Appendix D

Methodologies and Calculations

Elk Habitat Model

Effective habitat was modeled as all areas within the elk yearlong and crucial ranges that were either 0.5 miles from roads or at less than 0.5 miles where visibility of the road was obscured by topography at a lesser distance. It was assumed that by calculating the loss of effective habitat around roads that access the wells, the loss of effective habitat around wells was generally accommodated. The model did not account for vegetation.

The visibility model employed a 98-foot digital elevation model (DEM) to account for topography (U.S. Geological Survey National Elevation Database). Because no development would occur in the WSA, it was assumed that no roads occurred or were used in the WSA. The model was run for the entire yearlong elk range and subsequently clipped to the FCPA. This ensures that roads immediately outside the FCPA but within 0.5 miles would show the loss of effective habitat. The same algorithm was used for the elk crucial range. A security patch was defined as a block of contiguous effective habitat with a size of 250 acres or more. This is a common minimum patch size that has been employed in other studies (Christensen et al. 1991, Leege 1984, cited in BLM [2007]).

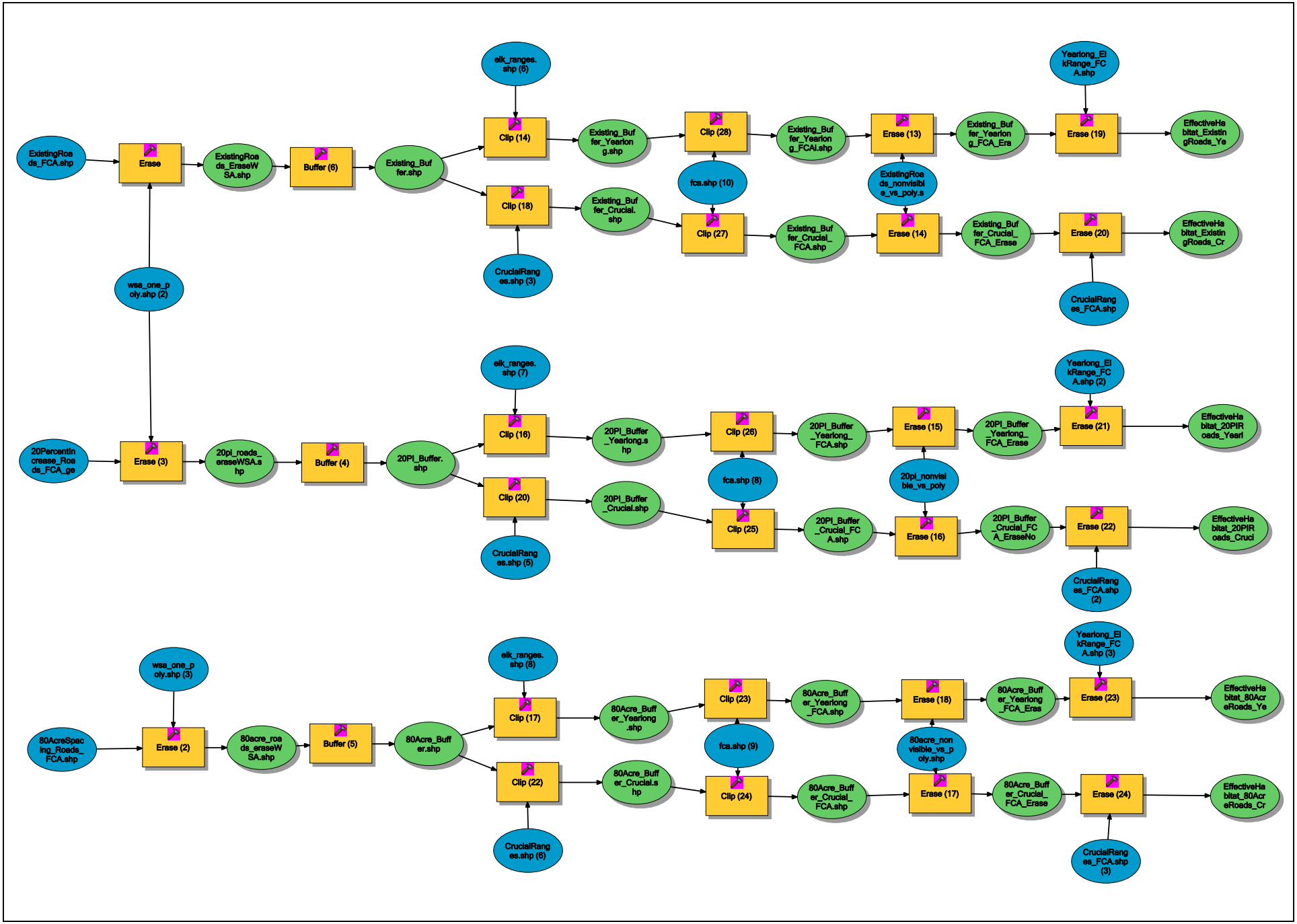
Alternative I was analyzed using the existing road layer as a base. An 80-acre grid was superimposed on the FCPA and potential roads were estimated. Roads avoided slopes greater than 25 percent, could not cross into isolated areas, and were required to reach a theoretically possibly well location. The WSA was not included in the road analysis.

Alternative II was analyzed with the existing road layer, which did not avoid slopes greater than 25 percent.

Alternative III was analyzed by eliminating a 0.5-mile buffer around the WSA, and then using an algorithm that employed the 80-acre spacing road layer. The algorithm took the longest road, then the next longest road, etc., until the 20 percent increase in road density was actualized.

If the last road added was too long (and surpassed the target), it was clipped back to the appropriate length to reach the 20 percent increase in road density. This process was conducted separately for the yearlong elk range and the crucial elk range, in order to ensure the 20 percent increase in each.

Roads and habitat modeling was conducted using GIS. A graphic of this methodology is shown below.



Elk Effect Habitat

Disturbance Calculations

Assumptions for CBNG disturbance calculations were derived, for the most part, from the Powder River Basin Oil and Gas Final Environmental Impact Statement (BLM 2003). Assumptions based on specific Fortification Creek Planning Area information are noted.

The following assumptions were used.

Facility	Initial Disturbance
Well Pads	0.7 acres per pad
Roads	The roads will be 24' road width and 48' disturbance width; for every mile of road approximately 5.8 acres of ground is disturbed
3" pipeline	20 foot width disturbance
12 " poly pipeline	50 foot width disturbance
12" steel	100 foot width disturbance
Overhead electric	0.1 mile from drop for each well (FCPA assumption)
	3.6 acres of disturbance each mile
Booster Stations	0.017 acres per well
Reciprocating Stations	0.0124 acres per well pad
Central Metering Stations	0.2 acres for every 10 well
Water Facilities	1 for every 3 wells
	0.3 acres per well
Long-Term Disturbance	
Well Pads	0.7 acres per pad
Roads	The roads will be 24' road width; for every mile of road approximately 2.9 acres of ground is disturbed
3" pipeline	20 foot width disturbance
12 " poly pipeline	50 foot width disturbance
12" steel	100 foot width disturbance
Overhead electric	0.1 mile from drop for each well (FCPA assumption)
	3.6 acres of disturbance each mile
Booster Stations	0.017 acres per well
Reciprocating Stations	0.0124 acres per well pad
Central Metering Facilitiess	0.1 acres for every 10 well
Water Facilities	1 for every 3 wells
	0.3 acres per well

Central Metering Facilities are not generally used by most operators. However, because of well visitation restrictions and rough topography resulting in less effective telemetry, they have been include in disturbance calculations.

Water Discharge and Storage Calculations

Water discharge and storage were calculated assuming average discharge and storage rates from WDEQ permits in the FCPA. Using the information in the following table, the average well flow rate was divided by the number of permitted wells to get an average rate for the FCPA.

Table 4-11 Fortification Creek Planning Area CBNG 2008 Groundwater Extraction Wells and Flow Rates[1]

Permit Number	Number of Groundwater Wells	Groundwater Well Flow Rate (mgd)	Drainage Channel Discharge Point (discharge type)[2]
WY0039616	180	4.16	(2 OCR/1A)
WY0046485	111	2.01	(2 OCR/1A)
WY0047538	32	0.1	(2 OCR/1A)
WY0047546	24	0.52	(2 OCR/1B)
WY0047554	36	0.52	(2 OCR/1B/1A)
WY0048097	33	1.01	(2 OCR)
WY0048593	48	0.32	(1A/1B)
WY0050156	58	0.13	(2 OCR)
WY0050211	33	0.32	(1A/1B)
WY0051985	624	16.16	(2 DD)
WY0052809	122	1.55	(2 OCR/2 DD)
WY0053601	26	0.55	(1B)
WY0053953	10	0.25	(2 OCR)
WY0054780	184	13.9	(2 DD)
WY0055115	22	0.934	(2 OCR)
WY0055352	45	0.878	(2 OCR)
WY0055441	7	0.35	(2 OCR)
WY0056081	212	3.9	(2 DD)

[1] Extraction Well and Flow Rates table summarized from WDEQ and BLM 2008 permit holder data.
[2] Discharge Types defined as: 2 OCR = Option 2 on-channel reservoirs; 2 DD = Option 2 direct discharge; 1B = Option 1B full containment-class 4; 1A = Option 1A full containment-class 3.

The average value of 0.026mgd was used to calculate discharge and storage volumes below.

Volume	Current Conditions	Alternative I	Alternative II	Alternative II
Number of Wells	94	726	468	574
FCPA				
mgd	2.474172	19.10903	12.31822	15.10824
mbd	0.044985	0.347437	0.223968	0.274695
mby	16.19458	125.0773	80.62832	98.89029
Discharged Water				
mgd	1.855629	14.33177	9.238662	11.33118
mbd	0.033739	0.260578	0.167976	0.206021
mby	12.14593	93.80795	60.47124	74.16772
Stored Water				
mgd	0.618543	4.777257	3.079554	3.77706
mbd	0.011246	0.086859	0.055992	0.068674
mby	4.048644	31.26932	20.15708	24.72257