BLM

Appendix E

Threshold and Temporal Analysis

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1.0 Introduction

This appendix documents the assumptions and methodology used in the threshold and temporal analysis and summarizes the results of each analysis. The first half of the appendix is devoted to the threshold analysis performed for Alternatives B and C. The second half focuses on the temporal analysis.

2.0 Threshold Analysis

The threshold analysis protocol was developed in five steps, which are discussed in more detail below:

1. Define the assumptions for phased development with reclamation,
2. Divide the White River Field Office (WRFO) Planning Areas into discrete units of analysis,
3. Define the total area for a multi-well pad configuration,
4. Forecast the number of well pads developed in Years 1 to 7, 10 and 20 for Alternatives B and C, and
5. Define an allocation model for allocating the well pads developed in a given year across the units of analysis.

The threshold analysis protocol was used to forecast acute and collective effects in one year increments from years 1 to 7, 10 and 20 for Alternatives B and C. The threshold analysis evaluated if estimated impacts exceeded thresholds established in Chapter 2 management decisions under Alternative B and C which are also summarized in Table E-1.

The threshold analysis protocol was developed to evaluate acute and collective effects, based on forecasted allocation of well pads by Game Management Unit (GMU), lease-holding, and seasonal range areas. Acute and collective effects are represented by buffered acres of surface disturbance associated with activity related to well pad development. Acute effects occur during the period of well pad development [model assumption = 2 years] when construction and drilling are conducted. Collective effects accumulate from the time the well pad development commences until successful interim reclamation activities are achieved [model assumption = 5 years]. The allocation model is based on current trends in oil and gas development and Bureau of Land Management (BLM) management practices.

An indicator resource provides insight into how other resources could potentially respond to the acute and collective effects. Mule deer seasonal range areas were selected as an indicator resource for evaluating acute and collective effects because of the widespread coverage of the seasonal use areas in the WRFO Planning Area and the interrelationship between these big game animals and other resources such as vegetation.

Table E-1 show the respective threshold assumptions for mule deer seasonal range areas for both alternatives B and C.

Table E-1. Alternatives B and C Threshold Assumptions

Alternative B	Alternative C
Acute Thresholds	**Acute Thresholds**
• 10% of winter range • 10% of severe winter range • 10% of summer range • 10% of winter concentration area • 5% of severe winter range/winter concentration area	• 25% of winter range • 25% of severe winter range • 25% of summer range • 25% of winter concentration area • 10% of severe winter range/winter concentration area
Collective Thresholds	**Collective Thresholds**
• 20 of winter range • 20 of severe winter range • 20 of summer range • 20 of winter concentration area • 10% of severe winter range/winter concentration area	• 25% of winter range • 25% of severe winter range • 25% of summer range • 25% of winter concentration area • 20 of severe winter range/winter concentration area

2.1 Develop Protocol

1. Define the assumptions for phased development with reclamation

The first step was to define the following assumptions for phased development with reclamation. Development of a multi-well pad is assumed to be a two-year cycle. Multi-well pad development during this two-year cycle contributes to both acute and collective effects.

Interim reclamation of vegetation on an individual well pad was assumed to start at the beginning of the third year after the start of well-pad development. Multi-well pad development would begin in year one and be completed in year two. Interim reclamation would then start in year three. When reclamation starts, it was assumed that an individual multi-well pad no longer contributes to acute effects. Interim reclamation was assumed to be completed at the end of the fifth year after the start of well-pad development. For example, interim reclamation would be implemented in years three, four, and five. At the beginning of the sixth year after the start of well-pad development, interim reclamation would achieve success criteria and it was assumed that the individual well pad would no longer contribute to collective effects. Consequently, collective effects are limited to a five year window for the purpose of the threshold analysis. Because the number of developed well pads increases in a linear fashion from year to year, the collective effects would still continue to increase, but at a rate moderated by interim reclamation.

2. Divide the WRFO Planning Areas into discrete units of analysis

The second step in development of the threshold analysis protocol was to divide the WRFO Planning Areas into discrete units of analysis. The unit of analysis is defined as the cumulative mule deer seasonal range within a lease-holding within a GMU. There are a total of 525 units of analysis in the WRFO Planning Area. Units of analysis include lease areas that have been aggregated for a single operator, administrative units, and unleased areas.

The units of analysis were created by "unioning" the GMU and lease-holding area with Alternatives B and C geospatial data to produce worksheets with acreage by GMU, lease-holding area, seasonal use area, and Conditions of Approval (COA). The unit of analysis area was then calculated as the sum total of Controlled Surface Use (CSU), No Surface Occupancy (NSO) (exceptions), Open, and Timing Limitations (TL) stipulations. The NSO stipulation areas were included because the BLM

could apply exceptions (allowing development) in these areas. Closed areas were excluded because these areas are closed to oil and gas development.

3. Define the total area for a multi-well pad configuration

The third step was to define total area for a multi-well pad configuration (multi-well pads are assumed to average eight wells per pad). The total area for a multi-well pad configuration is defined as the total acreage of surface disturbance associated with an individual well pad plus the total acreage of buffer associated with an individual well pad. The total acreage of surface disturbance associated with an individual well pad includes the well pad and associated infrastructure, the access road, the collector road, and the pipeline (including other utilities rights of way). Table E-2 summarizes the acreage of surface disturbance assumed for each component associated with an individual well pad. The total acreage of buffer applied to the individual well pad components is calculated using the assumptions for mule deer summarized in Table E-3.

Table E-2. Assumed Acreage of Surface Disturbance

Component	Assumed Length of Linear Features	Assumed Disturbance (acres)
Multi-well pad	NA	8.25 acres per pad; includes 7.25 acres for well pad and 1 acre for associated infrastructure
Resource road	2,042 feet	0.75 acre road (acreage applies to running surface) and 16 feet running width
Local road	1,742 feet	1 acre road (acreage applies to running surface) and 25 feet running width. 1 acre collector road allotments are allocated per well pad.
Pipeline (including other utilities rights of way)	2,723 feet	2 acre pipeline and 32 feet width. The assumed 32 feet wide corridor for the pipeline includes a potential maintenance road along the pipeline.
Total surface disturbance associated with a multi-well pad	NA	12 acres

Table E-3. Assumed Buffers for Both Acute and Collective Effects

Range	Alternative B Buffers Feet (meters)	Alternative C Buffers Feet (meters)
Winter ranges	660 (200)	660 (200)
Summer ranges	1,320 (400)	1,320 (200)

Using the assumptions for surface disturbance and for buffers and the detailed formulas summarized in Table E-4, the following total areas for multi-well pad configurations (eight wells per pad) were calculated:

- Alternative B Winter Ranges = 229 acres
- Alternative B Summer Ranges = 459 acres
- Alternative C Winter and Summer Ranges = 229 acres

Table E-4. Detailed Formulas for Calculating Total Area

Component	Detailed Formulas
Multi-well pad	• 8.25 acres for multi-well pad (square) * 43,560 square feet/acre = 359,370 square feet • Square root of (359,370 square feet) = 599 feet per side • Winter ranges (and summer range Alternative C): 200 meter buffer around well pad * 3.28 feet/meter = 656 feet • Summer range Alternative B: 400 meter buffer around well pad * 3.28 feet/meter = 1,312 feet • Winter ranges (and summer range Alternative C): Buffer area = 4*(656 feet * 599 feet) + PI*(656)^2 [Note: the buffer is rounded on corners] • Summer range Alternative B: Buffer area = 4*(1,312 feet * 599 feet) + PI*(1312)^2 [Note: The buffer is rounded on corners] • Total area = well pad area + buffer area
Resource road	• 0.75 acre for road * 43,560 square feet/acre = 32,670 square feet • 32,670 square feet / 16 feet wide = 2,042 feet (length of road) • Winter ranges (and summer range Alternative C): 200 meter buffer around road * 3.28 feet/meter = 656 feet • Summer range Alternative B: 400 meter buffer around road * 3.28 feet/meter = 1,312 feet • Winter ranges (and summer range Alternative C): Buffer area = 2*(656 feet * (2,042 feet - 2*(656 feet)) [Note: One end of the road intersects the well pad and the other end intersects the local road.] • Summer range Alternative B: Buffer area = 2*(1,312 feet * (2,042 feet - 2*(1,312 feet)) [Note: One end of the road intersects the well pad and the other end intersects the local road.] • Total area = resource road area – (resource road overlap with well pad and local road buffer areas) + buffer area
Local road	• 1 acre for road * 43,560 square feet/acre = 43,560 square feet • 43,560 square feet / 25 feet wide = 1,742 feet (length of road) • Winter ranges (and summer range Alternative C): 200 meter buffer around road * 3.28 feet/meter = 656 feet • Summer range Alternative B: 400 meter buffer around road * 3.28 feet/meter = 1,312 feet • Winter ranges (and summer range Alternative C): Buffer area = 2*(656 feet * 1,742 feet) [Note: This is for one segment of the local road allocated to the well pad. Consequently, no additional buffer is included for the ends of the road segment.] • Summer range Alternative B: Buffer area = 2*(1,312 feet * 1,742 feet) [Note: This is for one segment of the local road allocated to the well pad. Consequently, no additional buffer is included for the ends of the road segment.] • Total area = local road area + buffer area

Table E-4. Detailed Formulas for Calculating Total Area

Component	Detailed Formulas
Pipeline (including other utilities rights of way)	• 2 acre pipeline, 32 feet width [Note: The assumed 32 feet wide corridor for the pipeline includes a potential maintenance road along the pipeline.] • 2 acre for pipeline * 43,560 square feet/acre = 87,120 square feet • 87,120 square feet / 32 feet wide = 2,723 feet (length of pipeline) • Winter ranges (and summer range Alternative C): 200 meter buffer around pipeline * 3.28 feet/meter = 656 feet • Summer range Alternative B: 400 meter buffer around pipeline * 3.28 feet/meter = 1,312 feet • Winter ranges (and summer range Alternative C): Buffer area = 2*(656 feet * (2,723 feet – 656 feet)) + 1*(656 feet * 32 feet) + ½*PI*(656 feet)^2 [Note: One end of the pipeline intersects the well pad.] • Summer range Alternative B: Buffer area = 2*(1,312 feet * (2,723 feet - 656 feet)) + 1*(1,312 feet * 32 feet) + ½*PI*(1,312 feet)^2 [Note: One end of the pipeline intersects the well pad.] • Total area = pipeline area – (pipeline area overlap with well pad buffer area) + buffer area
Total area associated with a multi-well pad	Total area for well pad configuration = multi-well pad area + resource road area + local road area + pipeline area

4. Forecast the number of well pads developed in Years 1 through 20 for Alternatives B and C

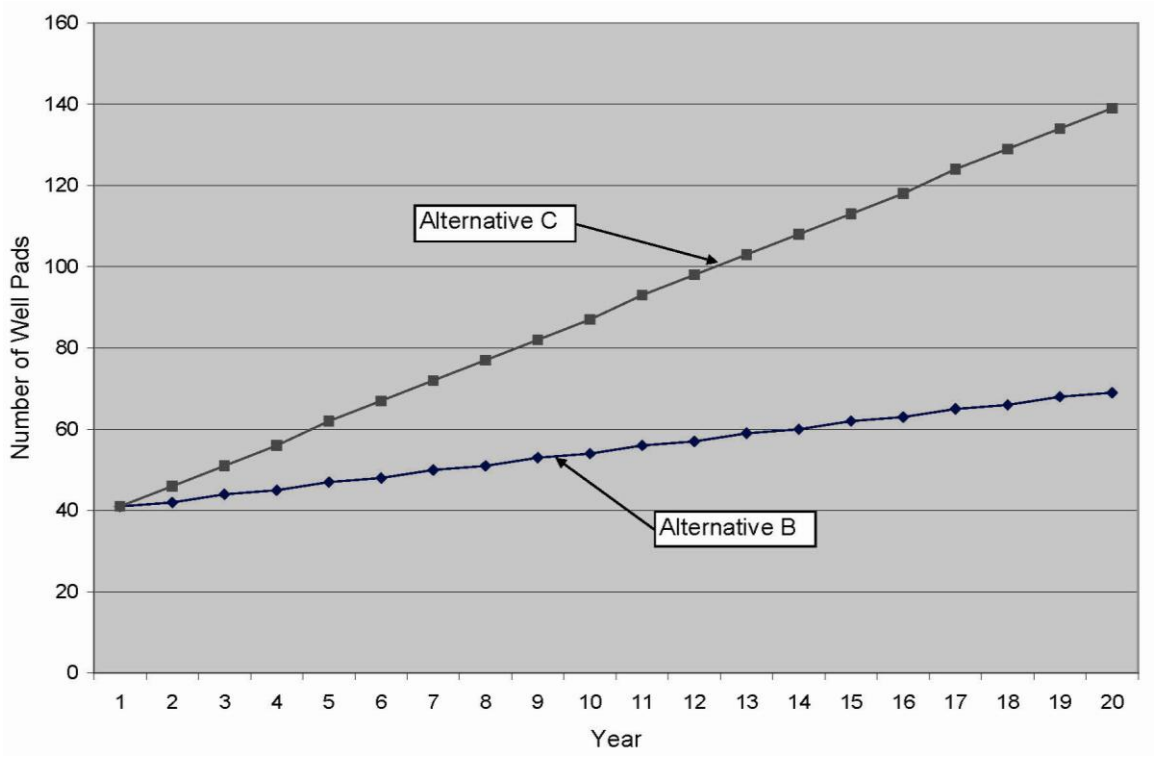
The fourth step was to forecast the number of well pads developed in Years 1-7, 10 and 20 for Alternatives B and C. For the purposes of the threshold analysis, BLM assumed that the number of new well pads developed per year would increase at a linear rate over the 20 years. Consequently, the following linear equations were developed for Alternatives B and C to describe this linear increase:

- Alternative B: Number of Well pads = 1.5 * (Year) + 40
- Alternative C: Number of Well pads = 5.2 * (Year) + 36

These equations are of the form y = mx + b, where "m" is the slope and "b" is the y-intercept. To develop the linear equations, it was first necessary to estimate the number of well pads drilled in Year 1. The number of well pads drilled in Year 1 was derived from the Reasonable Foreseeable Development (RFD) Scenario document (BLM 2007) page 63, Figure 1 where it is assumed that 331 wells will be drilled in Year 1. Dividing the 331 wells by an assumed 8 wells per well pad yields 41 well pads (when rounded to a whole number). Fixing Year 1 at 41 well pads, the slope of the line for the growth of development was varied iteratively until the total number of multi-well pads equaled the total numbers assumed for Alternatives B (1,100 multi-well pads) and Alternative C (1,800 multi-well pads). This resulted in a slope of approximately 1.5 well pads/year for Alternative B and 5.2 well pads/year for Alternative C. In addition, this resulted in a y-intercept of 40 well pads for Alternative B and 36 well pads for Alternative C.

Using the linear equations, the number of wells pads developed in Years 1-7, 10 and 20 was calculated. The estimated number of well pads developed in an individual year was rounded to a whole number. The linear growth in well pad development for Alternatives B and C is shown in Figure E-1.

Figure E-1. Linear Growth Well Pad Development



5. Define an allocation model for allocating the well pads developed in a given year across the units of analysis

The fifth step was to define an allocation model for allocating the well pads developed in a given year across the units of analysis. Table E-5 summarizes the allocation of well pads in an individual year. Within the MPA, 90 percent of total well pads assigned to the administrative unit lease-holdings were allocated by sorting the units of analysis in descending order by size and then allocating well pads proportionally to unit size. If the total area available in a unit of analysis was less than the area required to accommodate a single well pad without exceeding the acute threshold, then the unit of analysis was not included in the well pad distribution. For Alternatives B and C, the minimum size of a unit of analysis to receive a well pad is summarized in Table E-6.

Table E-5. Allocation of Well Pads in an Individual Year

Category	Mesaverde Play Area	Other Areas	Areas not included in Well Pad Allocation
GMUs designated to represent areas	GMU 22	GMUs 10, 11, 21, 31, 32, and 211	GMUs 12, 23, 24, 30, and 33
Percentage of individual year well pad allocation	95%	5%	0%
Division within area	90% of the 95% of the total new well pads will go in an administrative unit lease-holding, based on current development trends; and 10% of the 95% will go to other non-administrative unit lease-holdings.	Not applicable	Not applicable

Table E-6. Minimum Acres Required to Receive a Well Pad

Range	Alternative B (acres)	Alternative C (acres)
Winter ranges	2,290	916
Summer ranges	4,590	916
Severe winter range/winter concentration area	4,580	2,290

The 10 percent of well pads assigned to non-administrative unit lease-holdings within the MPA (MPA) and the 5 percent of total well pads assigned to other areas outside of the MPA are distributed randomly. If the total area available in a unit of analysis was less than the area required to accommodate a single well pad without exceeding the acute threshold, then the unit of analysis was not included in the well pad distribution.

2.2 Implement Protocol

Following the five steps of development in the threshold analysis protocol, the threshold analyses for Years 1 through 20 for Alternatives B and C then proceeded according to the following process:

1. Assign allocated number of multi-well pads to seasonal use areas
2. Multiply the number of multi-well pads times the total acreage per pad (including buffer) to calculate the total area-of-effect.
3. Calculate acute effect in acres.
4. Divide the acute effect in acres by the total area available per seasonal use area to calculate the acute effect as a percent of total available area
5. Calculate collective effect in acres.
6. Divide the collective effect in acres by the total area available per seasonal use area to calculate the collective effect as a percent of total available area.
7. If year is less than or equal to 20, then repeat the preceding six steps.

Acute and collective effects across GMU 22 Administrative Unit lease-holdings are presented in Figure E-2 (Alternative B) and Figure E-3 (Alternative C). These effects were calculated for the total area of Administrative Unit lease-holdings within GMU 22. The results presented on Figures E-2 and E-3 likely represent a worst case scenario since the analysis uses a random distribution of well pads that does not account for the influence of planned well pad clustering, which would reduce the number of acute and collective effects by encouraging more shared facilities. Although the threshold analysis was performed at the unit of analysis level, these GMU 22 wide results provide an indication of the effects across all of the units of analysis contained within the GMU 22 Administrative Unit lease-holdings. The acute and collective effects for the non-administrative unit lease-holdings within GMU 22 and for the other areas outside of GMU 22 fall below the thresholds.

Figure E-2. Alternative B GMU 22 Administrative Unit Lease-Holdings Effects

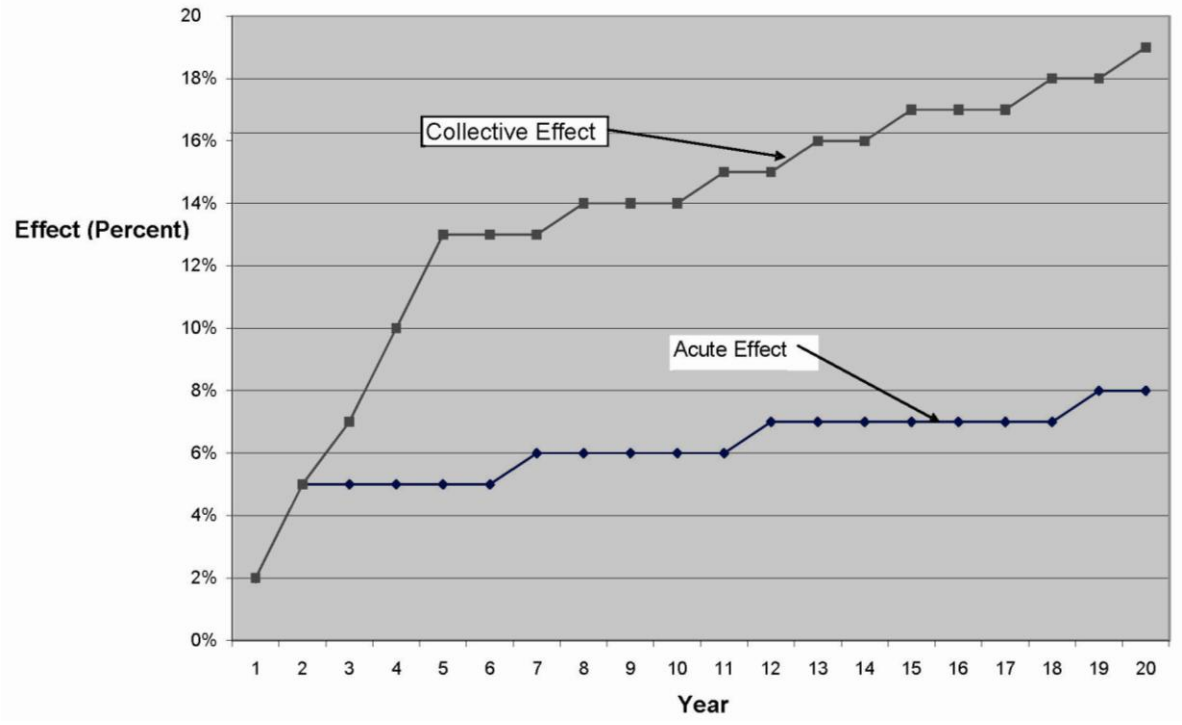
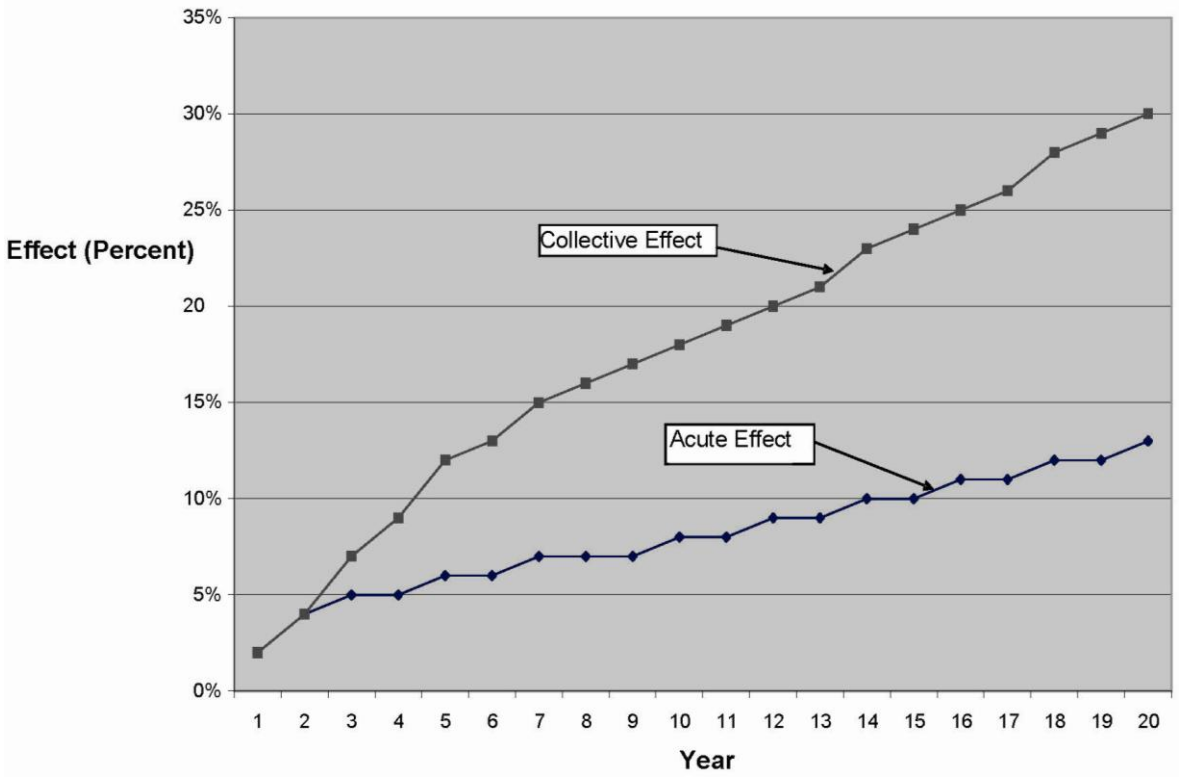


Figure E-3. Alternative C GMU 22 Administrative Unit Lease-Holdings Effects



3.0 Temporal Analysis

The temporal analysis protocol was developed to estimate acres of oil and gas-related surface disturbance before and after interim reclamation in the MPA for Alternatives A, B, C, and D over the 20-year planning period. Based on the RFD Scenario document (BLM 2007), 95 percent of oil and gas development during the planning period will occur in the MPA; consequently, the temporal analysis focused on estimating surface disturbance on BLM mineral estate within this area. Many of the methods used in this analysis are similar in concept to protocols developed for the threshold analysis. However, an additional step was performed to allocate oil and gas-related surface disturbance to different land classifications identified for five key resources: soil, water, vegetation, mule deer range, and energy and minerals.

The temporal analysis protocol was a four-step process:

1. Define assumptions for the temporal analysis.
2. Forecast the surface disturbance associated with well pads developed during each year of the planning period for management Alternatives A, B, C, and D.
3. Develop a method to predict the general distribution of oil and gas surface disturbance across the MPA.
4. Perform a proportional analysis to allocate oil and gas surface disturbance to land area features for soil, water, vegetation, mule deer range, and energy and minerals.

3.1 Analysis Protocol

1. Define assumptions for the temporal analysis.

The first step was to define the analysis assumptions. Since the analysis was confined to the MPA, a key assumption was that 95 percent of oil and gas surface disturbance would occur in this area. As stated above, this assumption has its basis in the RFD Scenario document (BLM 2007). The number of total well pads allowed under each management alternative was taken from the air emissions assumptions outlined in Record 5a of Table 2-1 (Chapter 2 of the RMPA/EIS). Under this management action, the total number of well pads allowed during the planning period increases steadily between alternatives, from a low of 550 under Alternative A to a high of 2,556 well pads under Alternative D. The number of well pads expected in the MPA was calculated by multiplying the numbers from Record 5a by 0.95. According to this methodology, the number of well pads developed in the MPA under Alternative A would be 523 (550 x 0.95 ≈ 523) (results were rounded to the nearest whole number of well pads). This calculation was repeated to estimate the number of well pads expected in the MPA under Alternatives B, C, and D (Table E-7).

Table E-7. Number of Well Pads Allowed by Alternative

Planning Unit	Alternative A	Alternative B	Alternative C	Alternative D
White River Field Office	550	1,100	1,800	2,556
Mesaverde Play Area	523	1,045	1,710	2,428

Consistent with the threshold analysis, it was assumed that each well pad would result in 12 acres of surface disturbance on BLM mineral estate. Development of a multi-well pad was assumed to occur over a two-year cycle for Alternatives B and C. In contrast, Alternatives A and D were assumed to require a three-year development cycle per well pad. This assumption was made because Alternatives A and D do not include the threshold concept for managing impacts to mule deer. Absent the threshold concept, timing limitations would remain in effect on mule deer seasonal range, meaning that year-round drilling could not occur.

Another analysis assumption was that Phase II interim reclamation would start immediately at the conclusion of the well pad development cycle. For Alternatives A and D, this implies that reclamation would begin at the start of Year 4 once the three-year development cycle was completed. For Alternatives B and C, the onset of reclamation would begin one year earlier due to the shorter two-year development cycle. An assumption common to all alternatives is that Phase II interim reclamation would require three years for successful completion. This implies that for Alternatives A and D, the time frame from initial development to the conclusion of interim reclamation on a well pad would be six years. The time frame for Alternatives B and C would be a year shorter at five years.

Another important assumption regarding reclamation is, that for each well pad, a portion of the development area would remain in a disturbed state through the well production phase. Since well production is expected to last much longer than well development, it was assumed that all oil and gas wells developed under this Resource Management Plan Amendment (RMPA) would remain in production for the entire 20-year planning period. Each well pad was assumed to require a five-acre production footprint. Therefore, 7 of the 12 surface disturbance acres required per pad would be reclaimed during Phase II interim reclamation.

2. Forecast the surface disturbance associated with well pads developed during each year of the planning period for management alternatives A, B, C, and D.

The second step of the analysis was to forecast surface disturbance associated with well pads developed during each year of the planning period. The amount of oil and gas surface disturbance, $A_{(t),}$ in a given year (t) can be estimated from the following equation:

$$A(t) = W(t)*12 \quad \text{(Equation 1)}$$

In the above equation, $W_{(t)}$ represents the number of well pads constructed in Year (t), and the multiplier 12 represents the 12 acres of surface disturbance assumed per pad. This equation applies to each of the four management alternatives. The terms in the equation represent the quantity of well pads or surface disturbance created in a given year. Cumulative surface disturbance throughout a range of years would be calculated by summing the equation result for each year in the range.

In order to solve Equation 1, it was also necessary to estimate how the number of well pads constructed in the MPA will vary from year-to-year during the planning period. The temporal variation in well pad construction was already estimated for Alternatives B and C during the threshold analysis:

$$\text{Alternative B: } W(t) = 1.5 * (t) + 40 \quad \text{(Equation 2)}$$

$$\text{Alternative C: } W(t) = 5.2 * (t) + 36 \quad \text{(Equation 3)}$$

Equations 2 and 3 assume that well pad development will occur at an increasing linear rate over the 20-year planning period. The term $W_{(t)}$ represents the number of well pads constructed in a given year. To develop these equations, it was necessary to first estimate the number of well pads drilled in Year 1. The number of well pads drilled in Year 1 was derived from the RFD Scenario document (BLM 2007) page 63, Figure 1 where it is assumed that 331 wells will be drilled in Year 1. Dividing this number by an assumed 8 wells per well pad yields 41 well pads (when rounded to a whole number). Fixing Year 1 at 41 well pads, the slope of the line for the growth of development was varied iteratively until the total number of multi-well pads equaled the total numbers assumed for Alternative B (1,100 multi-well pads) and Alternative C (1,800 multi-well pads). This resulted in a slope of approximately 1.5 well pads/year and a y-intercept of 40 for Alternative B. Likewise, the slope of the Alternative C equation is 5.2 well pads/year and the y-intercept is 36. Equations 2 and 3 are only valid for the number of years in the planning period. They cannot be used to extrapolate the number of well pads constructed prior to Year 1 or beyond Year 20.

The same method was used to develop a linear equation for well pad development under Alternative D. Starting with 41 well pads in Year 1, the slope of the equation was adjusted iteratively until the total number of well pads equaled 2,556 for the 20-year planning period. This resulted in a slope of approximately 9.1 well pads/year and a y-intercept of 32.

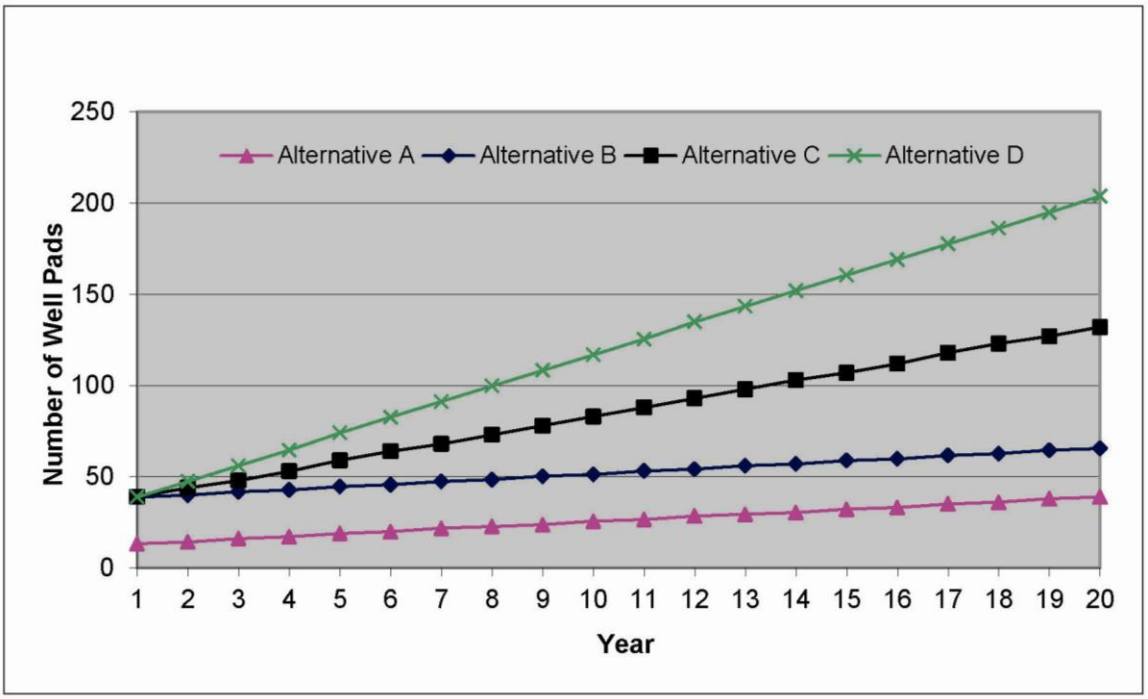
$$\text{Alternative D: } W(t) = 9.1 * (t) + 32 \quad \text{(Equation 4)}$$

For Alternative A, the number of well pads installed in Year 1 had to be adjusted downward to maintain an increasing rate of development during the planning period. A trial-and-error estimate produced a Year 1 total of 14 well pads. From this baseline, an increasing rate of development could be maintained at approximately 1.4 well pads/year to achieve a total of 550 well pads during the planning period. The y-intercept of the Alternative A equation is 13.

$$\text{Alternative A: } W(t) = 1.4 * (t) + 13 \quad \text{(Equation 5)}$$

The equations for Alternatives A, B, C, and D apply to the entire Planning Area. To estimate the number of well pads developed annually in the MPA, the total number of well pads derived from Equations 2 through 5 were then multiplied by 0.95. Figure E-4 below illustrates the projected trend of well pad development for Alternatives A through D in the MPA.

Figure E-4. Linear Growth of Well Pad Development in the MPA



The data shown on Figure E-4 can be used to estimate oil and gas surface disturbance in a given year by multiplying the entire series by 12 according to Equation 1. This estimate of surface disturbance is limited in that it does not take into account the effects of interim reclamation. By Year 6 or 7 (depending on the alternative), well pads initiated during Year 1 would achieve successful interim reclamation, and the portion of each well pad that is reclaimed (i.e., 7 acres) would partially offset new surface disturbance that occurs during subsequent years. For Alternatives A and D, this "interim reclamation offset" would begin in Year 7. Prior to Year 7, annual surface disturbance would still be calculated according to Equation 1. After that time, the interim reclamation offset can be taken into account by adjusting Equation 1 to:

$$\Delta A(t) = W(t) * 12 - W(t - 6) * 7 \qquad \text{(Equation 6)}$$

In Equation 6, $\Delta A_{(t)}$ corresponds to the net change in surface disturbance that would occur during Year (t) of the planning period, where $t \geq 7$ and $t \leq 20$.

The reclamation offset begins in Year 6 under Alternatives B and C due to the shorter well pad development cycle assumed for these alternatives. Prior to Year 6, annual surface disturbance would still be calculated according to Equation 1. After that time, Equation 1 would be modified to:

$$\Delta A(t) = W(t) * 12 - W(t - 5) * 7 \qquad \text{(Equation 7)}$$

Again, $\Delta A_{(t)}$ corresponds to the net change in surface disturbance that would occur during Year (t) of the planning period, except that (t) will now be between 6 and 20.

Equations 1 through 7 were used during the temporal analysis to estimate surface disturbance in the MPA after Phase II interim reclamation for each alternative at Years 1-7, 10, and 20.

3. Develop a method to predict the general distribution of oil and gas surface disturbance across the MPA.

Exact locations in the MPA where oil and gas well pads would be constructed depend on a number of factors and cannot be predicted with complete certainty. However, with the aid of some simplifying assumptions, it is possible to generally predict what areas of the MPA are more likely to be developed. Oil and gas conditions of approval and lease stipulations identified in the management alternative tables (i.e., Tables 2-1 to 2-21 of the RMPA/EIS) – including Closed, NSO, CSU, TLs, and Open – provide the guiding principles for these predictions.

Prior to the temporal analysis, a spatial analysis was performed to overlay lease stipulations resulting from various management actions. Where different stipulation types overlapped, NSO stipulations were assigned the highest priority since they are more restrictive of oil and gas surface disturbance than any stipulation type except Closed. Closed stipulations were not given priority since no areas of the MPA would be closed to oil and gas development under any alternative. It was assumed during the temporal analysis that oil and gas surface disturbance would not occur in NSO stipulation areas. Although BLM can occasionally grant exceptions to NSO stipulations, this assumption is valid because the number of exceptions granted would likely be small compared to the total stipulation area.

The exclusion of NSO stipulation areas leaves a reduced footprint available for oil and gas surface disturbance in the MPA. The remaining stipulation types (i.e., CSU, TLs, open) do not specifically prohibit oil and gas surface disturbance. Therefore, it was assumed that well pads would be distributed evenly among areas of the MPA available for surface occupancy. In other words, all areas of the MPA not subject to NSO stipulations would have the same average spatial development density (i.e., the same number of well pads per acre of available land). This concept is a fundamental principle of the temporal analysis.

The final assumption made during step 3 pertained to the lease status of BLM mineral estate in the MPA. Spatial data available at the time of the analysis indicates that some areas of BLM mineral estate are not currently leased for oil and gas development. However, it was assumed for the analysis that all available parcels would eventually be leased, and thus had the same probability of future development as parcels that have already been leased.

4. Perform a proportional analysis to allocate oil and gas surface disturbance to land area features analyzed for soil, water, vegetation, mule deer range, and energy and minerals.

The final step of the temporal analysis involved allocating oil and gas surface disturbance projected under each alternative to different land area features for soil, water, vegetation, mule deer range, and energy and minerals. The purpose of the allocation was to identify which features could experience a greater impact from oil and gas development as a result of having a higher proportion of land available for surface occupancy. For example, vegetation classes in the MPA include vegetation types such as aspen and piñon/juniper, among others. It is possible that NSO stipulations established in the alternative comparison tables (Tables 2-1 to 2-21) may afford greater protection from surface disturbance to aspen stands than piñon/juniper. The difference arises due to management actions that are specifically designed to protect aspen, and potentially from management actions that are designed to protect other resources where aspen trees may also be present. Overall, the allocations performed during this step make it possible to evaluate how the sum total of NSO stipulations might

shift oil and gas development away from some resources while simultaneously concentrating it near others.

The datasets used during step 4 represent the intersection of data features in Chapter 3 of the RMPA with the hierarchy of leasing stipulations developed for Chapter 2 of the RMPA. The result of these data intersections were clipped to the MPA boundary using GIS tools. The Chapter 3 spatial datasets utilized for the five resource areas are listed in Table E-8. This table also describes whether the different datasets used in the analysis have overlapping features and whether they cover the entire MPA. For datasets that cover the MPA and have no overlap between data categories, calculated percentages should sum to 100 percent.

Some data features that were clipped for the analysis, such as watersheds, have boundaries that extend beyond the analysis area. For example, only a small portion of the Lower White River watershed is within the MPA. Thus, analysis results and percentages presented for the Lower White River watershed apply only to that portion of the watershed that is within the MPA. Areas of the watershed that are outside the MPA were not considered during this analysis since area outside of the MPA is only expected to receive five percent of oil and gas development during the planning period. The same concept applies to other features that extend beyond the MPA boundaries, such as saline soils, vegetation types, and mule deer range.

Table E-8. Spatial Datasets Used in Step 4 of the Temporal Analysis

Resource	Spatial Datasets	Overlapping Features?	Coverage
Soil	Fragile soils on slopes greater than 35 percent; Saline soils	No	Portions of MPA
Water	Watersheds (based on 8-digit hydrologic unit codes)	No	Entire MPA
Vegetation	Vegetation land cover	No	Entire MPA
Mule Deer Range	Summer range, winter range, severe winter range, and winter concentration areas for mule deer	Yes	Entire MPA
Energy and Minerals	Oil shale lease areas; Oil shale research, development, and demonstration tracts; Multi-mineral zone; Sodium lease areas	Yes	Portions of MPA

A temporal analysis table was developed for each alternative and each of the five resources listed in Table E-8, resulting in 20 temporal analysis tables. Each table has eight lines that represent either a known feature area, or a calculated area or percentage. The temporal analysis tables are provided in Chapter 4 and at the end of this Appendix. An explanation of each line in the tables is presented below.

Line 1 represents the total area of each land area feature, otherwise referred to as a "feature class."

Line 2 represents the percent of land area that each feature class comprises in the MPA. It is calculated according to the formula:

Percent of Land Area in the MPA = 100 x (Feature area/MPA area) (Equation 8)

Line 3 represents the area of each feature class that would be managed with NSO stipulations under the respective alternative.

Line 4 represents the area of each feature class that would not be subject to NSO lease stipulations. It is calculated according to the formula:

Area Available for Surface Occupancy = Feature area – NSO Stipulation area (Equation 9)

Line 5 represents the ratio of a feature area that is not subject to NSO stipulations divided by the total area in the MPA that is not subject to NSO stipulations. It is calculated according to the following formula:

Percentage of Acres Available for Surface Occupancy in the MPA =
100 x (Area Available for Surface Occupancy for an individual feature/
Total Area Available for Surface Occupancy in the MPA) (Equation 10)

Line 6 represents the total number of well pads planned during the 20-year planning period. The well pad estimate is predetermined for the MPA as 95 percent of the total well pads allowed under each alternative. For each feature class, the estimated number of well pads is calculated as follows:

Estimated Number of Well Pads = Number of Well Pads in the MPA
x Percent of Acres Available for Surface Occupancy in the MPA (Equation 11)

Line 7 represents the estimated area of surface disturbance that could occur in each feature class during the planning period based on the estimated number of well pads. It is calculated as follows:

Estimated Area of Surface Disturbance during the 20-yr Planning Period =
Estimated Number of Well Pads (rounded to the nearest well pad) x 12 acres (Equation 12)

Line 8 represents the percent of each feature area that could be developed during the 20-year planning period, a value that can also be referred to as "development density." It is calculated as follows:

Percent of Total Land Area Developed During the 20-yr Planning Period =
100 x (Estimated Area of Surface Disturbance During the 20-yr Planning Period/
Feature Area in the Mesaverde Play Area). (Equation 13)

3.2 Implement Protocol

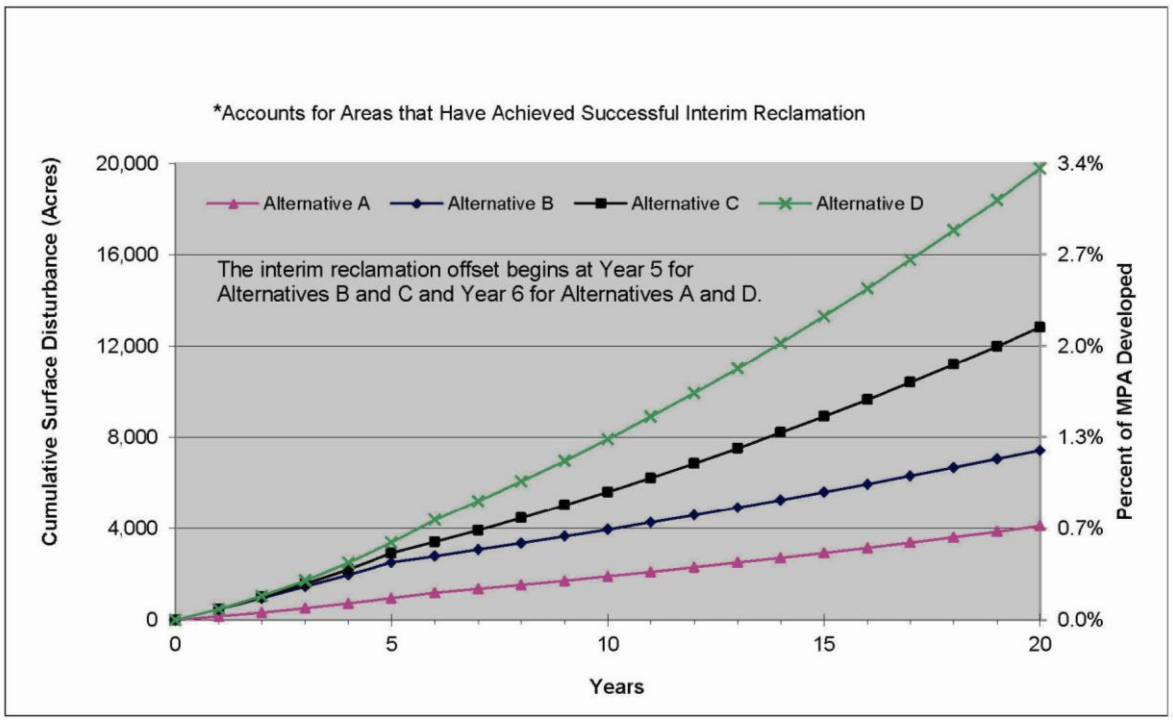
This section presents calculation results from steps 2 and 4 of the temporal analysis. The reader should remember that step 2 involved forecasting surface disturbance associated with oil and gas development during the planning period. This was accomplished by using Equations 1, 6, and 7, and then summing the results for each year to estimate the cumulative surface disturbance at Year 20 (represented by the summation symbol $\sum$). Table E-9 presents the cumulative surface disturbance at Year 20 both before and after interim reclamation. Figure E-5 shows cumulative surface disturbance by alternative during each year of the planning period.

Table E-9. Temporal Analysis Results, Step 2

Description	Units	Alternative A	Alternative B	Alternative C	Alternative D
Assumed number of well pads, WRFO ($\sum W_{(t)}$ **Eqns. 2, 3, 4, 5**)	---	550	1,100	1,800	2,556
Assumed number of well pads, MPA ($\sum W_{(t)}$***0.95**)	---	523	1,045	1,710	2,428
Surface disturbance per well pad	Acres	12	12	12	12
Total surface disturbance in MPA during the 20-yr planning period ($\sum A_{(t)}$ **Eqn. 1**)	Acres	6,276	12,540	20,520	29,136
Unreclaimed surface disturbance area in the MPA at end of 20-yr planning period after interim reclamation ($\sum \Delta A_{(t)}$ **Eqn. 6/7**)	Acres	4,113	7,423	12,834	19,784

Note: The summation symbol ∑ represents the total quantity for years 1 through 20 of the planning period.

Figure E-5. Cumulative Oil and Gas Surface Disturbance in the MPA During the 20-Year Planning Period



The 20 temporal analysis tables developed for soil, water, vegetation, mule deer range, and energy and minerals under step 4 of the analysis are presented as Attachment 1 to this appendix. The results of step 4 are also presented graphically on Figures E-6 through E-10, which have been included as Attachment 2. The values presented on Figures E-6 through E-10 were calculated using the equation for **Line 8** of the temporal analysis tables described in step 4.

4.0 References

U.S. Department of the Interior, Bureau of Land Management (BLM). 2007. Reasonable Foreseeable Development Scenario for Oil and Gas Activities in the BLM White River Field Office: Rio Blanco, Moffat and Garfield Counties, Colorado. September 10.

5.0 Attachment 1

5.1 Temporal Analysis Tables

Table E-10. Estimated Surface Disturbance by Mule deer Range Area in the Mesaverde Play Area White River Field Office – Alternative A

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Summer Range	Winter Range	Severe Winter Range	Winter Concentration Areas
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	304,100	414,600	121,300	5,300
2	Percent of Land Area in the MPA	%	100	51	70	20	0.9
3	NSO Stipulation Areas in the MPA [2]	Acres	65,500	37,700	51,700	15,500	700
4	Area Available for Surface Occupancy	Acres	533,200	266,400	362,900	105,900	4,600
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	50	68	20	0.9
6	Estimated Number of Well Pads [3]	---	523	262	357	104	4
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	6,300	3,100	4,300	1,200	50
8	Percent of Range Type within the MPA Developed During 20-yr Planning Period [5]	%	1.1	1.0	1.0	1.0	0.9

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for muledeer range are only for the identified range type. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-4 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-11. Estimated Surface Disturbance by Muledeer Range Area in the Mesaverde Play Area White River Field Office – Alternative B

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Summer Range	Winter Range	Severe Winter Range	Winter Concentration Areas
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	304,100	414,600	121,300	5,300
2	Percent of Land Area in the MPA	%	100	51	70	20	0.9
3	NSO Stipulation Areas in the MPA [2]	Acres	242,800	141,000	154,200	46,000	2,000
4	Area Available for Surface Occupancy	Acres	355,900	163,100	260,500	75,300	3,300
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	46	73	21	0.9
6	Estimated Number of Well Pads [3]	---	1,045	479	766	221	10
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	12,500	5,700	9,200	2,700	120
8	Percent of Range Type within the MPA Developed During 20-yr Planning Period [5]	%	2.1	1.9	2.2	2.2	2.3

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for muledeer range are only for the identified range type. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-4 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-12. Estimated Surface Disturbance by Muledeer Range Area in the Mesaverde Play Area White River Field Office – Alternative C

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Summer Range	Winter Range	Severe Winter Range	Winter Concentration Areas
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	304,100	414,600	121,300	5,300
2	Percent of Land Area in the MPA	%	100	51	70	20	0.9
3	NSO Stipulation Areas in the MPA [2]	Acres	150,900	88,600	98,500	31,900	1,100
4	Area Available for Surface Occupancy	Acres	447,800	215,500	316,100	89,400	4,200
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	48	71	20	0.9
6	Estimated Number of Well Pads [3]	---	1,710	824	1,209	342	16
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	20,500	9,900	14,500	4,100	190
8	Percent of Range Type within the MPA Developed During 20-yr Planning Period [5]	%	3.4	3.3	3.5	3.4	3.6

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for muledeer range are only for the identified range type. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-4 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-13. Estimated Surface Disturbance by Muledeer Range Area in the Mesaverde Play Area White River Field Office – Alternative D

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Summer Range	Winter Range	Severe Winter Range	Winter Concentration Areas
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	304,100	414,600	121,300	5,300
2	Percent of Land Area in the MPA	%	100	51	70	20	0.9
3	NSO Stipulation Areas in the MPA [2]	Acres	96,600	56,700	69,100	18,700	1,100
4	Area Available for Surface Occupancy	Acres	502,100	247,400	345,500	102,600	4,200
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	49	69	20	0.8
6	Estimated Number of Well Pads [3]	---	2,428	1,198	1,674	497	20
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	29,100	14,400	20,100	6,000	240
8	Percent of Range Type within the MPA Developed During 20-yr Planning Period [5]	%	4.9	4.7	4.8	4.9	4.6

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for muledeer range are only for the identified range type. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-4 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-14. Estimated Surface Disturbance for Energy and Mineral Lease Areas in the Mesaverde Play Area White River Field Office – Alternative A

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Oil Shale Leasing	Oil Shale Research	Multi- Mineral Zone	Sodium Leases
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	289,600	810	164,000	18,200
2	Percent of Land Area in the MPA	%	100	49	0.1	28	3.1
3	NSO Stipulation Areas in the MPA [2]	Acres	65,500	22,100	40	13,200	1,900
4	Area Available for Surface Occupancy	Acres	533,200	267,500	770	150,800	16,300
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	89	50	0.1	28	3.1
6	Estimated Number of Well Pads [3]	---	523	263	1	148	16
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	6,300	3,200	10	1,800	190
8	Percent of Mineral Feature Surface Estate within the MPA Developed During 20-yr Planning Period[5]	%	1.2	1.1	1.5	1.1	1.1

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for MPA are for all resources. The NSO stipulations areas for mineral classes are only for the identified class. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-17 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-15. Estimated Surface Disturbance for Energy and Mineral Lease Areas in the Mesaverde Play Area White River Field Office – Alternative B

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Oil Shale Leasing	Oil Shale Research	Multi- Mineral Zone	Sodium Leases
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	289,600	810	164,000	18,200
2	Percent of Land Area in the MPA	%	100	49	0.1	28	3.1
3	NSO Stipulation Areas in the MPA [2]	Acres	242,800	119,300	100	38,000	4,300
4	Area Available for Surface Occupancy	Acres	355,900	170,300	710	126,000	13,900
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	60	48	0.0	35	0.0
6	Estimated Number of Well Pads [3]	---	1,045	501	0	371	0
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	12,500	6,000	0	4,500	0
8	Percent of Mineral Feature Surface Estate within the MPA Developed During 20-yr Planning Period[5]	%	3.5	2.1	0.0	2.7	0.0

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for MPA are for all resources. The NSO stipulations areas for mineral classes are only for the identified class. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-17 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-16. Estimated Surface Disturbance for Energy and Mineral Lease Areas in the Mesaverde Play Area White River Field Office – Alternative C

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Oil Shale Leasing	Oil Shale Research	Multi- Mineral Zone	Sodium Leases
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	289,641	810	163,951	18,246
2	Percent of Land Area in the MPA	%	100	49	0.1	28	3.1
3	NSO Stipulation Areas in the MPA [2]	Acres	150,900	64,900	40	22,100	5,100
4	Area Available for Surface Occupancy	Acres	447,800	224,800	770	141,900	13,100
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	75	50	0.0	32	0.0
6	Estimated Number of Well Pads [3]	---	1,710	860	0	543	0
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	20,500	10,300	0	6,500	0
8	Percent of Mineral Feature Surface Estate within the MPA Developed During 20-yr Planning Period[5]	%	4.6	3.6	0.0	4.0	0.0

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for MPA are for all resources. The NSO stipulations areas for mineral classes are only for the identified class. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-17 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-17. Estimated Surface Disturbance for Energy and Mineral Lease Areas in the Mesaverde Play Area White River Field Office – Alternative D

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Oil Shale Leasing	Oil Shale Research	Multi- Mineral Zone	Sodium Leases
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	289,600	810	164,000	18,200
2	Percent of Land Area in the MPA	%	100	49	0.1	28	3.1
3	NSO Stipulation Areas in the MPA [2]	Acres	69,600	40,300	40	15,700	2,900
4	Area Available for Surface Occupancy	Acres	502,100	249,300	770	148,300	15,300
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	84	50	0.0	30	0.0
6	Estimated Number of Well Pads [3]	---	2,428	1,208	0	719	0
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	29,100	14,500	0	8,600	0
8	Percent of Mineral Feature Surface Estate within the MPA Developed During 20-yr Planning Period[5]	%	4.9	5.0	0.0	5.3	0.0

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for MPA are for all resources. The NSO stipulations areas for mineral classes are only for the identified class. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-17 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-18. Estimated Surface Disturbance for Fragile, Highly Erodible, and Saline Soil Areas in the Mesaverde Play Area – White River Field Office – Alternative A

Line [1]	Description	Note	Units	Mesaverde Play Area	Fragile Soils on Slopes Greater than 35 Percent	Saline Soils
1	Land Area in the Mesaverde Play Area (MPA)	---	Acres	598,700	121,900	2,000
2	Percent of Land Area in the MPA	---	%	100	20	0.3
3	NSO Stipulation Area in the MPA	---	Acres	65,500	17,100	300
4	Area Available for Surface Occupancy	---	Acres	533,200	104,800	1,700
5	Percentage of Acres Available for Surface Occupancy in the MPA	---	%	100	20	0.3
6	Estimated Number of Well Pads[2]	(1)	---	523	103	2
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period[3]	(2)	Acres	6,300	1,200	24
8	Percent of Soil Feature within the MPA Developed During the 20-yr Planning Period[4]	(3)	%	1.1	1.0	1.2

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[3] Assumed that each well pad would require 12 acres of surface disturbance.

[4] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature.

Table E-19. Estimated Surface Disturbance for Fragile, Highly Erodible, and Saline Soil Areas in the Mesaverde Play Area –White River Field Office – Alternative B

Line [1]	Description	Note	Units	Mesaverde Play Area	Fragile Soils on Slopes Greater than 35 Percent	Saline Soils
1	Land Area in the Mesaverde Play Area (MPA)	---	Acres	598,700	121,900	2,000
2	Percent of Land Area in the MPA	---	%	100	20	0.3
3	NSO Stipulation Area in the MPA	---	Acres	242,800	121,800	2,000
4	Area Available for Surface Occupancy	---	Acres	355,900	120	0
5	Percentage of Acres Available for Surface Occupancy in the MPA	---	%	100	0.0	0.0
6	Estimated Number of Well Pads[2]	(1)	---	1,045	0	0
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period[3]	(2)	Acres	12,500	0	0
8	Percent of Soil Feature within the MPA Developed During the 20-yr Planning Period[4]	(3)	%	2.1	0.0	0.0

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[3] Assumed that each well pad would require 12 acres of surface disturbance.

[4] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature.

Table E-20. Estimated Surface Disturbance for Fragile, Highly Erodible, and Saline Soil Areas in the Mesaverde Play Area –White River Field Office – Alternative C

Line [1]	Description	Note	Units	Mesaverde Play Area	Fragile Soils on Slopes Greater than 35 Percent	Saline Soils
1	Land Area in the Mesaverde Play Area (MPA)	---	Acres	598,700	121,900	2,000
2	Percent of Land Area in the MPA	---	%	100	20	0.3
3	NSO Stipulation Area in the MPA	---	Acres	150,900	60,600	2,000
4	Area Available for Surface Occupancy	---	Acres	447,800	61,300	0
5	Percentage of Acres Available for Surface Occupancy in the MPA	---	%	100	14	0.0
6	Estimated Number of Well Pads[2]	(1)	---	1,710	234	0
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period[3]	(2)	Acres	20,500	2,800	0
8	Percent of Soil Feature within the MPA Developed During the 20-yr Planning Period[4]	(3)	%	3.4	2.3	0.0

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[3] Assumed that each well pad would require 12 acres of surface disturbance.

[4] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature.

Table E-21. Estimated Surface Disturbance for Fragile, Highly Erodible, and Saline Soil Areas in the Mesaverde Play Area –White River Field Office – Alternative D

Line [1]	Description	Note	Units	Mesaverde Play Area	Fragile Soils on Slopes Greater than 35 Percent	Saline Soils
1	Land Area in the Mesaverde Play Area (MPA)	---	Acres	598,700	121,900	2,000
2	Percent of Land Area in the MPA	---	%	100	20	0.3
3	NSO Stipulation Area in the MPA	---	Acres	69,600	46,300	310
4	Area Available for Surface Occupancy	---	Acres	502,100	75,700	1,700
5	Percentage of Acres Available for Surface Occupancy in the MPA	---	%	100	15	0.3
6	Estimated Number of Well Pads[2]	(1)	---	2,428	367	8
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period[3]	(2)	Acres	29,100	4,400	100
8	Percent of Soil Feature within the MPA Developed During the 20-yr Planning Period[4]	(3)	%	4.9	3.6	4.7

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[3] Assumed that each well pad would require 12 acres of surface disturbance.

[4] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature.

Table E-22. Estimated Surface Disturbance by Vegetation Community in the Mesaverde Play Area – Alternative A

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Aspen	Conifer	Developed and Non-vegetated	Grass-lands	Grease-wood	Mountain Shrub	Pinyon/ Juniper	Riparian and Wetlands	Sage-brush	Salt Desert
1	Land Area in the MPA	Acres	598,700	17,400	9,400	13,500	14,900	6,400	142,100	239,300	660	151,000	4,000
2	Percent of Land Area in the MPA	%	100	2.9	1.6	2.3	2.5	1.1	23.7	40	0.1	25.2	0.7
3	NSO Stipulation Areas and Effective NSO Areas in the MPA [2]	Acres	68,200	1,200	2,300	3,000	2,000	1,000	14,900	28,200	170	14,800	600
4	Area Available for Surface Occupancy in the MPA	Acres	530,500	16,200	7,100	10,500	12,900	5,400	127,200	211,100	490	136,200	3,400
5	Percentage of Vegetation Class in the MPA Available for Surface Occupancy	%	89	93	76	77	86	85	90	88	73	90	83
6	Estimated Number of Well Pads [3]	---	523	16	7	10	13	5	125	208	0.6	134	3
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	6,300	192	84	120	156	60	1,500	2,496	0	1,608	36
8	Percent of Vegetation Class Available within the MPA Developed During 20-yr Planning Period [5]	%	1.0	1.1	0.9	0.9	1.0	1.0	1.1	1.0	0.9	1.1	1.0

NOTES:

[1] The line-by-line analysis methodology is described in Appendix E.

[2] NSO stipulation areas for MPA are for all resources. NSO Stipulations area for vegetation communities are only for the identified community. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-3 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a vegetation community divided by the total land area of that vegetation community within the MPA. Does not account for areas that would be reclaimed.

Table E-23. Estimated Surface Disturbance by Vegetation Community in the Mesaverde Play Area – Alternative B

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Aspen	Conifer	Developed and Non-vegetated	Grass-lands	Grease-wood	Mountain Shrub	Pinyon/ Juniper	Riparian and Wetlands	Sage-brush	Salt Desert
1	Land Area in the MPA	Acres	598,700	17,400	9,400	13,500	14,900	6,400	142,100	239,300	660	151,000	4,000
2	Percent of Land Area in the MPA	%	100	2.9	1.6	2.3	2.5	1.1	23.7	40	0.1	25.2	0.7
3	NSO Stipulation Areas and Effective NSO Areas in the MPA [2]	Acres	314,100	16,400	9,200	11,800	10,200	4,800	87,600	115,400	500	55,300	2,900
4	Area Available for Surface Occupancy in the MPA	Acres	284,600	1,000	200	1,700	4,700	1,600	54,500	123,900	164	95,700	1,100
5	Percentage of Vegetation Class in the MPA Available for Surface Occupancy	%	48	5	2	13	31	25	38	52	25	63	28
6	Estimated Number of Well Pads [3]	---	1,045	3	1	6	17	6	200	455	1	351	4
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	12,500	36	12	72	204	72	2,400	5,460	12	4,212	48
8	Percent of Vegetation Class Available within the MPA Developed During 20-yr Planning Period [5]	%	2.1	0.2	0.1	0.6	1.4	1.1	1.7	2.3	1.1	2.8	1.2

NOTES:
[1] The line-by-line analysis methodology is described in Appendix E.
[2] NSO stipulation areas for MPA are for all resources. NSO Stipulations area for vegetation communities are only for the identified community. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-3 and Appendix A for exception, modification, and waiver criteria.
[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.
[4] Assumed that each well pad would require 12 acres of surface disturbance.
[5] Represents the ratio of estimated surface disturbance for a vegetation community divided by the total land area of that vegetation community within the MPA. Does not account for areas that would be reclaimed.

Table E-24. Estimated Surface Disturbance by Vegetation Community in the Mesaverde Play Area – Alternative C

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Aspen	Conifer	Developed and Non-vegetated	Grass-lands	Grease-wood	Mountain Shrub	Pinyon/ Juniper	Riparian and Wetlands	Sage-brush	Salt Desert
1	Land Area in the MPA	Acres	598,700	17,400	9,400	13,500	14,900	6,400	142,100	239,300	660	151,000	4,000
2	Percent of Land Area in the MPA	%	100	2.9	1.6	2.3	2.5	1.1	23.7	40	0.1	25	0.7
3	NSO Stipulation Areas and Effective NSO Areas in the MPA [2]	Acres	192,700	16,300	9,300	8,800	5,800	2,200	52,500	62,900	380	33,200	1,400
4	Area Available for Surface Occupancy in the MPA	Acres	406,000	1,100	143	4,700	9,100	4,200	89,600	176,400	283	117,700	2,600
5	Percentage of Vegetation Class in the MPA Available for Surface Occupancy	%	68	6.2	1.5	34.7	61.4	65.4	63.1	73.7	42.6	78	64.9
6	Estimated Number of Well Pads [3]	---	1,710	5	1	20	38	18	378	743	1	496	11
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	20,500	60	12	240	456	216	4,536	8,916	12	5,952	132
8	Percent of Vegetation Class Available within the MPA Developed During 20-yr Planning Period [5]	%	3.4	0.3	0.1	1.8	3.1	3.3	3.2	3.7	2.23	3.9	3.3

NOTES:
[1] The line-by-line analysis methodology is described in Appendix E.
[2] NSO stipulation areas for MPA are for all resources. NSO Stipulations area for vegetation communities are only for the identified community. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-3 and Appendix A for exception, modification, and waiver criteria.
[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.
[4] Assumed that each well pad would require 12 acres of surface disturbance.
[5] Represents the ratio of estimated surface disturbance for a vegetation community divided by the total land area of that vegetation community within the MPA. Does not account for areas that would be reclaimed.

Table E-25. Estimated Surface Disturbance by Vegetation Community in the Mesaverde Play Area – Alternative D

Line (1)	Description	Units	Mesaverde Play Area (MPA)	Aspen	Conifer	Developed and Non-vegetated	Grass-lands	Grease-wood	Mountain Shrub	Pinyon/ Juniper	Riparian and Wetlands	Sage-brush	Salt Desert
1	Land Area in the MPA	Acres	598,700	17,400	9,400	13,500	14,900	6,400	142,100	239,300	660	151,000	4,000
2	Percent of Land Area in the MPA	%	100	2.9	1.6	2.3	2.5	1.1	23.7	40	0.1	25.2	0.7
3	NSO Stipulation Areas and Effective NSO Areas in the MPA (2)	Acres	129,500	4,300	6,900	8,400	4,000	1,300	32,600	48,200	320	22,300	1,200
4	Area Available for Surface Occupancy in the MPA	Acres	469,200	13,100	2,500	5,100	10,900	5,100	109,500	191,100	340	128,700	2,800
5	Percentage of Vegetation Class in the MPA Available for Surface Occupancy	%	78	76	27	38	73	79	77	80	51	85	70
6	Estimated Number of Well Pads (3)	---	2,428	68	13	27	56	26	567	989	2	666	15
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period (4)	Acres	29,100	816	156	324	672	312	6,804	11,868	24	7,992	180
8	Percent of Vegetation Class Available within the MPA Developed During 20-yr Planning Period (5)	%	4.9	4.7	1.6	2.4	4.5	4.9	4.8	5.0	3.2	5.3	4.4

NOTES:
(1) The line-by-line analysis methodology is described in Appendix E.
(2) NSO stipulation areas for MPA are for all resources. NSO Stipulations area for vegetation communities are only for the identified community. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-3 and Appendix A for exception, modification, and waiver criteria.
(3) Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.
(4) Assumed that each well pad would require 12 acres of surface disturbance.
(5) Represents the ratio of estimated surface disturbance for a vegetation community divided by the total land area of that vegetation community within the MPA. Does not account for areas that would be reclaimed.

Table E-26. Estimated Surface Disturbance by Watershed in the Mesaverde Play Area White River Field Office – Alternative A

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Colorado Headwaters-Plateau	Lower White	Parachute-Roan	Piceance-Yellow	Upper White
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	64	28,100	31,100	501,100	35,500
2	Percent of Land Area in the MPA	%	100	0.0	4.7	5.2	84.1	6.0
3	NSO Stipulation Areas in the MPA [2]	Acres	64,100	0	14,300	2,300	45,900	1,600
4	Area Available for Surface Occupancy	Acres	531,700	64	13,800	28,800	455,200	33,900
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	0.0	2.6	5.4	85.6	6.4
6	Estimated Number of Well Pads [3]	---	523	0	14	28	448	33
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	6,300	0	170	340	5,400	400
8	Percent of Watershed within the MPA Developed During 20-yr Planning Period [5]	%	1.0	0.0	0.6	1.1	1.1	1.1

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for each watershed are only for the identified watershed. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-2 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-27. Estimated Surface Disturbance by Watershed in the Mesaverde Play Area White River Field Office – Alternative B

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Colorado Headwaters-Plateau	Lower White	Parachute-Roan	Piceance-Yellow	Upper White
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	64	28,100	31,100	501,100	35,500
2	Percent of Land Area in the MPA	%	100	0.0	4.7	5.2	84.1	6.0
3	NSO Stipulation Areas in the MPA [2]	Acres	240,400	12	22,900	18,300	188,300	11,000
4	Area Available for Surface Occupancy	Acres	355,400	52	5,200	12,800	312,800	24,500
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	0.0	1.5	3.6	88	6.9
6	Estimated Number of Well Pads [3]	---	1,045	0	15	38	920	72
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	12,500	0	180	460	11,000	860
8	Percent of Watershed within the MPA Developed During 20-yr Planning Period [5]	%	2.0	0.0	0.6	1.5	2.2	2.4

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for each watershed are only for the identified watershed. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-2 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-28. Estimated Surface Disturbance by Watershed in the Mesaverde Play Area White River Field Office – Alternative C

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Colorado Headwaters-Plateau	Lower White	Parachute-Roan	Piceance-Yellow	Upper White
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	64	28,100	31,100	501,100	35,500
2	Percent of Land Area in the MPA	%	100	0.0	4.7	5.2	84	6.0
3	NSO Stipulation Areas in the MPA [2]	Acres	148,600	10	21,700	10,300	111,500	5,191
4	Area Available for Surface Occupancy	Acres	447,200	54	6,400	20,800	389,600	30,300
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	0.0	1.4	4.7	87.1	6.8
6	Estimated Number of Well Pads [3]	---	1,710	0	25	80	1,489	116
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	20,500	0	300	960	17,700	1,400
8	Percent of Watershed within the MPA Developed During 20-yr Planning Period [5]	%	3.0	0.0	1.1	3.1	3.6	3.9

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for each watershed are only for the identified watershed. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-2 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

Table E-29. Estimated Surface Disturbance by Watershed in the Mesaverde Play Area White River Field Office – Alternative D

Line [1]	Description	Units	Mesaverde Play Area (MPA)	Colorado Headwaters-Plateau	Lower White	Parachute-Roan	Piceance-Yellow	Upper White
1	Land Area in the Mesaverde Play Area (MPA)	Acres	598,700	64	28,100	31,100	501,100	35,500
2	Percent of Land Area in the MPA	%	100	0.0	4.7	5.2	84.1	6.0
3	NSO Stipulation Areas in the MPA [2]	Acres	94,500	3	16,000	3,700	71,500	3,300
4	Area Available for Surface Occupancy	Acres	501,300	61	12,100	27,400	429,600	32,200
5	Percentage of Acres Available for Surface Occupancy in the MPA	%	---	0	2.4	5.5	85.7	6.4
6	Estimated Number of Well Pads [3]	---	2,428	0	58	133	2,081	156
7	Estimated Area of Surface Disturbance During the 20-yr Planning Period [4]	Acres	29,100	0	700	1,600	25,000	1,900
8	Percent of Watershed within the MPA Developed During 20-yr Planning Period [5]	%	5.0	0.0	2.5	5.1	5.0	5.3

NOTES:

[1] The line-by-line analysis methodology is described elsewhere in this appendix.

[2] The NSO stipulations areas for the MPA are for all resources. The NSO stipulations areas for each watershed are only for the identified watershed. This is a conservative assumption, as it does not include exceptions to NSO stipulations. Refer to Table 2-2 and Appendix A for exception, modification, and waiver criteria.

[3] Assumed that 95 percent of reasonably foreseeable oil and gas development would occur in the MPA.

[4] Assumed that each well pad would require 12 acres of surface disturbance.

[5] Represents the ratio of estimated surface disturbance for a feature divided by the total land area of that feature class within the MPA.

6.0 Attachment 2

6.1 Temporal Analysis Figures

Temporal analysis figures including:

- Figure E-6 Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Soil Class during the 20-year Planning Period
- Figure E-7 Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Watershed during the 20-year Planning Period
- Figure E-8 Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Vegetation Class during the 20-year Planning Period
- Figure E-9 Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Range Type during the 20-year Planning Period
- Figure E-10 Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Mineral Estate Category during the 20-year Planning Period

Figure E-6. Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Soil Class during the 20-year Planning Period

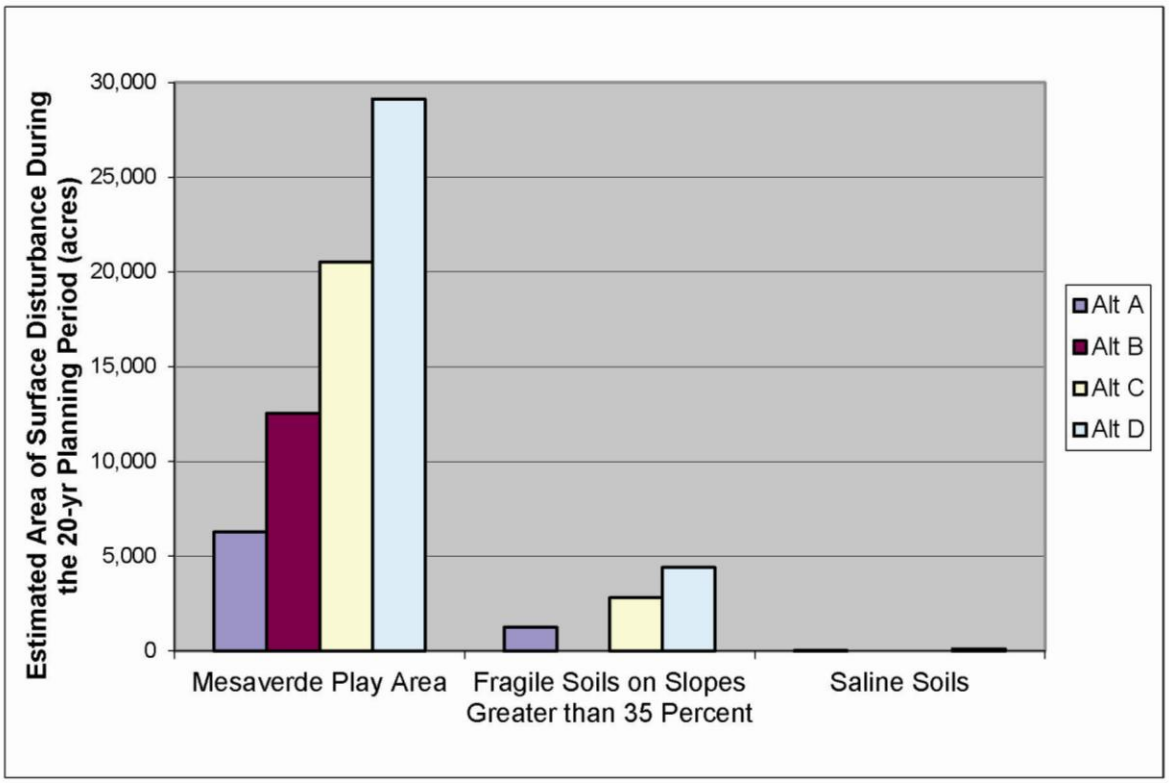


Figure E-7. Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Watershed during the 20-year Planning Period

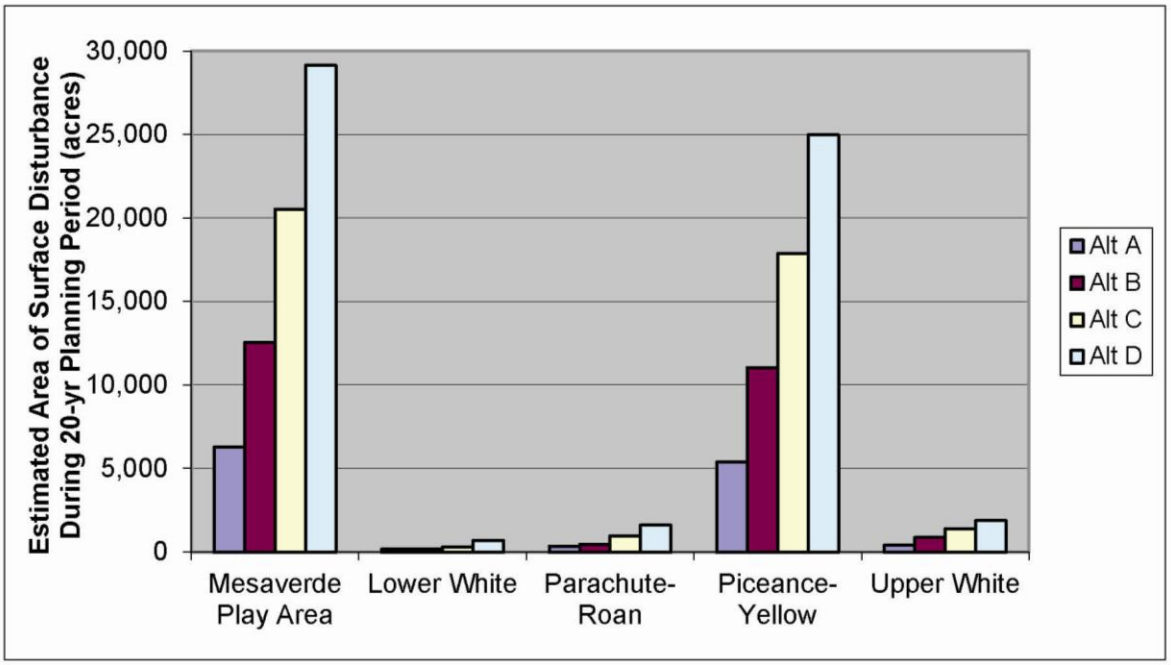


Figure E-8. Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Vegetation Class during the 20-year Planning Period

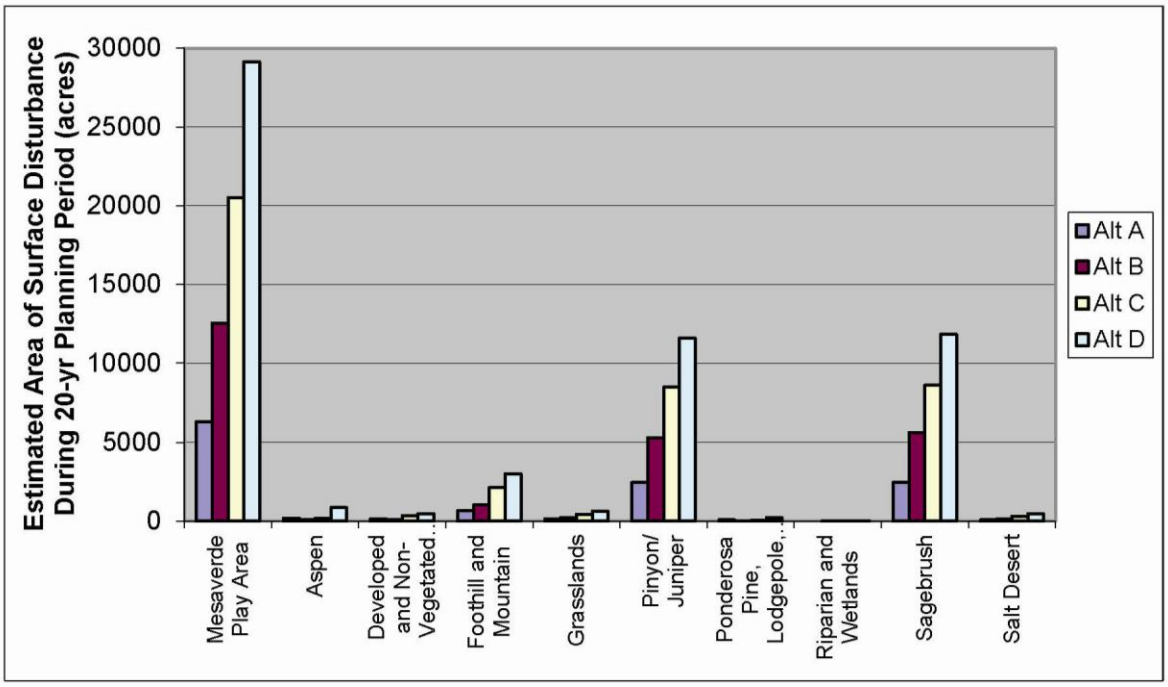


Figure E-9. Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Range Type during the 20-year Planning Period

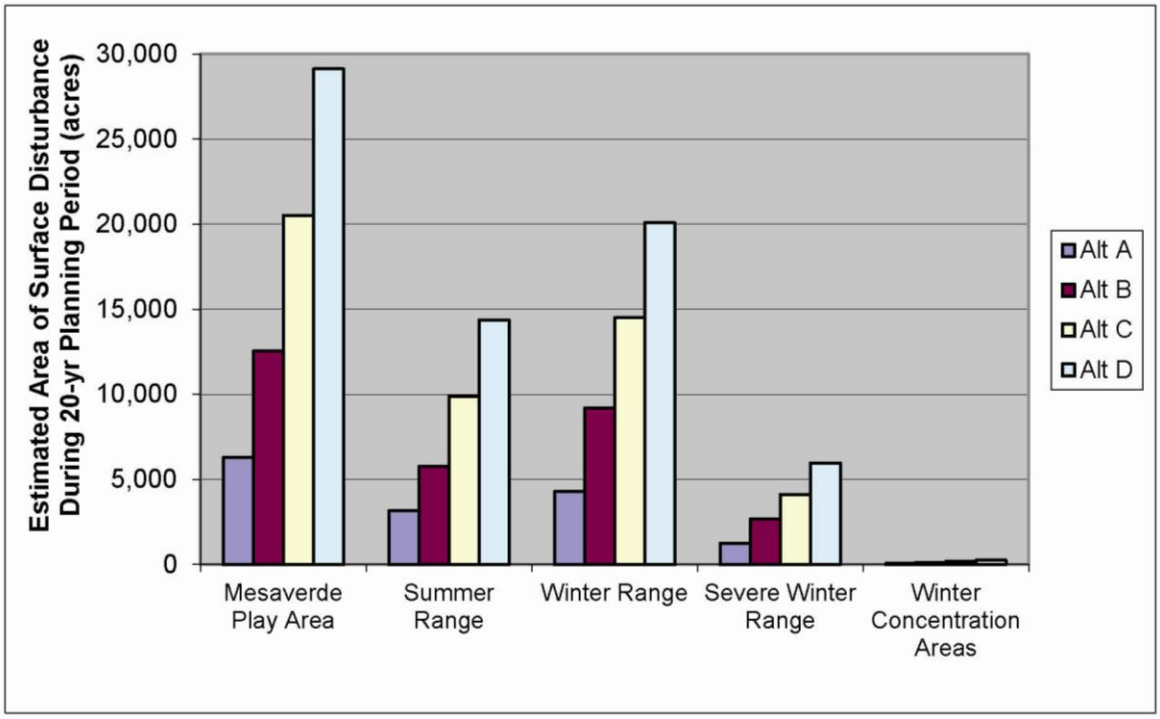
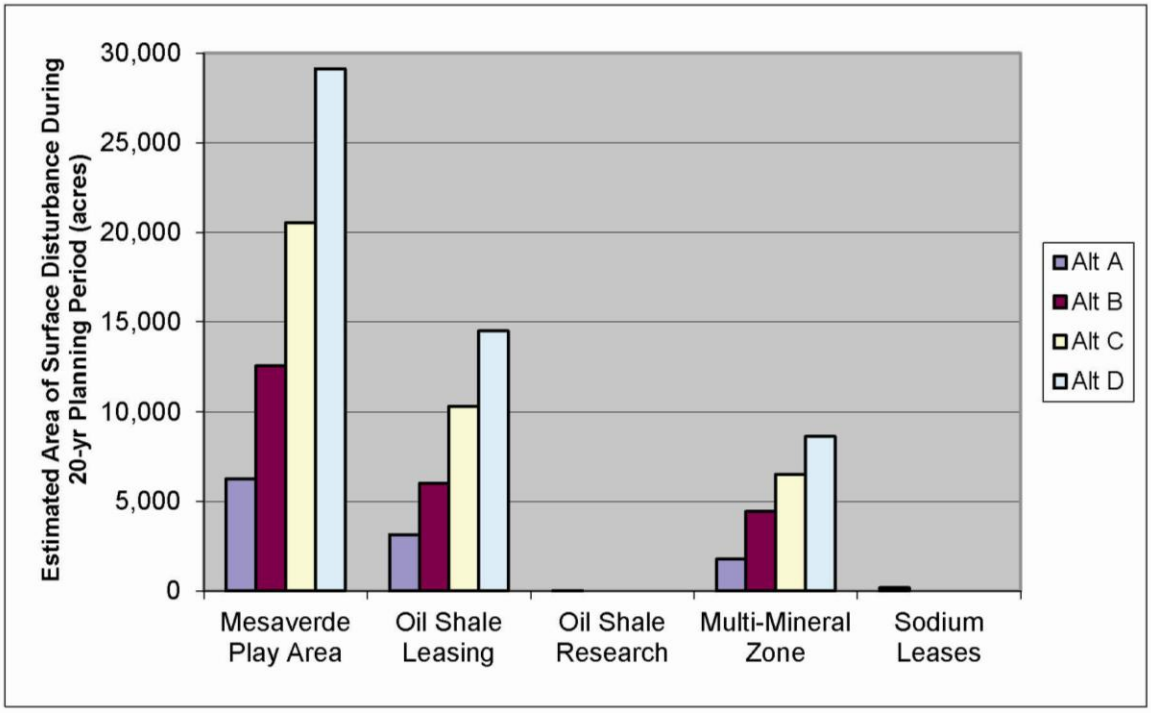


Figure E-10. Estimated Area of Surface Disturbance in the Mesaverde Play Area in Each Mineral Estate Category during the 20-year Planning Period



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