreation use and management problems may exist.
d) Management strategy options to address items identified in c) above
e) Need for monitoring recreation use, user preferences, resource and facility condition, and the basis to integrate information for better planning, development and management

7 The estimated potential effects of other resource management activities on recreation is based upon a combination of field staff inputs in conjunction with a broad scale landscape evaluation using a series of forest management activity map overlays Maps of resource management areas and management activities were compared to maps of proposed recreation activities for each alternative The extent and type of potential effects on proposed recreation actions were estimated and recorded

SECTION 4 - BIOLOGICAL DIVERSITY EVALUATION PROCESS

The key elements analyzed for biological diversity include old growth forests, travel corridors for terrestrial wildlife, habitat effectiveness, and interior forests. The following is a discussion of the evaluation process for these elements

Old Growth Forests

Inventories of old growth in the ARNF were conducted from 1990 through 1992, and updates continue as losses occur or new sites are found. The survey was for old growth forests of greatest concern, most affected in the past, or likely to be affected in the future by management activities. Old growth dominated by other forest species such as aspen, limber pine, bristlecone pine, and Rocky Mountain juniper were not defined or inventoried.

Definitions are based on structural characteristics that include indices for old trees. Structural requirements are described but exacting, rigid definitions are avoided. Key old-growth characteristics are primary considerations and as a minimum rule, large live trees, some of which were old and declining, either snags or fallen trees; and greater than 20 percent overhead canopy closure were all prerequisites for a site to be called old growth. Common old growth characteristics were not determinants of whether old growth existed but were qualifiers in assessing old-growth condition, in addition to key characteristics. For more information, refer to the planning record documents

Three definitions were developed for forested sites dominated by different conifer species The following are **key old-growth characteristics** by major conifer zone.

In sites dominated by spruce or fir

- Presence of large live trees (14"+ diameter breast height (dbh)), including 15 or more trees per acre 12"+ dbh.
- Presence of large snags (14"+ dbh), including 2 or more snags/acre 12"+ dbh.
- Presence of large fallen trees (14"+ diameter), including 3 or more per acre 12"+ diameter
- Presence of multi-storied canopy
- Overhead canopy closure >20%
- Presence of large, old, declining live trees

In sites dominated by lodgepole pine.

- Presence of 15 or more large live trees (10"+ dbh) per acre
- Presence of 2 or more large snags (10"+ dbh) per acre
- Presence of 3 or more large fallen trees (10"+ diam) per ac Overhead canopy closure >20%.
- Presence of large, old, declining live trees

In sites dominated by Douglas-fir or ponderosa pine:

- Presence of large live trees (18"+ dbh), including 15 or more trees per acre 12"+ dbh
- Presence of large snags (14"+ dbh), including 2 or more snags/acre 12"+ dbh

- Presence of large fallen trees (14"+ diameter), including 3 or more per acre 12"+ diameter.
- Presence of multi-storied canopy.
- Overhead canopy closure >20%
- Presence of large, old, declining live trees.

The following are other **common old growth characteristics** for all before mentioned forested sites
- Presence of more than one tree species.
- Presence of small openings with grasses, forbs, or shrubs.
- Presence of seedlings, saplings, or poles.
- Little or no evidence of logging
- Little or no evidence of fire, insect, or wind disturbance.

<u>Travel Corridors for Terrestrial Wildlife</u>

Two basic types of corridors are approximated and analyzed. One is a forested corridor where certain wildlife species (lynx as an example) tend to confine their habitation Most public concern about corridors has been focused on connectivity of forests. The other type is an open corridor where certain wildlife species (bighorn sheep as an example) tend to confine their habitation. The following are generalized approximations of both kinds of corridors that are important for numerous wildlife.

Forested Corridors
- forest structural stages 5, 4C, 4B, 3C and 3B (refer to Habitat Effectiveness Section in this Appendix for definitions)
- minimum width 100 meters
- minimum area 20 acres
- gaps or interruptions (conditions other than described) no wider than 100 meters

Open Corridors
- forest structural stages 1 and 2 (refer to Habitat Effectiveness Section in this Appendix for definitions)
- shrublands, grasslands, rock
- minimum width 100 meters
- barriers or interruptions (conditions other than described) no wider than 100 meters

<u>Habitat Effectiveness</u>

Effective habitat is considered to be mostly undisturbed habitat which is buffered from regularly used roads and trails The following table displays the method used to estimate effective habitat based on distances from travelways that are open to public use, that receive either motorized or nonmotorized use, and that receive moderate to high-use (11 or more people or vehicles/week)

Table B.1 Habitat Effectiveness Criteria for the ARNF and PNG.

Distances Within Which Wildlife are Affected *	Terrain and Vegetation Conditions †
500 Meters	Downhill (>10% to 80% slope) in open country (no vegetation obscuring view, including SSs 1 and 2)
400 Meters	Flat (0 thru 10% slope) in open country
300 Meters	Uphill (>10% to 80% slope) in open country
400 Meters	Downhill (>10% to 80% slope) in SSs 3A and 4A
300 Meters	Flat (0 thru 10% slope) in SSs 3A and 4A
200 Meters	Uphill (>10% to 80% slope) in SSs 3A and 4A
200 Meters	Slopes 0 to 80% in SSs 3B and 4B
100 Meters	Slopes 0 to 80% in SSs 4B, 4C and 5
0 Meters ‡	Slopes 80% or greater

* Qualifiers

- Terrain that would interrupt a straight line path within these distances limits will have shorter affected distances, regardless of vegetation or structural stage (with a minimum of 100 meters on slopes <80%)
- The area within the affected distances is considered ineffective habitat and, conversely, the area outside is considered effective habitat
- Effectiveness is decreased near roads and trails only during those seasons when human use occurs.

† Abbreviations - SS = structural stage

1 = grass and forbs	
2 = shrubs and seedlings	
3 = saplings and poles	A = 0 to 40% canopy closure
4 = mature forest	B = 40 to 70% canopy closure
5 = old growth forest	C = 70 to 100% canopy closure

‡ Less than 2 miles of travelway occur on slopes of 80 percent or greater Some affected (disturbed) habitat resulted from estimates along all travelways, since disturbance on travelways is not separated from each 50x50 meter GIS cell which roads or trails cross

The ARNF and PNG is using this model or method to estimate the amount and location of generally undisturbed, or effective, wildlife habitat which is buffered from most human influence Conversely, what is most disturbed or least effective habitat is also estimated It is used to quantify and compare differences among alternatives being considered and incorporated with other proposed direction for managing human disturbance and wildlife habitat

This provides a consistent approach for approximation and comparison of relatively undisturbed versus disturbed habitats Disturbance distances from human activity vary with intensity of human use, vegetation type, vegetation density, terrain and location of travelway These are all factors the ARNF and PNG has data for and that can be assessed using a computerized geographic information system (GIS). There may be other factors that would likely refine disturbance approximations for various forms of wildlife, but such additional information is not yet available. Assumptions and estimates are based on the best available research findings and indications (Ward 1976; Hicks and Elder 1979, Lyon 1979, Rost and Bailey 1979, Thomas et al.

1979; Thomas and Toweill 1982; Lyon 1983, Hoover and Wills 1984; Ward 1984; Lyon et al. 1985, Freddy et al. 1986, Brown 1987; Smith and Long 1987, Knight and Gutzwiller 1995; Miller and Knight 1995)

This method of estimation is based on elk and deer, and otherwise serves as a general indicator for other wildlife habitat effectiveness. Other forest and grassland species have been reported to be disturbed by human activities within similar distance limits used for elk and deer (Holmes et al , 1993, Holmes 1994, Knight and Cole 1995, Gabrielson and Smith 1995, Bowles 1995, Anthony et al 1995, Larson 1995, Burger 1995, Knight and Temple 1995). The method does not fit any single species perfectly, including elk and deer, because any model can not entirely represent reality. Certain species dwell but are not known to be disturbed within the various distances, and other species are sometimes disturbed beyond (e.g., elk have been reported disturbed up to ½ miles from roads). However, this model approximates disturbed habitat that is most affected by concentrated human travel from habitat that is least affected or disturbed.

This method supplements the use of travelway mileage and density (miles per square mile) information by locating relatively disturbed and undisturbed habitat in relation to regularly used roads and trails Location of affected habitat is an important aspect, in addition to density figures alone For example, an average density is of limited value where few travelway miles exist in half of a geographic area and numerous miles exist in the other half. Both travelway density and location of effective habitat are available, to allow for the most thorough evaluation and appropriate management A computerized GIS provides the long awaited capability to manage data spatially, in a way that is more realistic than without it (Regan et al 1995).

This method produces results and recommendations that complement and compare well with established road density methods. It simply adds the ability to deal with the same basic information spatially, as well as additional factors that influence habitat effectiveness.

Considering only road densities in habitat management would ignore several important aspects including:

1) Trails, in addition to roads, contribute to disturbance and reduced effective habitat This applies to both motorized and nonmotorized use of trails
2) Density does not identify remaining islands of refuge in areas that otherwise appear to be completely disturbed This is important, especially along the Front Range, where habitat fragmentation is high and remaining undisturbed sites are scarce
3) Density does not show where necessary travelways could be specifically located on the ground to minimize new disturbance, or where potential travelway closures could maximize additional effective habitat
4) Density does not account for differences in intensity of human use, vegetation type, vegetation density, terrain and location of travelway which affect how wildlife are impacted or insulated from disturbance
5) Since density is only area specific, certain site specific concerns (e.g , raptor nests, travel corridors, wildlife concentration areas) are less able to be analyzed, evaluated and most appropriately managed for

Effective habitat is estimated to exist on about 67 percent of the ARNF. The following table displays the amounts of effective habitat by geographic area (for National Forest system lands only) in relationship to travelway densities The geographic area with the least proportion (39 percent) is Mammoth which is a small area with interspersed land ownership, development and high road densities near population centers of the Front Range The highest habitat effectiveness occurs in Neota Wilderness Area with 95 percent Effective habitat is estimated to exist on about 60 percent of the PNG

Table B.2 Habitat Effectiveness Compared with Road and Trail Densities by Geographic Area

Geographic Area Name	FS Habitat Effectiveness	Open Roads	Open Trails	Total Density (mi/mi²)	Mean Density	Density Range
					By Subgroups	
Arapaho National Rec Area	47	1 7	0 7	2 4		
Berthoud Pass	70	1 0	0 4	1 4	1.2	
Boulder Creek	52	1 6	0 6	2 2	2 3	
Bowen	73	0 2	0 9	1 1		
Brainard Lake	48	1 6	2 2	3 8		
Broken Rack	69	1 7	0 1	1 8		
Buckhorn	63	1 4	0 3	1 7		
Buffalo Park	78	0 8	0 4	1 2		
Cabin Creek	53	3 3	0 0	3 3		to
Cache la Poudre	90	0 0	0 1	0 1		
Cameron Pass	55	1 9	0 3	2 2		
Caribou	53	2 6	0 0	2 6		1 7
Cedar Park	74	0 9	0 1	1 0		
Cherokee Park	54	2 0	0 2	2 2		
Chicago Creek	54	2 4	0 3	2 7		
Comanche Peak Wilderness	77	0 0	0 9	0 9		
Crooked Creek	60	1 9	0 5	2 4	1 8	
Crosier	72	0 4	0 7	1 1		0 8
Crown Point	60	1 4	0 4	1 8		2 4
Deadman	56	1 8	0 1	1 9		
Elk Creek	42	3 3	1 5	4 8		to
Elk Ridge	80	0 7	0 1	0 8	0 6	
Elkhorn	54	1 7	0 0	1 7		
Evergreen	72	0 6	1 1	1 7		
Grassland (Single Area)	60	1 1	0 0	1 1		
Greyrock	71	0 7	0 2	0 9		1 7
James Creek	57	2 0	0 3	2 3		
Laramie River Valley	66	1 4	0 1	1 5		
Lion Gulch	71	1 0	0 3	1 3		to
Loveland Pass	66	1 7	0 4	2 1		
Lump Gulch	49	2 9	0 4	3 3		
Mammoth	39	2 3	0 0	2 3	3 3	
Middle St Vrain	59	1 6	0 8	2 4		
Never Summer Wilderness	68	0 2	1 1	1 3		
Parkca	67	1 5	0 5	2 0		
Pingree	58	1 5	0 4	1 9		
Poudre Canyon	62	1 2	0 4	1 6		1 3
Ranch Creek	60	1 4	0 6	2 0		to
Redfeather	52	1 7	0 1	1 8		3 3
Roach	56	1 9	0 0	1 9		
Thorodin	59	1 3	0 6	1 9		
Sheep Creek	62	1 8	0 0	1 8		
Stillwater	44	2 3	1 2	3 5		2 3

Geographic Area Name	FS Habitat Effectiveness	Open Roads	Open Trails	Total Density (mi/mi²)	Mean Density	Density Range
					By Subgroups	
Sugarloaf	41	2 9	0 3	3 3		4 8
Winter Park	54	2 5	0 6	3 1		
Yankee Hill	47	2 7	0 1	2 8		
Little Gravel	72	1 5	0 2	1 7		
Niwot Ridge	74	0 7	0 5	1 2		
North St Vrain	75	0 9	0 4	1 3		
Indian Peaks Wilderness	77	0 0	0 9	0 9		
Mt Evans Wilderness	77	0 7	0 2	0 9		
Poverty	77	0 7	0 1	0 8		
Fraser Experimental Forest	78	0 8	0 4	1 2		
Lone Pine	80	0 5	0 2	0 7		0 8
James Peak	82	0 1	0 6	0 7		to
Rawah Wilderness	83	0 0	0 6	0 6		0 1
Vasquez	84	0 0	0 6	0 6		
Tabernash	87	0 3	0 5	0 8		
Williams Gulch	88	0 4	0 2	0 6		
Neota Wilderness	95	0 0	0 1	0 1		
Forest wide	67	1 2	0 4	1 6		

Interior Forests

Interior forests are considered to be contiguous areas of relatively dense and large trees that are buffered from the temperature, light and humidity differences of sizeable openings in the forest, and from the human disturbance along regularly used roads and trails That is, interior forests occur totally within effective habitat and are further reduced in area by the influence of adjacent openings

The following are the criteria and the process used to delineate interior forests

- Tree stands with structural stages 5, 4C and 4B (refer to Habitat Effectiveness Section in this Appendix for definitions). Tree stands within 100 meters of each other were connected
- Buffers were created around tree stands if areas that could affect the interior forest characteristic were present. For example, a *100 meter buffer* was subtracted from the perimeter of the tree stands if the area adjacent to the stand was open (structural stages 1, 2, 3A, 4A) or nonvegetated. No deduction was made if adjacent to structural stages 3B or 3C
- Buffers of variable distances were created based on the distance from open roads and trails, within which wildlife are estimated to be affected (see Habitat Effectiveness Section in this Appendix) These distances were subtracted from the perimeter of the tree stand
- Minimum width of an interior forest is 100 meters, minimum area is 20 acres

SECTION 5 - WATERSHED ASSESSMENT AND YIELDS

Watershed Condition Assessment

Introduction. This is a broad level ("coarse filter") assessment of the existing physical, chemical and biotic conditions of watersheds across the ARNF The assessment was conducted for this Land and Resource Management Plan process, and was the first level of assessment conducted for a Region-wide effort to determine watershed conditions

The assessment can be used to prioritize watershed improvement and/or protection needs and prioritize the need for more detailed analyses. Results will be used to define existing conditions for several Forest Plan objectives. Additionally, this information can be used as a communication tool for Forest and Regional leadership and the public, to better focus management programs on physical, chemical and biotic components of watershed stewardship.

This assessment is not intended to replace project level analysis of direct, indirect, or cumulative effects, but to examine watershed and stream health relative to Forest Plan Objectives. While the assessment may provide one basis for understanding potential conflicts and opportunities with other resources, it does not establish thresholds, and does not prohibit or prescribe future management activities

Analysis Area This assessment includes all lands managed by the ARNF, excluding portions of the Willams Fork drainage for which the ARNF recently acquired management responsibility, and excluding the Pawnee National Grassland. Due to the limited availability of data and knowledge about conditions, watersheds where the ARNF manages less than 10 percent of the land area were not rated Thirty watersheds, totaling 302,151 acres (13 percent of the total assessment area), fall into this category

The remaining 147 watersheds included in the assessment range in size from 560 acres to 59,420 acres A mixture of private and government entities own and/or manage most of these watersheds The ARNF manages less than half of the land base in approximately 50 percent of these watersheds Only one of the 147 watersheds analyzed contains lands which are managed entirely by the Forest Service

Methods. This assessment is an extension of the "Watersheds of Concern" assessment done for the Draft Environmental Impact Statement for the *Forest Plan* and follows portions of additional guidance outlined in the "Watershed Condition Assessment Criteria" (USDA Forest Service Rocky Mountain Region, FINAL 03/31/97) The general process outlined in the "Watershed Condition Assessment Criteria" was followed Specific procedures, assumptions and any discrepancies are noted below.

The assessment relies upon a combination of existing data sources and professional judgement/knowledge and includes assumptions on a Forestwide basis There is insufficient existing data readily available to directly describe Forestwide watershed and/or stream conditions. Consequently, the majority of data used in this assessment provides an indirect index of watershed and stream conditions.

Watershed Conditions. The approach used to determine watershed condition was to examine watershed sensitivity and disturbances along with conditions in the channel. Each watershed was placed into one of the watershed condition classes listed below. Emphasis was placed on the ability of a watershed to function as a sponge and filter and to sustain the physical, chemical, and biotic integrity of its aquatic ecosystems.

<u>Class I</u>: The watershed is in **GOOD CONDITION** and fully functioning. Only major reset events cause long-term changes. Human disturbances are not compromising watershed function or stream segment integrity. Indicated by factors like:

- No stream segment is seriously degraded.
- Watershed function is robust throughout the watershed.
- There is no downward trend in watershed function or in the physical, chemical, or biotic integrity of stream segments

<u>Class II</u>· The watershed is in **FAIR CONDITION**, or in a downward trend, or not yet fully recovered from past damage. Although the watershed is considered functional, it is at risk of additional degradation Recovery is feasible naturally or via revised management with minimal capital investment. Indicated by factors like

- A minor portion of stream segments are seriously degraded.
- Watershed function is degraded in isolated areas of the watershed.
- Existing and foreseen disturbances are causing downward trend in watershed function or stream segment integrity toward Class II conditions

<u>Class III</u>: The watershed is in **POOR CONDITION** and is not functional Recovery may require capital investments and revised management Land-disturbing actions are not precluded, but must complement recovery Indicated by factors like:

- A major portion of stream segments is seriously degraded.
- Watershed function is degraded over much of the watershed.
- Existing and foreseen disturbances are causing downward trend in watershed function or stream segment integrity toward Class III conditions.

Watershed Sensitivity Watershed sensitivity was simplified to consider 1) surface erosion potential and mass movement potential within each watershed, and 2) the ability of the channel network to resist and recover from disturbances The erosion/mass movement potential rating was determined for individual Ecological Land Units (ELU's) The ELU ratings within a watershed were then combined to determine an overall watershed rating for erosion/mass movement ELU ratings only exist for those lands within the forest boundary. This information was extrapolated to lands outside the forest boundary to determine the overall watershed rating

The ability of a channel network to resist and recover from disturbances was estimated for the main stem of each watershed from field experience, photo and map interpretation, and using a Geographic Information System For example, a channel network which has "high" resistance (e g Rosgen A1-2 channel types) would be well entrenched and have high stream power with the ability to transport increased sediment loads A "low" resistant channel network (e g. Rosgen C4-6) would have low gradient, little entrenchment, low stream power and relatively little sediment transport capacity The following table describes these erosion and mass movement sensitivity ratings

Table B. 3. Erosion/Mass Movement Sensitivity Rating

Rating	Description
High	35% or more of watershed area with high erosion and mass movement ratings.
Moderate	15-35% of the watershed area with high erosion and high mass movement ratings, OR 35% of the watershed area with any combination of high and either moderate or low erosion/mass movement
Low	Watersheds which do not meet the above criteria, generally having much of the area in a combination of moderate and low erosion/mass movement ratings.

The following matrix was developed, based on erosion/mass movement potential and channel resistance/resilience, to estimate the sensitivity of the entire watershed·

Table B.4. Watershed Sensitivity

		Channel Network Resistance/Resilience		
		High	**Medium**	**Low**
Erosion/ Mass Movement Potential	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Medium	High	High

This matrix displays watershed sensitivity as a function of the supply of sediment (surface and mass erosion potential) and the ability of stream network to transport that sediment. For instance, a highly resistant channel network in a moderate erosion/mass movement watershed results in a low sensitivity watershed: one that is easily able to handle increases in sediment loads On the other hand a low resistant channel network in a moderate erosion/mass movement watershed results in a high sensitivity rating. one that would more readily be expected to experience sedimentation or aggradation due to increases in sediment loads

This sensitivity matrix focuses on physical factors such as changes in sediment or flow, and does not address sensitivity to chemical (e g acid mine drainage) or biotic (e.g. diseases) factors.

Disturbance Indicators Where possible, disturbance information was obtained from various Forest databases, and then overlayed with watersheds in a Geographical Information System. The information used is considered the best readily available data, but is qualified by the fact that the databases are in various stages of development, completeness and accuracy. Information on lands managed by the ARNF is more complete and accurate than information on other lands For some data elements, information is only available for lands managed by the ARNF.

Roads and changes in vegetation (e.g. harvest or fire) have the potential to significantly affect watershed condition and were used as indicators of watershed condition Each watershed was rated based on the following categories:

% of Watershed Area w/ Vegetation Change in Last 40 Years	
0 00 - 9 99%	LOW
10.00 - 24 99%	MODERATE
25%+	HIGH

Avg. # of Road Crossings per Stream Mile	
0.00 - 1.99	LOW
2.00 - 3 99	MODERATE
4.0+	HIGH

% of Stream Miles within 150 ft of Road	
0 00 - 29.99%	LOW
30.00 - 54.99%	MODERATE
55.00%+	HIGH

% of Watershed Area Which is Roaded	
0.00 - 0.29%	LOW
0.30 - 0 59%	MODERATE
0 60%+	HIGH

The category boundaries were established by ranking each of the indicators in descending order and visually looking for shifts in the data. Category boundaries simply provide a relative index of the activity across the ARNF and should not be used as absolute thresholds. The assumption is that a full range of disturbance indicators are found in the sampled watersheds.

Quantitative information on other factors that influence watershed conditions are incomplete and less reliable than road and vegetation information. Other major types of disturbances which were identified as potentially significant factors in controlling watershed conditions on the ARNF include: water quantity, mining, recreation, grazing, urban and rural development. Since limited reliable quantitative information is available to address these factors, Forest and District personnel were asked to subjectively determine if activities were significant or insignificant in influencing watershed and riparian conditions.

Total watershed disturbance was then systematically classified as high, moderate or low using the point system outlined in the following table. Watersheds were assigned points for each disturbance parameter (e g percent of watershed area which is roaded, water quantity, etc) and points are summed to provide and index of the cumulative amount of disturbance activities in a watershed Complete spreadsheets of the information used to determine watershed sensitivity and watershed disturbance are available in the planning record

Table B.5. Watershed Disturbance Index Point System

Parameter	Category/Rating	Points
Number Road Crossings/Stream Miles	Low	0
	Moderate	1
	High	2
Percent Streams near Roads	Low	0
	Moderate	1
	High	2
Percent Watershed Roaded	Low	0
	Moderate	1
	High	2
Vegetation Changes (includes harvest and fire)	Low	0
	Moderate	1
	High	2
Water Quantity	Insignificant	0
	Significant	1
Recreation	Insignificant	0
	Significant	1
Mining	Insignificant	0
	Significant	1
Grazing	Insignificant	0
	Significant	1
Non-USFS Land Uses	Insignificant	0
	Significant	1
	TOTALS	0-4 Low Disturbance
		5-9 Mod Disturbance
		10-13 High Disturbance

Watershed Condition Class Assignment Watershed Condition was then systematically estimated as a function of the overall watershed sensitivity and the overall watershed disturbance using the following matrix:

Table B.6. Watershed Condition Class

		Watershed Disturbance		
		Low	Medium	High
Watershed Sensitivity	Low	I	II	II
	Medium	I	II	III
	High	I	III	III

A watershed with a high amount of disturbance activities in a watershed which is not sensitive (low sensitivity) is classified in "Fair Condition" (Class II) Similarly, a watershed with high sensitivity, and a moderate amount of disturbance is classified in "Poor Condition" (Class III).

Watershed Condition Class Verification. The method outlined above to systematically determine watershed condition is based on simplified logical cause/effect relationships. This simplified, systematic approach takes advantage of readily available quantitative data, but cannot adequately account for all factors which determine watershed conditions For example, limiting factors which dictate watershed condition, such as a watershed with no disturbances except for a single major water diversion which completely dries a stream, would not be properly classified using the systematic approach described above

To account for this type of situation, all watersheds were reviewed by the Forest Hydrologist and various technical staff on the Forest after the initial systematic watershed condition class was assigned. Additional factors affecting watershed condition were considered during this review as well as situations where the systematic approach may not have accurately reflected the watershed condition

Watershed condition classes were also compared to the identified "Seriously-Degraded" stream segments to determine if watershed conditions were reflected in the stream network and vice-versa These streams are classified by the State as impaired or threatened in 319(a) report, 303(d) list, or current 305(b) report, and there is no known basis to refute this classification The State report lists causes, which may be physical, chemical, and/or biotic

In the majority of cases, the systematic approach outlined above placed the watersheds in the same condition class as the best professional judgement of the Forest's technical staff. Generally, watersheds which were rated in "Fair" or "Poor" condition had some stream segments which were identified as "Seriously-Degraded" In approximately one-third of the cases, the watershed condition determination resulting from the systematic process outlined above was modified based on additional data and professional judgement Many of these changes were due to a single limiting factor such as flow disruptions or urban/rural development, or a lack of reliable data Documentation for all changes are provided in the planning record.

Results A summary of watershed conditions across the ARNF is shown in the following table A graphical representation of watershed condition can be found in Chapter Three of the *FEIS*. The map also indicates watersheds where any stream or stream segment has a self-propagating population of any designated threatened, endangered, or sensitive aquatic or riparian species of plant or animal (regardless of genetic purity), or any critical habitat designated by the Fish and Wildlife Service.

Table B.7. Results of Watershed Condition Assessment for the ARNF

Watershed Condition	Number of Watersheds	Assessment Area (Acres)	Assessment Area (Percent)
Class I	41	515,082	25%
Class II	87	1,197,466	58%
Class III	19	339,405	17%
TOTALS	147	2,051,953	100%

Summary. This coarse filter watershed condition assessment is a general Forestwide assessment which can be appropriately used for broad scale applications It is not intended for project-level analysis and is not expected to be completely accurate when scrutinized by individual watersheds The ratings are relative to conditions across the ARNF and may not be directly comparable to other areas. The assessment does identify current conditions on a broad scale and provides a starting point to prioritize rehabilitation and protection needs on the Forest as outlined in the *Forest Plan*

Methods for Estimating Water Yields

This section outlines the methods used for estimating water yield increases due to vegetation management for the Forest Plan revision. The methods are primarily based on those found in Chapter Three of "An Approach to Water Resources Evaluation of Non-point Silvicultural Sources (A Procedural Handbook)", known as WRENSS (EPA, 1980) However, WRENSS was designed as a site specific procedure, and some assumptions were required to generalize it for use in (non-site specific) Forest Plan water yield modeling. Suggestions on modeling methods and assumptions were provided by Chuck Troendle, of the Rocky Mountain Forest and Range Experiment Station (RMS), and Jim Maxwell, R-2 Regional Hydrologist Complete results of the water yield analysis are available in the planning record.

There are several computer models of the WRENSS procedure The computer model used for this effort was one developed by Robert Swanston, formerly of the Canadian Forestry Service (the Canadian model). While there is a version developed by the RMS which provides some modifications that reflect the advancing state of the science, data entry and editing is much more difficult if the user is not intimately familiar with the software. The Canadian model has an interface which facilitates ease of use.

Some modifications to the original WRENSS procedure have also been made to the Canadian Model Inputs for wind speed, numbers of days with no snow, and snow scour are all designed to modify the original procedure with regard to snow loss and redistribution However, documentation provided with the model indicates that if Wind Speed is set to "zero", number of days with no snow is set to "zero", lapse rate is set to "one", and snow scouring is set to "yes", the model will provide the same results as the original WRENSS procedure. Chuck Troendle pointed out that while there is nothing wrong conceptually with adjusting snow scour factors, the WRENSS procedure inherently includes snow scour conditions that were present for the data sets used to develop the model, and that before these variables are added to the model, the original nomographs or their digital versions would need to be modified to zero out the effects of the assumed conditions He recommended setting the model to duplicate the original procedure The Forest followed this advice in the analysis.

FVS (Forest Vegetation Simulation) is the model used to provide tree growth and yield information for FORPLAN. It is the standard model used nationally by the Forest Service. Output from FVS was used to provide the vegetation information needed for input into WRENSS, including maximum basal area, pre- and post-treatment basal area, and tree height. Using FVS results ensured that we were working from the same basic set of data for water yield analysis that was used for other resource analyses that were done for the Forest Plan

To simplify modeling, FVS simulation was provided for a number of vegetation regimes Each regime was composed of a tree species, size and location. Eight regimes were modeled for water yield. They were, lodgepole pine large east, lodgepole pine medium east, lodgepole pine large west, lodgepole pine medium west, ponderosa pine medium east, spruce-fir medium to large east, spruce-fir medium to large west, and spruce-fir very large. These were the only regimes which would be affected by timber harvest in the first five decades

Only the effects of clearcutting were estimated using the WRENSS procedure. The effects of partial cutting were estimated by proportioning the water yield from clearcutting by the percent of basal area (BA) removed by the partial cut (e.g a partial cut removing 30% of the basal area will produce 30% of the water yield of a clear cut), as suggested by Chuck Troendle The original WRENSS procedure indicated that the relationship between basal area removed and water yield was not 1 1 (e.g a partial cut removing 30% of the basal area would be expected to produce less than 30% of the water yield of a clear cut). This has not been borne out by more recent research.

The FORPLAN model for the Arapaho Roosevelt produced a harvest category called "special cuts" This was primarily harvest that would be done to benefit other functions, although it would be accomplished through commercial timber harvest. After consultation with the forest silviculturist and wildlife biologist about the kind of treatments which could be expected, lodgepole pine special cuts were treated as clearcuts, spruce-fir special cuts as first step shelterwood treatments, and ponderosa pine special cuts as if they would produce no water yield increase because of the lightness of the treatment.

Water yield was only modeled for the first five decades. Regulations require that the FORPLAN model be run for an entire rotation, but that is primarily to ensure that ASQ is sustainable. Five decades is long enough to show trends in changes in water yield from proposed management, and it is also the time period used for analysis of most other resources

Two of the input parameters required by the WRENSS model are pre-treatment and post-treatment basal areas. Post-treatment basal area was always zero because we were simulating the effects of clear cuts (see above). We had initially intended to estimate pre-treatment basal area by simply averaging the basal area of the suitable-scheduled stands Rudy King (Rocky Mountain Station biometrician) pointed out that the relationship of water yield to change in basal area was not linear, and that averaging the basal areas to produce an average water yield was incorrect He suggested that predicting water yield for a number of classes of basal areas for each species and averaging the results would be more robust. However, after examining the results of the FVS modeling and experimenting with WRENSS, it appears that change in water yield is insensitive to the limited range of pre-treatment basal areas predicted by FVS for the first five decades. We modeled the water yield produced by simulating clearcutting of the smallest and greatest pre-treatment basal areas predicted by FVS for the five decades of treatment. There was no difference in water yield between the two for any vegetation regime.

The following is a block by block discussion of the data required to drive WRENSS

Area. We selected 100 acres. Because the model delivers results in depth, rather than volume, and because we desired unit water yield, area is not particularly important However, we wanted a unit large enough so that we didn't experience the logical inconsistency of having windward widths or harvest block areas that were bigger than the unit areas (although it doesn't appear to matter to the model) Harvest of the entire unit was simulated

Aspect. Each combination of vegetation regime and treatment was modeled for each aspect Because aspect is a discrete rather than a continuous variable, a weighted mean average cannot be calculated. The model is also very sensitive to aspect. We modeled water yield for each aspect and then calculated a weighted mean water yield based on the area of a vegetation type occupying each aspect (this information can be obtained from GIS and RIS databases).

Precipitation. We digitized the isohyetal lines from the "Colorado Average Annual Precipitation Map, 1951-1980" (Colorado Climate Center, 1984) into our GIS. We then used GIS to determine the area of each vegetation type within each precipitation zone (e.g. 16-20 inches, 20-25 inches) and determined a mean weighted annual precipitation as described above for aspect The model requires monthly precipitation To determine this, we gathered monthly precipitation data from SNOTEL sites within or adjacent to the Forest, converted each monthly value to a percentage of annual precipitation and then averaged the values We then used the monthly distributions and the weighted mean annual precipitation for each of the vegetation types to calculate monthly precipitation input for the model.

Chuck Troendle suggested that rather than calculating a mean weighted annual precipitation for each vegetation regime, WRENSS should be run for every precipitation regime for a given timber type and the resulting water yield should be weighted by area. He suggested calculating water yields using this method for one or two timber types and comparing the results to those provided by the alternate method. When we did this for west slope and east slope lodgepole pine, we found that predicted water yield increased by 2 percent for the west side and decreased by 8 percent for the east side We concluded that any changes would be largely canceled out for Forest and that the potentially greater precision did not warrant the significantly greater data input which would be required

The WRENSS procedure adjusts precipitation and evapotranspiration based on the windward width of the harvested opening in relationship to the surrounding forest canopy Changes in aerodynamics above the canopy cause increased snow deposition into the harvested areas The model predicts that deposition will increase with increased opening size until the windward width is equal to approximately five tree heights. Deposition then begins to decrease until it returns to pretreatment conditions at approximately 13-14 tree heights in width. For openings larger than 24 tree heights, WRENSS predicts a reduction in snow retention as snow scour increases (see WRENSS Fig. III-6). This adjustment can be made in the model by adjusting the "Windward Width" variable.

Troendle recommended another approach. He said that more recent research in both Canada and the U S indicated that if sufficient roughness were left in harvest units to retain snow, harvest units of any size would accumulate additional snowpack, and that the amount of increased snow retention was primarily a function of aspect He suggested manually increasing the post-harvest precipitation by 20 percent for south aspects, 30 percent for east-west aspects, and 40 percent for north aspects.

Because the model does not allow for the adjustment of post-harvest precipitation (except through the indirect adjustment of windward width), this adjustment requires that the model be run twice for each vegetation regime The model is first run with unadjusted precipitation to estimate pre-treatment water yield, then the precipitation is increased and the model is run again to estimate post-treatment water yield. "Windward Width" is set to zero for both runs to effectively turn off the models adjustment of precipitation Water yield increase for the regime is then the difference between pre-treatment and post-treatment water yield

Lapse. Lapse allows the user to enter a multiplier which corrects for the effects of elevation on precipitation. It allows the use of local precipitation guage data in a watershed. Because local data was not available for an entire Forest and for the reasons documented above with regard to duplicating the original results of the WRENSS procedure, this parameter was set to "1", no correction

Elevation. The model does not allow entry of an elevation for the Rocky Mountain Region (WRENNS Region 4)

Tree Height. While we entered the average tree height provided by FVS for the first five decades, it is irrelevant if the adjustment to precipitation is made as discussed above.

Type. The only choices for the Rocky Mountain region are Lodgepole pine, Spruce-Fir, Ponderosa Pine, or deciduous Although there is a small component of Douglas Fir in this Forest's suited and scheduled lands, it is so small that the forester's lumped it with Ponderosa Pine for growth and yield modeling. We did the same for water yield modeling.

Wind Speed. As suggested above, wind speed was set to zero.

Days of no snow. As suggested above, days of no snow was set to zero.

Guage. Guage was set to none. This variable allows the user to set the type of wind shield used on a gage It is not applicable if precipitation is not based on site specific data.

Exposure. Exposure was set to zero. This, in conjunction with "Guage", allows the user to adjust precipitation. It is not applicable for this effort.

Unimpacted vs. Impacted. The Canadian model of the WRENNS procedure estimates water yield rather than the change in water yield. In order to estimate water yield increases, pre-treatment stand conditions were entered into the UNIMPACTED column, and post-treatment stand conditions were entered into the IMPACTED column. The model was then run first with unadjusted precipitation and again with adjusted precipitation The change in water yield was the difference between water yield for the UNIMPACTED, unadjusted precipitation units and the IMPACTED, adjusted precipitation units.

Max Basal Area (BA). The maximum BA predicted from FVS was entered. For stands treated with shelterwood harvest, maximum basal area was found on the unharvested simulation (several entries over the rotation may prevent the stand from reaching maximum basal area).

BA. As discussed above, the minor changes in pre-treatment basal area predicted by FVS for the first five decades did not produce differences in water yield when stand harvest was simulated. We entered the greatest basal area predicted for the first five decades

Area Cut. For UNIMPACTED, we entered "zero". For IMPACTED, we entered 100 acres. Because the intent was to estimate the unit water yield per acre harvested, it was important that the entire stand be harvested. Entering a value for AREA CUT that is smaller than the stand AREA will reduce the predicted water yield proportionately

BA in Cut. For UNIMPACTED, we entered the same basal area as in BA, see above For IMPACTED, we entered zero. Entering a value greater than zero allows the user to use the WRENSS procedure to estimate the effects of partial harvests As discussed above, we used the method suggested by Troendle to estimate the water yield of partial harvest based on the predicted water yield of clearcuts.

Roughness Height. The model is insensitive to this, if Wind Speed is set to zero as suggested. Default value is set to 1, we left it at that.

Windward Width. As discussed above, windward width of clearcut units affects snow deposition and snow scour. Because we manually adjusted precipitation as discussed above, windward width was set to zero to turn off the models adjustment of precipitation.

Block Area. If, and only if, WINDWARD WIDTH is entered as zero, the program takes the value entered into BLOCK AREA, assumes a rectangular opening and calculates the length of one side. This value is automatically entered into WINDWARD WIDTH We set this to zero in order to turn off the models adjustments to precipitation

This ends input into the program. The result is a list of water yield increase values. Three values were produced for every timber regime modeled by FVS, one for each aspect (North, South, and East-West) The three values were reduced to one by weighting them by the area occupied by a timber type on each aspect. The result was a mean weighted unit water yield for clearcuts expressed in terms of acre feet per acre harvested Yields from shelterwood or other partial harvest treatments were calculated by determining the percentage basal area removal for each step in the shelterwood harvest (as compared to the basal area before the first treatment) and multiplying the clearcut unit water yield by the percent basal area removal to reduce the water yield accordingly

Results from FORPLAN provided the average annual acres harvested for each vegetation regime by each treatment type for each decade. Multiplying the unit water yield increase for each vegetation regime and treatment type (e g. clearcut, 1st step shelterwood, 2nd step shelterwood, etc) by the average annual acres harvested for each regime and treatment produced an average annual water yield increase for each decade. Summing water yield increases for each vegetation regime and treatment produced a total average annual water yield increase for the decade

Increases in water yield produced by vegetation management persist for many years after the initial treatment as trees regenerate and grow. The water yield declines as the trees grow. To account for persistence in water yield increase, we used the linear 80 year recovery curve suggested by Troendle and King (1985) Water yield increases produced by harvest from a given decade were reduced by 12.5 percent for each subsequent decade For example, timber harvest in the 1st decade produced declining water yields in decades 1-5, timber harvest in the 2nd decade produced declining water yields in decades 2-5, etc Actual water yield persists for eighty years following treatment, but we only modeled the effects for the first fifty years Total water yield for each decade was calculated by summing the water yield produced by timber harvest in that decade with the water yield still being produced by harvest in previous decades.

SECTION 6 - RANGE CAPABILITY AND SUITABILITY FOR LIVESTOCK GRAZING

An analysis of the capability of rangelands to support livestock grazing and an analysis of the appropriateness for livestock grazing to occur on particular areas of land was completed as part of the Forest Planning process. The following definitions were used to complete the analysis.

Definitions and terminology (36 CFR 219.3)

"**Capability**" The potential of an area of land to produce resources, supply goods and services, and allow resource uses under an assumed set of management practices and at a given level of management intensity. Capability depends upon current conditions and site conditions such as climate, slope, landform, soils, and geology, as well as the application of management practices, such as silviculture, or protection from fire, insects, and disease

"**Suitability**" The appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences and the alternative uses foregone. A unit of land may be suitable for a variety of individual or combined management practices.

Rangelands identified as capable and suitable for domestic livestock grazing in the land and resource management plan may include areas that are not appropriate for domestic livestock grazing when analyzed at the site specific level, such as some wetlands or some campgrounds. Therefore, the appropriate site-specific decision would be not to allow grazing on those specific areas

In some situations domestic livestock need not be prohibited from areas not identified in the plan as capable and suitable For example, a forested area with sufficient forage to support domestic livestock may not be identified as capable and suitable but the presence of domestic livestock drifting from a adjacent suitable area may not conflict with other uses. In this situation, it would not be necessary to physically prevent access to the forested area by domestic livestock but there would be no forage allocation made

Capability Analysis. The following criteria were used to identify areas not capable of supporting livestock grazing:

- Slopes greater than 40 percent,
- Severely erodible soils,
- Forage production less than 200 pounds per acre,
- Water bodies,
- Limited water, and
- Other features like rock, pavement, roads, and cliffs

As a result of this analysis, 305,187 acres were found to be capable and 983,862 acres were found not capable on the ARNF On the PNG, 192,504 were found to be capable and 556 acres were found to be not capable. The planning record contains additional information.

Suitability Analysis. A suitability analysis identifies where grazing is appropriate, considering environmental and economic consequences and alternative uses foregone. Suitability for rangeland is also evaluated when each allotment management plan is completed. Currently, nine of forty-seven allotments have been completed. The remainder of the allotments are scheduled and will be analyzed by 2010.

Range Management Prescriptions To assess the economic and environmental consequences of range management, three different range management prescriptions were developed and analyzed

The first range management prescription is the continuation of current management This is the baseline, or "no action" prescription Under the current management prescription, existing improvements that have reached the end of their physical life span will be reconstructed New improvements will be added to the Forest as identified by project analysis Areas identified as being in unsatisfactory condition will become satisfactory through mitigation identified in site specific analysis and allotment management plans. Generally for this prescription, lands in unsatisfactory condition will be rehabilitated using practices like altering the timing of grazing, increasing utilization standards, or fencing Under this management prescription, about 3.5 acres per AUM (or 0.29 AUMs/acre) is sustainable over the 50-year planning period.

The second range management prescription is a reduced level of grazing. In most areas, existing improvements that have reached the end of their physical life span will be reconstructed New improvements will be constructed to improve areas in unsatisfactory condition. New improvements will exclude livestock from grazing in areas identified as not suitable for livestock grazing The priority for improvements would be areas where there is a conflict with wildlife, riparian areas, or other areas in unsatisfactory condition. Generally for this prescription, lands in unsatisfactory condition will be rehabilitated by prohibiting use or fencing. Other practices may also be used depending on the site-specific analysis. Under the reduced level of management, about 4 5 acres per AUM (or 0 22 AUMs/acre) is sustainable over the 50-year planning period

The third range management prescription analyzed is a no grazing prescription This is a benchmark prescription and developed only to analyze affects Under this prescription, few structural improvements are maintained for livestock management Most improvements, such as fences, are for other management purposes There would be no permitted livestock on the Forest Lands in unsatisfactory condition would be rehabilitated through natural recovery processes.

Environmental Consequences Potential environmental consequences to terrestrial habitat and wildlife includes occupying habitat, consuming or trampling vegetation, or affecting nesting habitat Under the no-action prescription, only isolated occurrences of competition for habitat are expected In the past, these conflicts are mostly due to livestock use and grazing on winter range or other important habitat. Conflicts have generally been alleviated by fencing or altering the timing of grazing Livestock grazing is not known to be adverse at this level, particularly with the standards and guidelines regarding livestock grazing and protecting wildlife habitat

The reduced-level prescription would have even less potential to affect wildlife populations and terrestrial habitat due to lower grazing levels. The no-grazing prescription would have no wildlife - livestock grazing conflicts. However, the no grazing prescription on the Pawnee would create a detrimental situation for the Mountain Plover because the increase in plant height without grazing would limit the amount of nesting habitat unless other actions to reduce plant height are taken

The Forest and Grassland are capable of producing suitable food and cover for wildlife species and supporting livestock grazing under either the no-action or the reduced-level prescription for the following reasons On the Forest, only twenty percent of the capable lands (approximately 62,000 acres) are being grazed by livestock Management indicator species like elk, deer, bighorn sheep, leopard frog, boreal toad and Wilson's warbler plus other wildlife species depend upon habitat that may be affected by livestock Since so little of the Forest is being affected by livestock grazing and since there are Forestwide Goals, Standards and Guidelines to maintain these habitats, it is estimated that the Forest is capable of producing suitable food and habitat. On the Grassland, almost all the capable lands are being grazed by livestock but utilization levels are managed to support wildlife species and livestock. Habitat and forage for management indicator species like pronghorn, mountain plover, lark bunting, mule deer, leopard frog plus other species is produced or maintained based on research from the Central Plains Experiment Range and other available data. Forestwide Goals, Standards and Guidelines also apply to the Grassland and require that livestock grazing be controlled or managed to provide sufficient habitat and forage The no-grazing prescription is also capable of producing suitable food and cover for wildlife species because there is no competition with any wildlife species from livestock grazing.

Effects to aquatic and riparian resources are often a major concern with livestock grazing on public land. The ARNF has many capable acres in or adjacent to riparian areas. The effects on riparian are a loss of willows and deep-rooted grasses and bank trampling. This leads to streambank erosion, stream widening, and reduces overhead cover for fish Under the no-action alternative, there is the most potential for these effects to take place. However, practices such as fencing, altering the timing of grazing, and higher utilization standards will minimize this potential Under the reduced-level alternative, fewer allotments remain open and more areas are excluded by fencing rather than changing the timing of grazing and requiring higher utilization standards Therefore, less damage to aquatic and riparian resources will result. Under the no-grazing alternative, no damage to aquatic and riparian resources would be due to livestock grazing However, there would not be a major difference between the no-action and reduced-level prescription because some grazing would continue in riparian areas under either prescription. Restoration and rate of recovery will be faster under the reduced-level prescription and fastest under the no-grazing prescription.

Aquatic and riparian resources on the PNG are very limited Most of these are fenced or otherwise excluded from grazing There would essentially be no difference between the three prescriptions on the PNG. Other environmental consequences of livestock grazing are described in Chapter 3 of the FEIS

The largest pest problem with rangelands is noxious weeds. Noxious weeds are discussed in the Rangeland section of Chapter 3 of the *FEIS*. There are no wild and free-roaming horse and burro populations on the ARNF-PNG and consequently, no effects or conflicts with livestock grazing.

Economic Consequences. The Forest desires to have a managed livestock grazing program where cost efficiencies are among the factors that are taken into consideration when deciding between range management prescriptions

Economic analyses were undertaken from two perspectives The first considers a taxpayer perspective, including only revenue received from grazing fees and agency expenses in managing for livestock production This is referred to as a "financial efficiency" analysis The second considers the full market value of grazing under permit as benefits and the same agency expenses as costs. This is referred to as a "cost efficiency" or "economic efficiency" analysis

The first analysis uses the 1996 grazing fee rate established by Congressional formula of $1 62 per animal unit month (AUM) for grazing on the National Forest and $1.70 per AUM for grazing on the National Grassland. The second analysis uses the RPA market clearing value of $9 60 per AUM for grazing on the National Forest and $12.00 per AUM for National Grassland.

Agency costs include permit administration and a portion of the development, maintenance, and reconstruction of allotment improvements.

Financial efficiency and cost efficiency are expressed in terms of present net value (PNV) on a per-acre basis Revenues, benefits, and costs are discounted over 50 years at a 4% discount rate The results are shown in the following table

Table B.8. Summary of Economic Analysis for Livestock Grazing Suitability

ANNUAL AVERAGE OVER 50 YEARS			
	Prescription A **Current Management**	***Prescription B*** **Reduced Level**	***Prescription C*** **No Grazing**
ARNF AUMs (Cattle)	25,433	8,200	0
PNG AUMs (Cattle)	55,560	54,630	0
Total AUMs	**80,993**	**62,830**	**0**
ARNF Suitable Acres	91,572	91,572	91,572
PNG Suitable Acres	192,504	192,504	192,504
Total Suitable Acres	**284,076**	**284,076**	**284,076**
ARNF AUMs per acre	0 2777	0 0895	0 0000
PNG AUMs per acre	0 2886	0 2838	0 0000
Total AUMs per acre	**0.2851**	**0.2212**	**0.0000**
ARNF acres per AUM	3 6005	11 1673	0 0000
PNG acres per AUM	3 4648	3 5238	0 0000
Total acres per AUM	**3.5074**	**4.5213**	**0.0000**

	Prescription A Current Management	Prescription B Reduced Level	Prescription C No Grazing
Revenue/AUM ARNF	1 62	1 62	1 62
Revenue/AUM PNG	1 70	1.70	1 70
Revenues/acre ARNF	0 45	0.15	0 00
Revenues/acre PNG	0 49	0 48	0 00
Average Revenue/Acre	0 48	0.37	0 00
Benefits/AUM ARNF	9 60	9.60	9.60
Benefits/AUM PNG	12 0	12 00	12 00
Benefits/acre ARNF	2 67	0 86	0 00
Benefits/acre PNG	3 46	3.41	0 00
Average Benefits/Acre	3 21	2 58	0.00
Permit Admin Costs	$479,000 00	$262,000 00	$0 00
Range Impr Costs	$97,000 00	$457,000.00	$0 00
Total Cost	$576,000 00	$719,000 00	$30,000 00
Costs per acre	$2 03	$2.53	$0 11
Net revenues per acre	-1.55	-2 16	-0.11
Net benefits per acre	1 18	0 05	-0 11
Financial Efficiency Per Acre			
Present Value Revenue	10 74	8 40	0 00
Present Value Costs	45 59	56 90	2.37
Present Net Value	-34 85	-48 50	-2 37
Economic Efficiency Per Acre			
Present Value Benefit	72 09	58 11	0 00
Present Value Costs	45.59	56 90	2 37
Present Net Value	26 50	1 21	-2 37

The economic analysis indicates that Prescription A provides the highest and prescription B the lowest financial efficiency PNV per acre Prescription C provides the lowest economic efficiency and the highest financial efficiency PNV per acre.

The local economic impacts of grazing suitable lands in each alternative is included in the comprehensive estimate of jobs and income This is found in the Social and Economic section of the *FEIS*

Alternative Uses Foregone. Few lands are incompatible with grazing or browsing. Management area prescriptions identify forest management activities that are allowed and appropriate for the area Livestock grazing has been identified as an appropriate activity to occur within all the management areas with the exception of MA 8.21 Developed Recreation Complexes and MA 8.22 Ski-Based Resorts. Grazing is not appropriate in these management areas in order to prevent the loss of alternative uses like recreation Other management areas allow only limited grazing to maintain alternative uses. Management areas MA 1 1 Wilderness, MA 1.41 Core Habitats-Existing, and MA 2.2 Research Natural Areas are examples where only limited grazing is allowed See the Management Area Direction in the *Forest Plan* for the complete listing

There are other areas of land within the Forest that do not have permitted livestock grazing for various reasons Areas with intermixed ownership patterns, although capable, are generally not suitable due to administrative costs, concerns of private landowners and homeowners, and the difficulty of controlling livestock in these types of areas. The development of subdivisions or other homesites within the National Forest boundary during the last 10 to 15 years is reducing the amount of area suitable for grazing. Areas such as campgrounds and administrative sites are not suitable for livestock grazing. There are also areas on the Forest where no range allotments exist, due to logistical limitations for livestock access to the area. These unsuitable areas are common to all alternatives. The planning record contains additional details about suitability determination.

Other than the situations described above, few alternative uses are foregone by implementing either the no-action or reduced-level prescription. Because so much of the ARNF is not capable for livestock grazing, there are few limitations to other uses due to the livestock grazing program On the PNG, implementing either prescription would not affect or change how the Grassland is used. There is almost no difference between no-action and reduced-level prescription for the ARNF or the PNG. The no-grazing prescription would not impact other uses or require that other uses be foregone

Suitable Lands. Suitability is affected by the incompatible uses listed above. The environmental and economic consequences for the three range management prescriptions do not affect the suitability determination. For prescriptions A and B (the two "action" range management prescriptions), environmental consequences are acceptable and economically efficient Range prescriptions are applied to the alternatives in a cost efficient manner, based on the theme of the alternative and allocation of management area prescriptions Because range is not an issue for the Plan Revision, prescription A (current management) is applied to the suitable acres of all alternatives except H Because of the theme of the alternative, prescription B (reduced management) is applied to the suitable acres in Alternative H The following table summarizes the suitable range acres available on the Forest by Alternative

Table B.9. Suitable Acres/AUMs by Alternative

Unit	Alternative					
	A	B	C	E	H	I
ARNF						
Suitable Acres	91,572	62,653	91,572	62,653	48,550	105,800
AUMs	25,433	17,400	25,433	17,400	8,200	30,400
PNG						
Suitable Acres	192,504	192,504	192,504	192,504	191,984	192,504
AUMs	55,560	55,380	55,560	55,507	54,630	55,560

Alternatives A, C, and I have the most suitable acres because the theme of the alternatives features commodity production and because the amount of Management Areas allowing or featuring livestock grazing is the highest. These three alternatives include the capable lands within open and vacant allotments as suitable for grazing. These allotments have not been grazed for thirty years but could be grazed in the future Alternatives B and E have less suitable acres because the themes of the alternatives are less commodity oriented and the amount of Management Areas allowing or featuring livestock grazing is lower These two alternatives do not include the capable acres within the vacant allotments These capable acres were determined to be unsuitable due to their location mostly within lands of intermingled ownership or within old sheep allotments at high elevations. Alternative H has the lowest number of suitable acres because it allocates most of the Forest and Grassland to Management Areas that limit or do not allow livestock grazing Alternative H also does not include the capable acres within vacant allotments as suitable for grazing for the same reasons as Alternatives B and E

SECTION 7 - SOCIAL AND ECONOMIC IMPACT ANALYSIS

Analysis Overview. Many communities and people in the Colorado area are dependent upon the Forest for their economic, recreational, and social way of life Many of the ICOs reflect the importance of the Forest to both local and regional publics. Social and economic impact analysis examines the consequences of different land management decisions on the people and communities surrounding the Forest, especially within the Forest's influence area (Clear Creek, Gilpin, Boulder, Larimer, Grand, and Weld Counties)

Economic effects analyzed included changes in employment and in total income Payments in lieu of taxes would also vary These economic effects are accompanied by social effects in local communities Social effect included changes in population and land uses; lifestyle, attitudes, beliefs, and values and in community identity (stability and cohesion) The framework of the economic and social analysis was developed under the guidance of the Regional Sociologist, the Regional Economist, and FSH 1909 17, "Economic and Social Analysis."

Economic Impact Analysis

Overview. Economic impacts were estimated using the best available data and tools Not one tool or data set were used for all purposes As noted in each section below, data that was best suited for estimating the impacts of one resource were not necessarily the best for estimating impacts of other resources Some data are confidential in nature, other data are available to the public IMPLAN PRO (described below) was the primary tool for determining impacts, but the method of using IMPLAN PRO varied by resource and data availability.

Measures of Impacts. Impacts to local economies can be measured in several ways Typically, employment and income are the most common and best understood measures. Employment is expressed in "jobs" -- a job can be seasonal or year-round, full-time or part-time. The income measured used is Personal Income expressed in 1996 "dollars"

Base Year Data. The most comprehensive and nationally consistent data available for employment and income are provided by Bureau of Economic Analysis' Regional Economic Information System (REIS) The most recent release of county-level data was June 1996 This release included data from 1969 to 1994. IMPLAN PRO uses this data as well as ES-202 data from the BLS as the fundamental basis in its economic data base Adjustments to the data are necessary to complete the IMPLAN PRO data base and fully integrate it into the input-output framework.

IMPLAN PRO IMPLAN PRO is a system composed of both software and data IMPLAN was originally developed by the USDA-Forest Service in the late '70s and early '80s to model the many rural economies affected by agency programs and policies. It was a secondary-data-based input-output modeling system This software remains in the public domain, but a completely revised and upgraded version of IMPLAN, call IMPLAN PRO, has been developed by the Minnesota IMPLAN Group, Inc (MIG) The data base is also proprietary and supplied by MIG IMPLAN, and now IMPLAN PRO is used by universities, extension professionals, private consultants, and public agencies throughout the country as a reliable, cost-effective way to estimate the employment, income, and other economic effects of both private and public sector endeavors Numerous academic papers and publications each year use and cite the IMPLAN modeling system

For the purpose of analyzing the impacts of Forest Plan revision alternatives, the 1993 database was used. Although IMPLAN PRO models reflect 1993 conditions, the dollar impact results may be expressed in whatever year is appropriate by using inflation factors 1996 is used in the *FEIS*

IMPLAN PRO was used to provide Type II multipliers for direct dollar changes or response coefficients for changes in output production 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 output. Spreadsheets were then employed to calculate total effects Specifications for developing response coefficients are stated in each section below

Three IMPLAN PRO models were developed: one for Larimer and Weld Counties, one for the Denver-Boulder area (Adams, Arapahoe, Boulder, Clear Creek, Denver, Douglas, Gilpin, and Jefferson Counties), and one for Grand County. One additional model was developed to account for the processing of sawtimber in Albany and Carbon Counties, Wyoming

Timber Data Primary data for the sawmill and logging sectors in the Rocky Mountain Region are not readily available in published data bases. Because there are often only 1 or 2 mills in a county, privacy laws restrict access to this data Occasionally, informal surveys done by industry agreement or state-wide surveys by public agencies provide the best available data The best and most recent employment data that allows correlations with production were collected by the timber industry in New Mexico and Arizona and by the University of Wyoming for southern Wyoming. The New Mexico and Arizona information was provided to the Forest Service in 1990 in conjunction with studies done regarding the Mexican Spotted Owl The Wyoming data was provided in January 1996 While data for individual firms is confidential and was not made available to the Forest Service, industry-wide employment data was available. A comparison of direct employment per MMBF log scale to the mills was made, and revealed small differences between the studies The Wyoming data was used to estimate impacts from sawmill production

The best source of wages and salaries came from "1995 Statewide Wage Survey Results: Agriculture Forestry, Construction and Operator Occupations" in the September 1995 issue of Wyoming Labor Force Trends (Wyoming Employment Resources Division). Another study by the same state agency in June 1992 entitled "Wyoming Timber Industry. Structure, Conduct, and Expectations" provided similar information. In both studies, payroll expenses per employee were shown by three-digit SIC industry (241 & 242) Because personal income includes all sources of income rather than simply employee compensation, the relationship between the two in IMPLAN PRO was used estimate personal income from this payroll data

Type II multipliers for employment and personal income were developed by industry aggregate from model reports Multipliers for the Logging sector (#133) and Sawmill sector (#134) were then applied to the direct employment and personal income per MMBF from above to determine total effects per MMBF. Results were then multiplied by total MMBF production to estimate total effects in the local economy.

Oil and Gas Data. Oil and natural gas production and sales by county for 1993 and 1996 was obtained from the Colorado Oil and Gas Conservation Commission. Sales data (expressed in barrels and thousand cubic feet) for the county modeled provided a total physical production estimate Because the model has a single sector for both oil and gas production, gas production was converted to oil barrel equivalent using a national average of BTU per barrel and per MCF used in Forest Service RPA analysis (5.6256 barrels = 1 MCF) Production of oil & gas on NFS land for each alternative was expressed in MM barrel equivalents.

To use the data above, it was necessary to know the impacts of a given change in total production Natural Gas & Crude Petroleum (sector #38) in IMPLAN PRO was used to estimate impacts. One percent of this sector's total industry output was run through the model, without using local purchase coefficients and compared with one percent of total quantity sold in 1993. Response coefficients per MM barrel equivalent for employment and personal income were calculated Results were then multiplied by total FS production for each alternative.

Grazing Data. The best available data for agriculture is found in the 1992 Census of Agriculture Total farm livestock inventory from Tables 14 and 17 times 12 months provided an estimate of total animal-months in the model area. Where disclosures existed in the Census data, numbers were estimated based on average farm numbers in nearby counties. Animal-months of grazing on Forest Service land were provided from FS permit records A proportion of FS animal-months to total animal-months was calculated.

To use the data above, it was necessary to know the impacts of a one percent change in total production. Range-fed Cattle (sector #4) in IMPLAN PRO was used to estimate impacts. One percent of this sector's total industry output was run through the model, without using local purchase coefficients Results were then multiplied by the changing proportion of FS animal-months to total animal months for each alternative.

Recreation and Wildlife Data. Surveys of recreationists expenditures for different kinds of recreation activities have been collected by Forest Service researchers over many years. PARVS is the FS database which holds national recreation expenditure information. This information has been organized for use in IMPLAN PRO by the Washington Office The expenditures were distributed among different industries according to their spending patterns The results were then converted to a common unit of measure -- Recreation Visitor Day (RVD). National expenditure profiles for non-residents expenditures within 50 miles of the activity site were used for estimating impacts from all recreation except for wildlife-related recreation

The U S Fish & Wildlife Service periodically conducts a national survey to obtain, among other information, data on recreation expenditures for hunting, fishing, and other wildlife-related recreation. This information is available by state These expenditures profiles were also organized for use in IMPLAN PRO by the Washington Office Expenditure profiles for non-resident expenditures in Colorado were used for estimating impacts from wildlife-related recreation.

Expenditures for every 1,000 RVDs (MRVD) were run through the model without local purchase coefficients applied The results (response coefficients for employment and total income)were then incorporated into a spreadsheet where they were multiplied by non-local MRVDs only Explanation of rationale for using only non-local MRVDs. Only non-local recreation expenditures ("tourism export") use is considered for impact analysis because it is customarily considered a basic economic activity.

Federal Expenditures & Employment Data Total Forest obligations by budget object code for Fiscal Year 1996 were obtained from the National Finance Center. Expenditure profiles by budget object code were provided by the Washington Office. The salary/non-salary ratio of 60 percent/40 percent were determined by examination of the budget object code data Forest Service employment per $million of salary expenditures was based on personal examination of historical FS obligations within the Rocky Mountain Region.

To obtain an estimate of total impacts from Forest Service spending, each portion (direct, indirect, and induced) of the impact must be handled separately. Direct impacts are simply Forest Service employment and salaries (cost to government) Indirect and induced impacts as the consequence of local non-salary expenditures are determined by using the budget object code information noted above. This profile was run through the model for non-salary expenditures per $1 million Induced impacts result from FS employees spending a portion of their salaries locally IMPLAN PRO includes a profile of personal consumption expenditures for three income categories, the middle income category was used to represent average Forest Service employees This profile was also run through the model per $1 million Across the United States, Americans typically spend about 67 percent of their total salary plus benefits Therefore, Forest Service salaries are multiplied by 0.67 before the induced coefficient on a "per $1 million" basis is applied

Revenue Sharing -- 25% Fund Payments Data Federal law requires that 25 Percent Fund payments be used for only schools or roads or both. Colorado law further requires that at least 5 percent of these funds must be spent for each purpose A 50 percent split was assumed for impact purposes

National expenditure profiles for "state/local government education" and "state/local government noneducation" are provided within IMPLAN PRO. One million dollars of each profile was used to obtain an estimate a response coefficient for these Forest Service payments to impact area counties

Changes from Draft to Final EIS Many changes were made for the *FEIS*. The differences from DEIS to FEIS are

- IMPLAN PRO was used rather than IMPLAN.
- Type II multipliers were used rather than Type III.
- Personal Income is used as the measure of income rather than Total Income by industry.
- National PARVS expenditure data for recreation were used rather than Region 2 data
- U S. F&WS expenditure data for hunting & fishing in Colorado were used rather than Region 2 data
- Grazing impacts were corrected from "thousand head-months" to "head-months"

- Impacts from oil & gas were corrected for the production of natural gas, 1996 oil and gas sales, and corporate headquarters employment in Denver
- Impacts from sawtimber processing were moved from Colorado model areas to Wyoming. Impacts from sawtimber logging were retained in Colorado
- Impacts from timber now include "products other than logs" in addition to sawtimber
- Impacts from sawtimber were based on local survey data for direct employment and wages rather than generalized estimates
- Forest-specific budget object code data was used in place of generalized estimates
- County and school district expenditures of revenue-sharing (25% fund) payments were included in impact estimates

More specific detail about the analysis can be found in the administrative record

Social Impact Analysis

Overview. The process consists of delineating and categorizing different Forest user groups within the local area and surrounding regions in which the social environment could be affected by land management planning decisions The effects that might result from the implementation of each alternative are then identified.

The effects of land management decisions are most evident in rural areas where the variety and quality of available natural resources often determine the chief means of socioeconomic livelihood and influence local preferences for the use of public lands Proposed changes in the availability or permitted uses of National Forest resources are of importance to residents of affected communities, commercial users, and recreational users. Other people, including many who visit the Forest, also have a strong interest in how forest resources are managed

Forest Zone of Influence for Social Analysis. The area considered in the social impact analyses is called the Forest zone of influence A description of the social environment often does not lend itself to political boundaries such as counties, so the zones are a geographic area that is characterized by particular patterns of lifestyles, economic conditions, developments and social trends The zones vary in size but are typically larger than individual towns and communities. The nine zones are Frazer Valley and East Middle Park, Clear Creek, Boulder, Estes; Poudre, Laramie River Valley, Redfeather; Pawnee; and, Denver-Boulder Metropolitan and North Front Range

Social Groups and Variables. People using the Forest are divided into social groups for purposes of analyzing social effects Social groups can be expected to react in the same general manner to various policies and decisions made by the Forest Service The five social groups identified as likely to be affected by the management direction expressed by the alternatives are

(1) Long-time residents. Families with traditionally rural-conservative philosophies more closely tied to the timber, mining or leasing, and grazing uses of the forest and grassland.

(2) Part-time residents: Families that permanently reside in predominately urban areas, but live part time on land adjacent to or within National Forest boundaries
(3) Local Business people People that are dependent on National Forest programs and products
(4) Regional recreationists. People who live in metropolitan areas and recreate in the forest and Grassland.
(5) Former urban residents: People who have moved from urban areas to areas adjacent to or within National Forest boundaries in search of a quite, more rural atmosphere

These groups were developed through a variety of sources, including examination of Forest land use trends on this Forest and similar urban Forests, public input during the scoping process, use surveys, and census data.

The impacts of the Forest Plan alternatives on social groups were measured and analyzed by the effect on the social groups. The indicators used to measure social effects are.
(1) Population and Land Use: This variable includes population characteristics and distribution, as well as the pattern of land uses within an area
(2) Lifestyle: This variable includes the quality of life for individuals and groups
(3) Attitudes, Beliefs, and Values This variable encompasses perceptions of agencies, dependency for basic needs and feelings of certainty about the future.
(4) Social Organization. This variable discusses the social groups within the zone and includes the elements of community stability and community cohesion Both concepts are related to the sense of belonging associated with mutual community interests and goals

Social Impact Analysis. Once the economic impacts in terms of jobs, personal income, and the returns to government are analyzed, the anticipated social impacts resulting from implementation of each alternative are assessed The identification of social impacts were qualitative rather than quantitative For each alternative, statements were developed regarding how some management practices and output levels would affect the social variables This analysis considered changes in quantitative outputs, resulting in perceived shifts in Forest-related work and leisure opportunities, and the social impact on the communities within the Forest's zone of influence

Some of the social impacts are tied to anticipated changes in the economic well-being of the counties (as estimated by the Forest's IMPLAN model), however, not all of the social impacts are directly linked to concerns about jobs and income Some of the social impacts revolve around the attitudes, beliefs, and values of different groups of citizens who are influenced either directly or indirectly by Forest management decisions. Sensitive issues regarding how the Forest should be managed polarize some groups against others as each group attempts to influence Forest Service decisions and policies

Gradual changes to the social structure of a community are inevitable and are usually a part of the growth and development of any community Drastic, rapid changes can be destructive to a community if they either cause the existing social infrastructure to be overwhelmed by a large influx of people with different social values or cause a large part of the existing social infrastructure to disappear as when a major way of life disappears from the community.

The principal effects on the social environment are often related to the degree of change from current or historic output levels and/or character of the Forest. The effects will depend on the nature of the alternative being considered Alternatives proposing the largest changes appear to have greater potential impacts Commodity-oriented alternatives tend to maintain the economic aspects of the social structure in the area, patterns of work are supported or enhanced by resource supplies provided by the Forest in these alternatives Alternatives that project reduced outputs of commodities tend to decrease jobs based on traditional Forest use

Other types of Forest Service decisions can influence the social well-being of Forest-dependent communities. Generally, individuals, groups, or communities that view or use the Forest from an amenity standpoint are positively impacted by amenity-oriented alternatives and negatively affected by alternatives with a commodity emphasis

The implications of land management decisions apply to entire communities as well as to groups within the communities. Community and group cohesion may be correlated to the degree of change proposed in forest management. Decisions such as those regarding whether or not to develop roadless areas for timber harvesting and how much timber should be harvested at the expense of scenic quality as well as other noncommodity types of resources may tend to polarize groups with different values and to pull together groups with common values Different issues may also change the composition of the groups.

To some degree the various groups tied to the Forest are inherently at odds due to their different perspectives on the Forest. Almost all groups and communities can adapt to slow changes in their environment; however rapid and dramatic changes in Forest management are likely to bring about some level of social disruption and create some potential for increased conflicts in communities or groups.

SECTION 8 - THE FOREST PLANNING MODEL (FORPLAN)

Overview. FORPLAN is a computerized linear programming model (LP) model that chooses among alternative activities given a set of constraints and an objective such as maximizing income or maximizing volume Although FORPLAN is a standardized model used by all National Forests in the development of Forest Plans, there is no standard way of using the model. The tool is flexible and can be adapted to the need of each individual planning problem

The ARNF used FORPLAN as a timber harvest scheduling tool FORPLAN was not used to make land allocation decisions Those decisions were made first, and the acres assigned to each management area were transferred to the model. The model then chose what type of harvest should be done and when to meet the objectives and the constraints.

FORPLAN was used to schedule timber harvests by decade for twenty decades (200 years). This long planning horizon was used due to the long rotation for species on the Forest

Timber Resource Suitability Assessment. This section summarizes the suitability of lands for timber production assessment. Due to the complexity of the analysis, this section of Appendix B does not go into the details of the analysis The details are contained in the planning record document titled: Detailed Description of Timber Resource Analysis

Timber resource suitability assessment consists of 3 parts, usually referred to as stages, defined in 36 CFR 219.14. Stage I is the physical and legal suitability assessment. Stage II is the financial efficiency assessment based on costs and revenues Stage III is allocation of lands to management prescriptions and timber harvest scheduling Stage III identifies the timber production rates for each alternative, based on the suitable lands, financial and environmental factors, and on a linear programming optimization

<u>Stage I - Physical and Legal Suitability</u>

In this stage, land is removed from further consideration for harvest based on physical characteristics, legal requirements or prior administrative commitments as displayed in the following table. Non-forested areas are also removed from further consideration Legal withdrawals for timber harvest are due to designation as wilderness or other legislative decisions Administrative withdrawals exist for rights-of-way and other similar encumbrances on uses of the land. Legal requirements are also imposed, by the National Forest Management Act, for conditions such as: potential for irreversible damage to soil production or watershed conditions, inability to achieve restocking within 5 years following harvest

Table B.10. Physical and Legal Suitability of Lands

	ACRES
TOTAL ARNF and PNG	??
Total Pawnee	192,542
Total Arapaho and Roosevelt	??
Unsuited - Non-Forest Vegetation	293,703
Unsuited - Withdrawn by Law	212,899
Unsuited - Withdrawn Administratively	27,826
Unsuited - Physically Not Suited	54,589
Total Unsuited	589,017
Total Tentatively Suitable	699,711

The suitable lands acreage is the same for all alternatives and will be assessed in the Stage II analysis which identifies financial efficiency.

Stage II - Financial Efficiency Assessment

The remaining suitable lands are analyzed for financial efficiency using direct benefits and costs. This stage does not screen any lands from further analysis or allocation, but displays information about financial efficiency This information is useful in guiding and interpreting the allocation process The land types, costs and revenues used in the analysis are found in the planning record. The following is a brief discussion of the analysis process and the results

The Stage II analysis consisted of cost, revenue and Present Net Value (PNV) determinations. Cost were estimated for· roading, sale preparation/administration, regeneration, thinning and inventory for each land type and harvest method during the stand life cycle (called a rotation) Revenue from timber sales was provided by the Regional Office based on an average of recent sales. PNV was calculated by discounting the revenues and costs to the present, then subtracting the cost from the revenue PNV was analyzed separately for existing stands and for future stands that regenerate following harvest.

The following tables show treatment type, timing and PNV with the highest PNV in each landtype (access class, forest type, management status) The list is separated into 3 sections to represent existing mature stands (some of which, may have been partially harvested at this time) and existing young stands that are regenerating.

Table B.11. Highest PNV for each Analysis Area and Treatment Type.

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
EXISTIING MATURE STANDS						
001	Accessed	LP East Lrg	Unmanaged	Clearcut	01/150	537 44
002	Accessed	LP East Lrg	Eqv Prep	Seed/Rem SW	01/150	33 82
003	Accessed	LP East Lrg	Eqv Seed	Removal SW	04/180	-25 47
004	Accessed	LP East Lrg	Eq SdwRgn	Removal SW	04/180	-51 52
005	Accessed	LP East Med	Unmanaged	Clearcut	01/110	104 80
006	Accessed	LP East Med	Eqv Prep	Seed/Rem SW	06/160	2 08
007	Accessed	LP East Med	Eqv Seed	Removal SW	08/180	-4 90
008	Accessed	LP East Med	Eq SdwRgn	Removal SW	06/160	-25 47
009	Accessed	LP West Lrg	Unmanaged	Clearcut	01/140	769.82
010	Accessed	LP West Lrg	Eqv Prep	Seed/Rem SW	01/140	257 57

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
011	Accessed	LP West Lrg	Eqv Seed	Removal SW	05/180	-7.38
012	Accessed	LP West Lrg	Eq SdwRgn	Removal SW	05/180	-9.97
013	Accessed	LP West Med	Unmanaged	Clearcut	01/120	229.37
014	Accessed	LP West Med	Eqv Prep	Seed/Rem SW	04/150	32.85
015	Accessed	LP West Med	Eqv Seed	Removal SW	07/180	-4 98
016	Accessed	LP West Med	Eq SdwRgn	Removal SW	06/170	-15.63
017	Accessed	SF FWid VLg	Unmanaged	Group Sel	01/210	1629.50
018	Accessed	SF FWid VLg	Eqv Prep	Seed/Rem SW	01/210	758.39
019	Accessed	SF FWid VLg	Eqv Seed	Removal SW	02/220	40 56
020	Accessed	SF FWid VLg	Eq SdwRgn	Removal SW	02/220	40.56
021	Accessed	SF East M-L	Unmanaged	Group Sel	01/180	374.68
022	Accessed	SF East M-L	Eqv Prep	Seed/Rem SW	04/210	22.39
023	Accessed	SF East M-L	Eqv Seed	Removal SW	04/210	-18.81
024	Accessed	SF East M-L	Eq SdwRgn	Removal SW	04/210	-79.28
025	Accessed	SF West M-L	Unmanaged	Group Sel	01/160	374.68
026	Accessed	SF West M-L	Eqv Prep	Seed/Rem SW	04/190	43 25
027	Accessed	SF West M-L	Eqv Seed	Removal SW	04/190	-24 41
028	Accessed	SF West M-L	Eq SdwRgn	Removal SW	04/190	-70.69
029	Accessed	PP FWid Mat	Unmanaged	3Step SW	04/160	-43.95
030	Accessed	PP FWid Mat	Eqv Prep	Seed/Rem SW	07/190	8 25
031	Accessed	PP FWid Mat	Eqv Seed	Removal SW	04/160	-59.27
032	Accessed	PP FWid Mat	Eq SdwRgn	Removal SW	04/160	-59.27
101	Accessed	LP East Lrg	Unmanaged	Special Cut	01/150	38 57
102	Accessed	LP East Med	Unmanaged	Special Cut	06/160	.67
103	Accessed	LP West Lrg	Unmanaged	Special Cut	01/140	154 75
104	Accessed	LP West Med	Unmanaged	Special Cut	02/130	15.47
105	Accessed	SF FWid VLg	Unmanaged	Special Cut	01/210	495.75
106	Accessed	SF East M-L	Unmanaged	Special Cut	04/210	2.39
107	Accessed	SF West M-L	Unmanaged	Special Cut	04/190	16 72

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
108	Accessed	PP FWid Mat	Unmanaged	Special Cut	04/160	-18 00
201	Not Accessed	LP East Lrg	Unmanaged	Clearcut	01/150	184 80
202	Not Accessed	LP East Lrg	Eqv Prep	Seed/Rem SW	06/200	-54 38
203	Not Accessed	LP East Lrg	Eqv Seed	Removal SW	04/180	-75 09
204	Not Accessed	LP East Lrg	Eq SdwRgn	Removal SW	04/180	-160 24
205	Not Accessed	LP East Med	Unmanaged	Clearcut	03/130	12.93
206	Not Accessed	LP East Med	Eqv Prep	Seed/Rem SW	06/160	-47.54
207	Not Accessed	LP East Med	Eqv Seed	Removal SW	08/180	-15.23
208	Not Accessed	LP East Med	Eq SdwRgn	Removal SW	06/160	-75.09
209	Not Accessed	LP West Lrg	Unmanaged	Clearcut	01/140	417.18
210	Not Accessed	LP West Lrg	Eqv Prep	Seed/Rem SW	07/200	-14 59
211	Not Accessed	LP West Lrg	Eqv Seed	Removal SW	04/170	-58.45
211	Not Accessed	LP West Lrg	Eqv Seed	Removal SW	05/180	-40.90
212	Not Accessed	LP West Lrg	Eq SdwRgn	Removal SW	05/180	-83.42
213	Not Accessed	LP West Med	Unmanaged	Clearcut	01/120	68 43
214	Not Accessed	LP West Med	Eqv Prep	Seed/Rem SW	06/170	-30.81
215	Not Accessed	LP West Med	Eqv Seed	Removal SW	07/180	-20 28
216	Not Accessed	LP West Med	Eq SdwRgn	Removal SW	06/170	-65.25
217	Not Accessed	SF FWid VLg	Unmanaged	Group Sel	01/210	1137.10
218	Not Accessed	SF FWid VLg	Eqv Prep	Seed/Rem SW	01/210	265.99
219	Not Accessed	SF FWid VLg	Eqv Seed	Removal SW	04/240	-124.71
220	Not Accessed	SF FWid VLg	Eq SdwRgn	Removal SW	04/240	-124.71
221	Not Accessed	SF East M-L	Unmanaged	Group Sel	03/200	31 11
221	Not Accessed	SF East M-L	Unmanaged	Group Sel	04/210	49 68
222	Not Accessed	SF East M-L	Eqv Prep	Seed/Rem SW	04/210	-129 43
223	Not Accessed	SF East M-L	Eqv Seed	Removal SW	04/210	-65.62
224	Not Accessed	SF East M-L	Eq SdwRgn	Removal SW	04/210	-231.10
225	Not Accessed	SF West M-L	Unmanaged	Group Sel	04/190	78 34
226	Not Accessed	SF West M-L	Eqv Prep	Seed/Rem SW	04/190	-108 57

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
227	Not Accessed	SF West M-L	Eqv Seed	Removal SW	04/190	-93.70
228	Not Accessed	SF West M-L	Eq SdwRgn	Removal SW	04/190	-222.50
229	Not Accessed	PP FWid Mat	Unmanaged	3Step SW	04/160	-152 67
230	Not Accessed	PP FWid Mat	Eqv Prep	Seed/Rem SW	07/190	-25.27
231	Not Accessed	PP FWid Mat	Eqv Seed	Removal SW	04/160	-167.99
232	Not Accessed	PP FWid Mat	Eq SdwRgn	Removal SW	04/160	-167.99
301	Not Accessed	LP East Lrg	Unmanaged	Special Cut	06/200	-52.37
302	Not Accessed	LP East Med	Unmanaged	Special Cut	07/170	-9.89
303	Not Accessed	LP West Lrg	Unmanaged	Special Cut	07/200	-21.02
304	Not Accessed	LP West Med	Unmanaged	Special Cut	07/180	-12 11
305	Not Accessed	SF FWid VLg	Unmanaged	Special Cut	03/230	28.04
306	Not Accessed	SF East M-L	Unmanaged	Special Cut	04/210	-149 42
307	Not Accessed	SF West M-L	Unmanaged	Special Cut	04/190	-135.09
308	Not Accessed	PP FWid Mat	Unmanaged	Special Cut	04/160	-126.72

Table B.12. Highest PNV for each Analysis Area and Treatment Type.

AA	Option	Road Status	Type	Age	Rx	Thin?	Harvest Dec/Age	PNVV$
EXISTING YOUNG/REGEN STANDS								
Y01	01	Accessed	LP East Yg	40	CC	Done	11/150	6.10
Y02	01	Accessed	LP East Yg	40	CC	No	13/170	1.14
Y02	02	Accessed	LP East Yg	40	CC	@40	11/150	-200.69
Y03	01	Accessed	LP East Yg	20	CC	No	15/170	.52
Y03	02	Accessed	LP East Yg	20	CC	@30	13/150	-136 32
Y04	01	Accessed	LP East Yg	10	CC	No	16/170	.35
Y04	02	Accessed	LP East Yg	10	CC	@30	14/150	-92.09
Y05	01	Accessed	LP East Yg	00	CC	No	17/170	.24
Y05	02	Accessed	LP East Yg	00	CC	@30	15/150	-62.21
Y06	01	Accessed	LP East Yg	F1	CC	No	18/170	.16
Y06	02	Accessed	LP East Yg	F1	CC	@30	16/150	-42 03

AA	Option	Road Status	Type	Age	Rx	Thin?	Harvest Dec/Age	PNVV$
Y07	01	Accessed	LP West Yg	40	CC	Done	11/150	11.39
Y08	01	Accessed	LP West Yg	40	CC	No	11/150	3 83
Y08	02	Accessed	LP West Yg	40	CC	@40	11/150	-195.40
Y09	01	Accessed	LP West Yg	20	CC	No	13/150	1.75
Y09	02	Accessed	LP West Yg	20	CC	@30	13/150	-133.90
Y10	01	Accessed	LP West Yg	10	CC	No	14/150	1.18
Y10	02	Accessed	LP West Yg	10	CC	@30	14/150	-90.46
Y11	01	Accessed	LP West Yg	00	CC	No	15/150	80
Y11	02	Accessed	LP West Yg	00	CC	@30	15/150	-61.11
Y12	01	Accessed	LP West Yg	F1	CC	No	16/150	.54
Y12	02	Accessed	LP West Yg	F1	CC	@30	16/150	-41.28
Y13	01	Accessed	PP Fwid Yg	30	CC	No	12/150	1.79
Y14	01	Accessed	PP Fwid Yg	00	CC	No	15/150	.55
Y15	01	Accessed	SF Fwid Yg	30	CC	No	12/150	3.10
Y16	01	Accessed	SF Fwid Yg	00	CC	No	15/150	.95

Table B.13. PNV for Future Stands

Type	Location	Treatment	Age	PNV
Lodgepole Pine	East Side	CC	170	24
Lodgepole Pine	East Side	CC with Thin	150	-62 21
Lodgepole Pine	West Side	CC	150	80
Lodgepole Pine	West Side	CC with Thin	150	-61 11
Ponderosa Pine	All	CC	150	55
Spruce-fir	All	CC	150	95

The following table shows the treatment type with the highest PNV for each landtype based on the earliest possible harvest for that landtype. This table only shows mature and young stands Future stands have very little difference in PNV

Table B.14. PNV For Earliest Treatments for Each Analysis Area

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
EXISITING MATURE STANDS						
001	Accessed	LP East Lrg	Unmanaged	3Step SW	01/150	-89.25
001	Accessed	LP East Lrg	Unmanaged	Clearcut	01/150	537.44
002	Accessed	LP East Lrg	Eqv Prep	Seed/Rem SW	01/150	33 82
003	Accessed	LP East Lrg	Eqv Seed	Removal SW	01/150	-73 07
004	Accessed	LP East Lrg	Eq SdwRgn	Removal SW	01/150	-153 14
005	Accessed	LP East Med	Unmanaged	3Step SW	01/110	-299.62
005	Accessed	LP East Med	Unmanaged	Clearcut	01/110	104 80
006	Accessed	LP East Med	Eqv Prep	Seed/Rem SW	01/110	-215.3
007	Accessed	LP East Med	Eqv Seed	Removal SW	01/110	-106.48
008	Accessed	LP East Med	Eq SdwRgn	Removal SW	01/110	-278.63
008	Accessed	LP East Med	Eq SdwRgn	Removal SW	02/120	-171 75
008	Accessed	LP East Med	Eq SdwRgn	Removal SW	03/130	-106.48
008	Accessed	LP East Med	Eq SdwRgn	Removal SW	04/140	-65 49
008	Accessed	LP East Med	Eq SdwRgn	Removal SW	05/150	-40 61
008	Accessed	LP East Med	Eq SdwRgn	Removal SW	06/160	-25.47
009	Accessed	LP West Lrg	Unmanaged	3Step SW	01/140	121.06
009	Accessed	LP West Lrg	Unmanaged	Clearcut	01/140	769 82
010	Accessed	LP West Lrg	Eqv Prep	Seed/Rem SW	01/140	257 57
011	Accessed	LP West Lrg	Eqv Seed	Removal SW	01/140	-21 85
012	Accessed	LP West Lrg	Eq SdwRgn	Removal SW	01/140	-59 03
012	Accessed	LP West Lrg	Eq SdwRgn	Removal SW	02/150	-34.86
012	Accessed	LP West Lrg	Eq SdwRgn	Removal SW	03/160	-21 85
012	Accessed	LP West Lrg	Eq SdwRgn	Removal SW	04/170	-14 76
012	Accessed	LP West Lrg	Eq SdwRgn	Removal SW	05/180	-9.97
013	Accessed	LP West Med	Unmanaged	3Step SW	01/120	-120 76
013	Accessed	LP West Med	Unmanaged	Clearcut	01/120	229 37
014	Accessed	LP West Med	Eqv Prep	Seed/Rem SW	01/120	-14 84

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
015	Accessed	LP West Med	Eqv Seed	Removal SW	01/120	-65.97
016	Accessed	LP West Med	Eq SdwRgn	Removal SW	01/120	-178.01
016	Accessed	LP West Med	Eq SdwRgn	Removal SW	02/130	-110.21
016	Accessed	LP West Med	Eq SdwRgn	Removal SW	03/140	-65 97
016	Accessed	LP West Med	Eq SdwRgn	Removal SW	04/150	-38 83
016	Accessed	LP West Med	Eq SdwRgn	Removal SW	05/160	-23 14
016	Accessed	LP West Med	Eq SdwRgn	Removal SW	06/170	-15 63
017	Accessed	SF FWid VLg	Unmanaged	3Step SW	01/210	565 67
018	Accessed	SF FWid VLg	Eqv Prep	Seed/Rem SW	01/210	758 39
019	Accessed	SF FWid VLg	Eqv Seed	Removal SW	01/210	35 65
020	Accessed	SF FWid VLg	Eq SdwRgn	Removal SW	01/210	35.65
021	Accessed	SF East M-L	Unmanaged	3Step SW	01/180	-212.11
021	Accessed	SF East M-L	Unmanaged	Group Sel	01/180	374 68
022	Accessed	SF East M-L	Eqv Prep	Seed/Rem SW	01/180	-120 98
023	Accessed	SF East M-L	Eqv Seed	Removal SW	01/180	-79 28
024	Accessed	SF East M-L	Eq SdwRgn	Removal SW	01/180	-340 80
025	Accessed	SF West M-L	Unmanaged	3Step SW	01/160	-191 02
025	Accessed	SF West M-L	Unmanaged	Group Sel	01/160	374 68
026	Accessed	SF West M-L	Eqv Prep	Seed/Rem SW	01/160	-111.56
027	Accessed	SF West M-L	Eqv Seed	Removal SW	01/160	-118 95
028	Accessed	SF West M-L	Eq SdwRgn	Removal SW	01/160	-340 80
029	Accessed	PP FWid Mat	Unmanaged	3Step SW	01/130	-306 42
030	Accessed	PP FWid Mat	Eqv Prep	Seed/Rem SW	01/130	-256 13
031	Accessed	PP FWid Mat	Eqv Seed	Removal SW	01/130	-281 45
032	Accessed	PP FWid Mat	Eq SdwRgn	Removal SW	01/130	-281.45
101	Accessed	LP East Lrg	Unmanaged	Special Cut	01/150	38.57
102	Accessed	LP East Med	Unmanaged	Special Cut	01/110	-16 77
103	Accessed	LP West Lrg	Unmanaged	Special Cut	01/140	154 75
104	Accessed	LP West Med	Unmanaged	Special Cut	01/120	12 30

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
105	Accessed	SF FWid VLg	Unmanaged	Special Cut	01/210	495.75
106	Accessed	SF East M-L	Unmanaged	Special Cut	01/180	-131.66
107	Accessed	SF West M-L	Unmanaged	Special Cut	01/160	-131.66
108	Accessed	PP FWid Mat	Unmanaged	Special Cut	01/130	-197.80
201	Not Accessed	LP East Lrg	Unmanaged	3Step SW	01/150	-441.89
201	Not Accessed	LP East Lrg	Unmanaged	Clearcut	01/150	184.80
202	Not Accessed	LP East Lrg	Eqv Prep	Seed/Rem SW	01/150	-318.82
204	Not Accessed	LP East Lrg	Eq SdwRgn	Removal SW	01/150	-505.78
205	Not Accessed	LP East Med	Unmanaged	3Step SW	01/110	-652.26
205	Not Accessed	LP East Med	Unmanaged	Clearcut	01/110	-3.92
206	Not Accessed	LP East Med	Eqv Prep	Seed/Rem SW	01/110	-568.02
207	Not Accessed	LP East Med	Eqv Seed	Removal SW	01/110	-267.42
208	Not Accessed	LP East Med	Eq SdwRgn	Removal SW	01/110	-631.27
209	Not Accessed	LP West Lrg	Unmanaged	3Step SW	01/140	-231.58
209	Not Accessed	LP West Lrg	Unmanaged	Clearcut	01/140	417.18
210	Not Accessed	LP West Lrg	Eqv Prep	Seed/Rem SW	01/140	-95 07
211	Not Accessed	LP West Lrg	Eqv Seed	Removal SW	01/140	-182.79
212	Not Accessed	LP West Lrg	Eq SdwRgn	Removal SW	01/140	-411.67
213	Not Accessed	LP West Med	Unmanaged	3Step SW	01/120	-473 40
213	Not Accessed	LP West Med	Unmanaged	Clearcut	01/120	68 43
214	Not Accessed	LP West Med	Eqv Prep	Seed/Rem SW	01/120	-367.48
215	Not Accessed	LP West Med	Eqv Seed	Removal SW	01/120	-226.91
216	Not Accessed	LP West Med	Eq SdwRgn	Removal SW	01/120	-530.65
217	Not Accessed	SF FWid VLg	Unmanaged	3Step SW	01/210	73.27
217	Not Accessed	SF FWid VLg	Unmanaged	Group Sel	01/210	1137 10
218	Not Accessed	SF FWid VLg	Eqv Prep	Seed/Rem SW	01/210	265.99
219	Not Accessed	SF FWid VLg	Eqv Seed	Removal SW	01/210	-456.75
220	Not Accessed	SF FWid VLg	Eq SdwRgn	Removal SW	01/210	-456 75
221	Not Accessed	SF East M-L	Unmanaged	3Step SW	01/180	-704.51

AA	Roads	Type/Size	MgtCond	Treatment	Decade /Age	PNV$
221	Not Accessed	SF East M-L	Unmanaged	Group Sel	01/180	-117.72
222	Not Accessed	SF East M-L	Eqv Prep	Seed/Rem SW	01/180	-613.38
223	Not Accessed	SF East M-L	Eqv Seed	Removal SW	01/180	-231.10
224	Not Accessed	SF East M-L	Eq SdwRgn	Removal SW	01/180	-833.20
225	Not Accessed	SF West M-L	Unmanaged	3Step SW	01/160	-683.42
225	Not Accessed	SF West M-L	Unmanaged	Group Sel	01/160	-117.72
226	Not Accessed	SF West M-L	Eqv Prep	Seed/Rem SW	01/160	-603.96
227	Not Accessed	SF West M-L	Eqv Seed	Removal SW	01/160	-343.67
228	Not Accessed	SF West M-L	Eq SdwRgn	Removal SW	01/160	-833.20
229	Not Accessed	PP FWid Mat	Unmanaged	3Step SW	01/130	-659.06
230	Not Accessed	PP FWid Mat	Eqv Prep	Seed/Rem SW	01/130	-608.77
231	Not Accessed	PP FWid Mat	Eqv Seed	Removal SW	01/130	-634.09
232	Not Accessed	PP FWid Mat	Eq SdwRgn	Removal SW	01/130	-634.09
301	Not Accessed	LP East Lrg	Unmanaged	Special Cut	01/150	-314.07
302	Not Accessed	LP East Med	Unmanaged	Special Cut	01/110	-125.49
303	Not Accessed	LP West Lrg	Unmanaged	Special Cut	01/140	-197.89
304	Not Accessed	LP West Med	Unmanaged	Special Cut	01/120	-148.64
305	Not Accessed	SF FWid VLg	Unmanaged	Special Cut	01/210	3.35
306	Not Accessed	SF East M-L	Unmanaged	Special Cut	01/180	-624.06
307	Not Accessed	SF West M-L	Unmanaged	Special Cut	01/160	-624.06
308	Not Accessed	PP FWid Mat	Unmanaged	Special Cut	01/130	-550.44

Table B.15. PNV for Earliest Treatments for Each Analysis Area.

AA	Option	Road Status	Type	Age	Rx	Thin?	Harvest Dec/Age	PNVV$
EXISTING YOUNG/REGEN STANDS								
Y01	01	Accessed	LP East Yg	40	CC	Done	11/150	6 10
Y02	01	Accessed	LP East Yg	40	CC	No	11/150	80
Y02	02	Accessed	LP East Yg	40	CC	@40	11/150	-200 69
Y03	01	Accessed	LP East Yg	20	CC	No	13/150	.37

AA	Option	Road Status	Type	Age	Rx	Thin?	Harvest Dec/Age	PNVV$
Y03	02	Accessed	LP East Yg	20	CC	@30	13/150	-136.32
Y04	01	Accessed	LP East Yg	10	CC	No	14/150	.25
Y04	02	Accessed	LP East Yg	10	CC	@30	14/150	-92.09
Y05	01	Accessed	LP East Yg	00	CC	No	15/150	.17
Y05	02	Accessed	LP East Yg	00	CC	@30	15/150	-62.21
Y06	01	Accessed	LP East Yg	F1	CC	No	16/150	.11
Y06	02	Accessed	LP East Yg	F1	CC	@30	16/150	-42.03
Y07	01	Accessed	LP West Yg	40	CC	Done	11/150	11.39
Y08	01	Accessed	LP West Yg	40	CC	No	11/150	3.83
Y08	02	Accessed	LP West Yg	40	CC	@40	11/150	-195.40
Y09	01	Accessed	LP West Yg	20	CC	No	13/150	1.75
Y09	02	Accessed	LP West Yg	20	CC	@30	13/150	-133.90
Y10	01	Accessed	LP West Yg	10	CC	No	14/150	1.18
Y10	02	Accessed	LP West Yg	10	CC	@30	14/150	-90.46
Y11	01	Accessed	LP West Yg	00	CC	No	15/150	.80
Y11	02	Accessed	LP West Yg	00	CC	@30	15/150	-61.11
Y12	01	Accessed	LP West Yg	F1	CC	No	16/150	.54
Y12	02	Accessed	LP West Yg	F1	CC	@30	16/150	-41.28
Y13	01	Accessed	PP Fwid Yg	30	CC	No	12/150	1.79
Y14	01	Accessed	PP Fwid Yg	00	CC	No	15/150	.55
Y15	01	Accessed	SF Fwid Yg	30	CC	No	12/150	3.10
Y16	01	Accessed	SF Fwid Yg	00	CC	No	15/150	.95

Column Explanations for Tables B.11 thru B.15.

AA - Analysis Area Number for Stage 2 Analysis

Access - Access Status, Accessed means that the stand is within access of an existing road Not Accessed means that road building must occur to conduct timber harvest

ForTyp - Forest Type/Size

- LP East Lrg - Lodgepole Pine, East Side, Large Size Trees
- LP East Med - Lodgepole Pine, East Side, Medium Size Trees
- LP East Yg - Lodgepole Pine, East Side, Young Stands
- LP West Lrg - Lodgepole Pine, West Side, Large Size Trees
- LP West Med - Lodgepole Pine, West Side, Medium Size Trees
- LP West Yg - Lodgepole Pine, West Side, Young Stands
- PP Fwid Mat - Ponderosa Pine, Forestwide, Large Size Trees
- PP FWid Yg - Ponderosa Pine, Forestwide, Young Stands
- SF FWid V G - Spruce-fir, Forestwide, Very Large Trees
- SF East M-L - Spruce-fir, East Side, Large Trees
- SF West M-L - Spruce-fir, West Side, Large Trees
- SF FWid Yg - Spruce-fir, Forestwide, Young Stands

Management Status

- Unman age - Existing Stands, unmanaged
- Eqv Prep - Existing Stands, with preparation shelterwood harvest
- Eqv Seed - Existing Stands, with seed cut shelterwood harvest
- Eq SdwRgn - Existing Stands, with seed cut and regeneration

Treatment

- Seed/Rem SW - Shelterwood Seed and Removal Cuts
- Removal SW - Shelterwood Removal Cuts
- 3STEP SW - Shelterwood, 3 Steps (Prep, Seed and Removal)
- Clearcut - Clearcut
- Special Cut - Clearcut with Precommercial Thin at Age 30-50

Decade/Age

- Decade - Decade of occurrence, 01 = 1st Decade in model
- Age - Age of Stand at occurrence, 150 = 150 years old

The following comments are general observations and interpretations from the analysis

For areas that have not been accessed by roads for timber harvest:

1 None of the mature landtypes and treatment types have a positive PNV, except for Large and Medium lodgepole pine, and Medium-Large and Very Large Spruce-fir. Large and Medium lodgepole pine are slightly positive, Large Spruce-fir is slightly positive, while Very Large Spruce-fir is highly positive There are few acres of Very Large Spruce-fir that are suitable for timber harvest.

2 The highest PNVs in most landtypes that do not have a positive PNV occur more than 150 years in the future, with most of the remaining occurring 40-70 years in the future This suggests that the stands do not currently have existing volumes and value to cover the cost of harvest, nor will they improve appreciably in the near future.

3 Most mature stands have strongly negative PNVs. This is due to multiple entries in shelterwood cuts that have very low volumes/values in relation to the costs of harvest

4 Young stands have low positive to slightly negative PNVs This is due to the harvest costs and revenues occurring far into the future. Discounting reduces the magnitude of

costs and revenues substantially over long periods of time. The PNV of costs and revenues discounted over 100 or more years is pennies. When you are comparing pennies the apparent difference between treatments is minimal.

For Areas that have been accessed by roads for timber harvest.

1 The same lodgepole pine and spruce-fir landtypes and treatment types have positive PNVs. Lodgepole pine with clearcuts also have positive PNVs. These are moderately to strongly positive

2 For other landtypes and treatment types, the PNVs are low positive to slightly negative

The reason for the change is that the cost of roading (primarily reconstruction) is somewhat less in areas that have already been accessed plus revenues have slightly increased

<u>Stage III - Timber Production Rates</u>

Stage III analysis was accomplished with Ranger District land allocation decisions about land allocations and FORPLAN analysis. All areas of the forest were allocated to management prescriptions, based on the theme of the alternative and the character of the land Management prescriptions either allowed scheduled timber harvest or they did not Many management areas have objectives where scheduled timber harvest is not compatible with the management area In some of those management areas, timber harvest may occur for purposes that meet the objectives of the management area For the prescriptions that allowed scheduled timber harvest, the District made additional decisions about the suitability of the area for scheduled timber harvest. In some areas, other concerns such as habitat objectives or economic/financial concerns caused areas to be removed from consideration for scheduled harvest.

The following table shows how the suitable lands from Stage I were allocated by alternative and analyzed in the Analysis of the Management Situation (AMS). See the Timber Section, Chapter 3 of the *FEIS*, for acres treated in the first decade

Table B.16. Suitable Land Allocations

Suitability Category	Alternatives (Acres)					
	A	B	C	E	H	I
Total Forest Acres	1,289,050	1,289,050	1,289,050	1,289,050	1,289,050	1,289,050
Unsuitable						
Non-forest Vegetation	294,067	294,067	294,067	294,067	294,067	294,068
Withdrawn - Legal Constraints	232,003	231,841	232,003	232,003	232,003	232,002
Withdrawn - Physical Constraints	53,996	53,997	53,997	53,997	53,996	53,996
Tentatively Suitable - Not Planned						
Financial - Economic Reasons	215,246	215,250	215,246	215,246	215,246	215,246
Resource Concerns	18,665	18,665	18,665	18,665	18,665	18,665
Will be withdrawn	149	16,882	392	5,432	13,660	392
Mgt. Area Incompatible	81,826	142,120	73,769	366,889	308,675	75,968
W.L. Winter Range	0	64,797	0	33,382	105,125	77,416
Old Growth	919	46,276	919	5,604	25,290	919
Intermix	0	11,304	1,903	1,903	0	1,456
Not Scheduled	37,477	5,214	11,234	20,058	0	19,007
Final - Suitable Planned	354,730	188,906	386,854	41,804	20,875	299,914

Note For definitions of these terms, see the Glossary in the *Forest Plan* Appendix

The Suited and Planned Final lands were scheduled for timber harvest using the FORPLAN analysis tool. This tool utilized the information from the Stage II analysis and the decisions from the Stage III analysis to create a harvest schedule. The harvest schedule utilized constraints on harvest due to watershed concerns, budget limitations and legal requirements for Non-declining Yield along with either of two objective functions to create an optimum harvest schedule. The analysis used two objective functions maximization of volume production over the next 200 years or maximization of PNV over the next 200 years These two objective functions yield results that create the most outputs or the most efficient means of creating outputs

The maximum volume objective function typically leads the model to select high volume stands that grow fast for harvest in the first 60 years It also selects treatments such as thinning that will boost volume production. The maximize PNV objective function tends to select the most positive PNVs as early as possible in the model. With the effect of discounting, negative PNVs that occur in the distant future do not impact the objective function very much

Looking at the total volume over 200 years and at the volume in the first decade, there is no strong differences between budget levels nor objective functions This is most likely due to the non-declining yield constraint. The non-declining yield constraint takes the productive capacity of the land and does not allow the model to harvest above this rate The total and 1st decade volumes are defined largely by the land area available to be harvested in the alternative Some differences exist between budget levels and objective functions For the maximize volume objective function, more thinning is employed. For the maximize PNV objective function, less thinning is employed. The volumes tend to vary slightly due to the thinning over the 200 year time period and slightly in the first decade.

To look at how the result vary by PNV, the next two tables only show the results for maximizing PNV

Table B.17. Maximum PNV for Experienced Budget Levels

Alt	PNV Total 200 Year	Annual Net Revenue 1st Decade	Annual Gross Revenue 1st Decade	Total Volume 200 Years	Annual Volume 1st Decade
	Million $			Board Feet	
				Billion	Million
A	-0 176	0 015	0 066	3 140	8 490
B	1 336	0 093	0 445	1 103	5 67
C	-2 432	0 245	1 367	3 535	17 420
E	0 550	0 036	0 144	0 369	1 840
H	0 312	0 017	0 017	0 176	0 91
I	0 679	0 210	1 070	2 740	13 690

Table B.18. Maximum PNV for Full Budget Levels

Alt	PNV Total 200 Year	Annual Net Revenue 1st Decade	Annual Gross Revenue 1st Decade	Total Volume 200 Years	Annual Volume 1st Decade
	Million $			Board Feet	
				Billion	Million
A	2 541	0 214	1 029	3 085	13 120
B	1 447	0 090	0 411	1 064	5 240
C	1 990	0 232	1 300	3 459	16 600
E	0.652	0.035	0 149	0 368	1 900
H	0.331	0 018	0 073	0 178	0 930
I	2 847	0.190	0 930	2 658	11 850

Typically the 200 year PNV and First Decade Net Revenue are positive. This shows that the model is harvesting the most efficient stands early in the planning horizon. Alternatives A and C are negative for PNV over the 200 years at the lower budget level, most likely due the requirement that the model schedule harvest of low value stands at some point in time. The budget isn't large enough relative to the land area to be able to delay harvest of negative PNV lands far enough into the future.

To look at how the results vary by maximize volume objective function, the following tables show the results for the maximum volume objective function only.

Table B.19. Maximum Volume for Experienced Budget Levels

Alt	PNV Total 200 Year	Annual Net Revenue 1st Decade	Annual Gross Revenue 1st Decade	Total Volume 200 Years	Annual Volume 1st Decade
	Million $			Board Feet	
				Billion	Million
A	-20 513	-0 288	0 066	3 415	8 490
B	-3 022	-0 139	0 470	1 234	6 000
C	-23 326	-0 885	1 410	3 834	17 970
E	-0 238	-0 014	0 150	0 393	1 910
H	-0 135	-0 004	0 075	0 198	0 960
I	-7 998	-0 388	1 084	2 888	13 820

Table B.20. Maximum Volume for Full Budget Levels

Alt	PNV Total 200 Year	Annual Net Revenue 1st Decade	Annual Gross Revenue 1st Decade	Total Volume 200 Years	Annual Volume 1st Decade
	Million $			Board Feet	
				Billion	Million
A	-49 887	-1 994	1 323	3 566	16 87
B	-8 148	-0 334	0 478	1 256	6 100
C	-38 485	-1 683	1 445	3 903	18 420
E	-2 012	- 093	0 155	0 415	1 970
H	-1.131	-0 046	0.077	0 205	0.990
I	-24 521	-1 096	1 120	3 006	14.280

With the maximize volume objective function, the 200 year PNV and the 1st decade net revenue are both negative. The net revenue in the first decade is only slightly negative, while the 200 year PNV is highly negative compared to the first decade net revenue. Since the first decade net revenue usually influences the PNV dramatically, the PNV appears to be influenced by factors after the first decade. It appears that the use of thinning in later periods is driving the model to have highly negative PNVs At the same time, less efficient stands are probably being harvested earlier in the planning horizon, in order to create more volume over the long run. These less efficient prescriptions are typically Spruce-fir or Ponderosa Pine/Douglas-fir, which produce some volume, but require a more expensive series of shelterwood treatments than clearcutting in lodgepole pine. The model is seeking volume, so it is not concerned with the financial efficiency of obtaining that volume.

Development of Yield Coefficients. The primary tool for projecting how tree stands would change over time is the Forest Vegetative Simulator (FVS), formally called PROGNOSIS Information produced by FVS includes changes over time to average diameter, number of trees per acre, basal area, total and merchantable board-foot volumes, and total and merchantable cubic-foot volumes per acre The projections were made by decades into the future.

The process of developing yield coefficients for the FORPLAN model involved several steps and are summarized as follows:

1 Strata was developed by subdividing forested areas into 32 classes by cover type and size class for modeling in the FVS Because of small representation in the suitable land area of the Forest and lack of analytical differences, some strata were combined to form 12 classes for modeling in FVS as shown in the following table

Table B.21. Forest Cover Type Classes by species, size class, and location (east or west side of the Continental Divide).

Description	FVS Harvest ID/ FORPLAN Harvest ID
Lodgepole Pine, Small, East	LPSE
Lodgepole Pine, Medium, East	LPSW
Lodgepole Pine, Large, East	LPLE
Lodgepole Pine, Small, West	LPSW
Lodgepole Pine, Medium, West	LPMW
Lodgepole Pine, Large, West	LPLW
Ponderosa Pine/Douglas-fir, Small, East	PPDFS
Ponderosa Pine/Douglas-fir, Mature, East	PPDFM
Spruce/Fir, Small, East/West	SFS
Spruce/Fir Medium/Large, West	SFMLW
Spruce/Fir Medium/Large, East	SFMLE
Spruce/Fir Very Large , West	SFVL

2 Timber inventories taken in 1989 and 1990 were used to project growth. At that time, forested areas were sampled by Standard Stage I cluster plot methods (R2-2410, revised 1/91) First stratified in 1974, these 300 plots were based on species, tree size, and density These plots were the basis for the existing *Forest Plan*. For the revised *Forest Plan*, plot measurements in 1989 and 1990 were remeasurements of plot data from 1975 and supplemented with 12 new plots. These new plots were established to increase sample numbers in those strata which had statistically changed because of growth or mortality and to replace some plots withdrawn for administrative reasons. In addition, 32 plots were added from Stage II plot data during Growth and Yield analysis These plots had statistically compatible data to further increase strata plots for statistical reliability.

3 To track the processing of the Stage I data through to FORPLAN, the Stage I data from 1989/90 was run through program RMSTAND to format the data for FVS to process Stratified plots were compiled into a data set and loaded into SQL relational tables for analysis within strata Data sets were verified for accuracy and reasonableness by testing for trees that were unreasonably different than expected and comparing against the original plot sheets Individual plots with higher than expected basal areas or volumes were compared against the Average Maximum Density curves to determine if the overall data set fell within the Regional expectations

4 The model was next calibrated to compare the growth characteristics of the Forests inventory data against those of the Regional data set. Running calibration statistics against the average data set for the Region yielded scale factor values for the strata within guidelines. The calibration statistics suggests that no additional internal calibration parameters were needed to modify modeled growth results from this data set.

5 Strata outputs were modeled given differing management methods which included clearcuts and 3-step shelterwood for lodgepole pine, group selection and 3-step shelterwood for spruce-fir, and, 2-step (2 aged) shelterwood for ponderosa pine. For a standard to which to compare the harvest method models against, an Inventory Run was applied on each strata. This run assumed a clearcutting option and unmanaged stand condition. Implicit in this run are the basic growth and yield parameters which will be applied to each strata type before parameters are applied specific to each harvest method These include local conditions of mortality or lessened growth caused by species specific agents such as mistletoe or Spruce-budworm They also contain expected lessened harvest volumes do to defects encountered in past harvest yields.

Determination of Culmination of Mean Annual Increment. Silvicultural prescriptions were selected for FORPLAN while considering requirements that final harvests of even-aged stands occur near the culmination of mean annual increment (CMAI) of growth (36 CFR 219 16 (a)(2)(iii)). Even-aged harvests include clearcuts and traditional seed step of shelterwood harvests. The definition does not include intermediate harvests like thinning. The age at CMAI will vary depending on site quality, forest type, management intensities and utilization standards, but generally will occur between 140 and 180 years for sawtimber on the Arapaho and Roosevelt National Forests.

The Inventory Runs were analyzed to determine the CMAI. The CMAI for lodgepole pine was approximately 140 years of average stand age This was used as the trigger for applying clearcut harvest options in lodgepole pine For group selection (patch clearcut) in spruce-fir, 180 years average stand age was calculated for CMAI Average stand age of 140 years was used for 3-step shelterwood for lodgepole pine with the final removal not taking place before this age. Average stand age of 180 years was used for 2-step shelterwood (2-aged stand) for ponderosa pine with the final removal not taking place before this age

It is a common option in building FORPLAN matrices to take a proportion of the inventory run yields as yields for shelterwood and other partial-cut choices This option is useful as an efficient means to explore all possible combinations of timing choices in shelterwood application To model shelterwood using portions, it is necessary to determine the shelterwood yield stream using FVS These yield streams are compared year-by-year with the clearcut yield table to determine the proportion of the clearcutting yield

For shelterwood harvest methods, timing choices and yields were analyzed varying parameters for regeneration densities and logging damage and mortality. Stagnation coefficients were added to mimic crown-length loss and hence, growth potential in older stands Given the low volume yield associated with this Forest, portions were developed to reflect a light initial entry to protect from windthrow with a minimum of 1 mbf/acre yield for economic consideration

Seed-cut entry was developed with windthrow in mind, balancing shade-tolerance characteristics of spruce-fir, ponderosa pine, and lodgepole cover types By experience, 20 years or longer is required for regeneration to become stocked to the point for removal cut timing. By definition 20 percent of the rotation is the maximum time between regeneration and removal cut for a stand to remain even-aged This yields up to 28 years for 140 year rotation and 36 years for 180 year rotation

SECTION 9 - ANALYSIS PRIOR TO DEVELOPMENT OF ALTERNATIVES

Planning Step 6, the Analysis of the Management Situation (AMS), was prepared prior to the development of alternatives. This planning step determined the ability of the Forest and Grassland to supply goods and services and projected resource demands. The analysis determined the decision space which identified the Forest's capability to address the ICOs The following were completed in the AMS prior to alternative development:

- development of minimum management requirements
- definition of the management situation for each Revision topic
- development of benchmarks or maximum potential to resolve each Revision topic.
- development of demand projections for each Revision topic
- comparison for each Revision topic current (No Action) levels, the benchmark (maximum potential) levels and effects, and the demand level.
- assessment of the need to revise the Plan.
- assessment of the opportunity to resolve issues and concerns by revising the Plan
- assessment and display of range of possible alternatives
- preliminary description of the Alternatives the forest evaluates in the next two planning steps

Development of Management Requirements. Management requirements are requirements of law and regulation that must be met while implementing management prescriptions for resource use Management requirements are specified in 36 CFR 219.27 Some management requirements are derived directly from laws Other management requirements are developed in response to requirements of law or regulation Attainment of management requirements should impose the least possible restrictions on the achievement of goals and objectives (FSH 1909 12.3 21 7/88).

Management requirements are identified in 36 CFR 219 27 in seven categories as shown below

- Resource Protection
- Vegetation Manipulation
- Silvicultural Practices
- Even-aged Management
- Riparian Areas
- Soil and Water
- Diversity

The IDT assessed the National and Regional direction for the management requirements as they pertained to the Forest and Grassland. Many of the requirements had little impact on other resource values and could be met with standards and guidelines that direct project implementation.

Standard and Guideline Development and Analysis. Forestwide Standards and Guidelines apply to all management areas, unless specifically exempted or amended by direction for an individual management area. The Standards and Guidelines specific to management prescriptions describe specific management direction for the existing management areas. Each management area has a desired future condition and a set of standards and guidelines comprising the management area management direction.

Existing Standards and Guidelines, both Forestwide and management area specific prescriptions, were reviewed to determine what additions/modifications/deletions were needed The objective was to develop a Standards and Guidelines that are responsive to legal concerns and to the Forest situation, and be implemented.

Standards and guidelines were reviewed to determine their ability to achieve outputs, meet forest goals and objectives, and resolve the issues The consequences of changing, dropping, or adding new Standards and Guidelines were evaluated. An interdisciplinary approach to analyzing Standards and Guidelines helped in evaluating the interrelationship between the Standard and Guidelines. Changes and new Standards and Guidelines needed to address current policy or direction were developed and forwarded to the Regional Office for approval.

SECTION 10 - FORMULATION OF ALTERNATIVES

The NFMA planning (36 CFR 219 12(e) and (f)) and the NEPA regulations (40 CFR 1502 14) require an analytical process that evaluates various minimum and maximum resource and economic production levels In addition, a wide range and relatively even distribution of alternatives must be developed to respond to issues and to reflect national goals such as the Resources Planning Act (RPA) program This broad range of alternatives provides the Regional Forester with the information needed to identify the alternative that comes nearest to maximizing net benefits to the public.

Requirements For Development of Alternatives According to NEPA/NFMA procedures, the IDT formulated a broad range of reasonable alternatives. The primary goal in formulating alternatives was to provide an adequate basis for identifying the alternative that come nearest to maximizing net public benefits. Alternatives were developed according to NFMA 36 CFR 219.12(f) to meet the following requirements:

(1) Reflect the full range of major commodity and environmental resource uses and values which could be produced from the Forest and represent a range of resource outputs and expenditure levels

(2) Be formulated to facilitate analysis of costs, use, and environmental tradeoffs among alternatives

(3) Be formulated to facilitate evaluation of the benefits and costs.

(4) Address and respond to the major public issues, management concerns, and resource opportunities.
(5) Reflect the current level of goods and services expected to be provided in the future if current management direction (including allocations, policies, and practices) continues This is called the No Action Alternative.
(6) Represent the most cost-efficient combination of management direction to meet the goals, Standards and Guidelines, Management Areas (MAs), and objectives of the alternative
(7) State the condition and uses that will result from long-term implementation; what goods and services will be produced, including the timing and flow of outputs, and the costs and benefits generated.
(8) State the resource management standards and guidelines and the purpose of the management direction proposed.
(9) Respond to and incorporate the RPA Program resource objectives

In addition to the above requirements and in response to Regional direction, alternatives were developed that considered the following:
(1) A financially efficient timber program
(2) An economically efficient timber program.
(3) Maintaining all existing unroaded areas in an undeveloped state.

Overview of Alternative Development Process. The formulation of alternatives is based upon information gathered during the first four steps of the planning process:
(1) Identification of Issues, Concerns, and Opportunities (ICOs)
(2) Development of planning criteria
(3) Resource inventories and data collection
(4) Analysis of the Management Situation

The alternatives reflect a range of future resource management options for the Forest. Each major ICO was addressed in all the alternatives The need to satisfy legal and regulatory mandates was also a factor in the development of most alternatives. Finally, cost efficiency was a consideration throughout the process The following discussion is a summary of the planning actions involved in the formulation and analysis of the alternatives.

The alternatives were basically designed to address the different ways in which people prefer to use the Forest and Grassland Most of the preferences, along with the physical, biological, and legal limits of Forest management are reflected in the ICOs which were identified at the outset, and served to guide the overall Forest planning process (see Appendix A)

The Analysis of the Management Situation was a key step in leading up to the development and evaluation of alternatives. Projected demands or consumption levels were estimated for the Forest resources In turn, the potential capability to supply the resources was analyzed

Members of the IDT suggested various approaches to addressing each identified ICO Those treated differently in individual alternatives and those treated similarly were both factors in creating the range of alternatives. Seven preliminary alternatives were developed to respond to the revision topics The following is a summary of each alternative

Alternative A. No action, emphasis on human use and commodity production.

Alternative B. No element of the ecosystem, including human use, receives a distinctly greater emphasis than all others. Ecosystem composition, structure, and function are maintained through a combination of natural ecological processes where feasible; management activities substitute where natural components are missing.

Alternative C. Commodity production is emphasized over all other elements of the ecosystem Ecosystem composition, structure, and function are maintained by management activities that provide for commodities production.

Alternative D. Natural processes, with little interference from humans, are emphasized to maintain biological diversity, over all other elements of the ecosystem. Ecosystem composition, structure, and function are maintained by allowing natural ecological processes to proceed, management activities are utilized to restore ecosystems.

Alternative E. Recreation is emphasized over all other elements of the ecosystem. Ecosystem composition, structure, and function are maintained through a combination of management activities to provide for human uses and natural ecological processes where feasible.

Alternative F This alternative strives to maintain natural or only slightly modified ecosystems, by limiting uses and activities to those having low impact or by restricting the activity to ecosystems with high tolerance and flexibility.

Alternative G This alternative provides minimal management at minimal budget levels Ecosystems will continue functioning in their current state, except that immediate suppression actions will be taken on all wildfires.

Alternative H. An eighth alternative was proposed by numerous citizens of varied interests and coordinated by the Colorado Environmental Coalition This alternative was adopted by the Forest Service as Alternative H This alternative emphasizes the need for biological diversity over human needs and is similar to Alternative F.

Alternative I. A ninth alternative was proposed by the Ecosystem Council for Multiple Use and was adopted by the Forest Service as Alternative I. In this alternative, human use, including commodity production, is emphasized over all other elements of the ecosystem

Alternatives Eliminated from Detailed Study Several alternatives were considered and eliminated from further detailed study during the planning process Alternatives were eliminated because they duplicated another alternative; an alternative was found to be unrealistic, the public brought to bear reasonable, convincing arguments to maintain or delete and alternative, and, another alternative better addressed a revision topic. Alternative C was initially eliminated by the IDT and later added back at the public request. When the IDT decided that a satisfactory set of alternatives had been developed, alternatives were then mapped.

Management Area Development and Management Prescriptions The identification of land areas which contribute to the goals and objectives of each alternative is an integral part of alternative development. Working from the various alternatives, areas of the Forest were identified as particular management areas and assigned a corresponding management prescription.

The Regional Menu of Management Prescriptions was used in the formulation of the alternatives Prescriptions were modified and/or new ones developed to provide more area-specific direction and to incorporate recommendations of the IDT and the public

Management areas were assigned and delineated based on resource objectives of specific locations for each alternative The process combined geographic area analysis and IDT judgement to reflect the optimum assignment of management areas to meet the goals and objectives of the alternatives. Several steps were involved in management area allocation and these steps are summarized as follows.

1 The existing and desired condition for various resources were described by geographic areas for each alternative This information came from the various desired future condition scenarios developed for each geographic area on the Forest and Grassland (see following section)

2 For each alternative, the resource emphasis was identified A narrative description of each alternative was used in this step.

3 For each alternative, preliminary decisions were made for timber suitability and scheduling; travel management and mode strategy; adopted ROS, adopted VQO; oil and gas leasing; grazing suitability; and, likelihood of roading an area The data used to help make these decisions were maps of old growth, roadless areas, previous harvested and disturbed areas, transportation base maps, Forest cover types; timber suitability; oil and gas potential, grazing allotments; and, key wildlife habitats

4 The initial set of alternative maps were then reviewed in detail by the public at open houses Refinement and fine tuning was the next step based on public comments, resolving inconsistencies among Ranger Districts, changes to the Regional set of management area prescriptions, and Regional direction on management area allocation (i e use of corridors and site specific management areas that dissect the forest)

Geographic Area Desired Future Condition. Management areas provide management direction for geographic areas on the Forest and Grassland and facilitate plan implementation. As part of the Revision process, ways to improve our ability to apply the management area concept on the ground were looked at. As the Plan is implemented, the focus shifts to the project level and site-specific issues To place a project in context, any planned work must be consistent with the broader level of implementation or geographic areas. Areas formerly designated as implementation areas were reviewed, and boundary changes made. These areas are now termed geographic areas. The approach taken was to develop Desired Future Condition (DFC) statements for each geographic area Several steps were involved in the development of geographic area DFCs These steps are summarized as follows

1. Each District prepared one or more Desired Future Condition for each implementation area. The DFC was general with site-specific decisions left to project level analysis and was a picture of the management activities for the area for the next 10-15 years. The DFC stated an emphasis (or emphases) for the area and was based on the ICOs

2. Since the revision was based on the "need to change", the Forest started with the existing allocation of management areas and focused on the management opportunities to address relevant revision topics For areas with consensus on management direction, only one DFC was needed In areas where there was no consensus or where several options were viable, such as in Roadless areas, alternative DFCs were developed that displayed all options for the implementation area.

3 After the DFC's were developed, the Districts and IDT applied them to the ground using different management area designations For areas with more than one DFC, the different DFCs were applied depending on the alternative being evaluated

4 Assigning DFCs to each alternative required knowing resource potentials and suitability limitations from Standards and Guidelines. This information was used to assign DFCs

Determination of Objectives. After management areas and desired future conditions were assigned for each alternative, the IDT determined the objectives (mapped and quantitative) for the geographic area. Maps included ROS, VQO, travel management, suited timberlands, lands available for oil and gas leasing, road development, grazing, and old growth

Objectives for each alternative were developed after land suitability and management areas were assigned by the IDT Models were used to develop the numbers for objectives.

Development of Practices After resource suitability and allocation maps were developed, the IDT and Districts applied practices needed to meet the goals, DFCs, and Standards and Guidelines of each geographic area. The practices were scheduled over the next decade The implementation costs of these projects, with the addition of general administration and monitoring costs were estimated to determine the approximate budget required to implement the plan.

Alternative Comparison Following alternative development and effects estimation, alternatives were compared. The purpose of alternative comparison is to evaluate how each alternative responds to the issues and concerns. Each alternative has a set of priorities for the goals, Standards and Guidelines, and objectives; therefore, alternatives provide different effects. As these different mixes and levels were determined for each alternative, trade-offs were made to produce one set of effects as opposed to another. By comparing the response to issues and concerns in terms of outputs and effects, the public can objectively evaluate the alternatives

A Geographic Information System was used on the forest to link specified locations with their associated attribute databases. All data was linked into one system A spatial display allowed us to visualize whether our objectives for a given alternative were being constrained by physical characteristics of the land, whether our standards and guidelines were limiting activities, or areas of the forest where Geographic Area DFC's were not compatible with a given alternative's goals.

Spatial displays or maps of the suitable/available lands (potential) and the allocation of Management Area prescriptions aided in comparing alternatives Spatial displays helped in the comparison by providing an insight with respect to cumulative effects, and allowing more sophisticated analyses using GIS

Management activities needing suitability and availability analyses were suited timber lands, oil and gas leasing, roadless areas, old growth, Wilderness recommendations, Wild and Scenic River recommendations, travel management, and recreation opportunity and development. This display gave a visual picture of where different activities were appropriate These spatial displays were used when assigning management prescriptions to geographic area DFCs The displays were also used for alternative comparison in those circumstances when suitability criteria changed by alternative.