Detailed Comments by the U.S. Environmental Protection Agency
on the
Statewide Draft Oil and Gas Environmental Impact Statement (Draft EIS) and Amendment of the Powder River and Billings Resource Management Plans
CEQ #020060

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As indicated in Parts I and II, below, if water that has been produced from coal bed methane (CBM) extraction is discharged to surface streams, it may have substantial effects on surface water quality and irrigated soils. EPA also has concerns with the impacts on air quality, low-income and minority communities, and groundwater.

I. Surface Water Quality Analysis

Summary of BLM's Analysis

BLM's Preferred Alternative, Alternative E, involves an unspecified mixture of beneficial use, recharge, and infiltration practices that are intended to avoid degradation of the watershed. Alternative C addresses discharging produced water to surface streams and rivers without treatment. The Draft EIS concludes that if produced water is allowed to flow to surface streams and rivers, as it would under Alternative C, it would cause soil dispersion and render all rivers in the planning area, except the Bighorn and Little Bighorn Rivers, potentially unsuitable for crop production. (Draft EIS, page 4-41, based on using an SAR value of 12 and based on a relationship of electrical conductivity (EC) and sodium adsorption ratio (SAR) that represents no reduction in infiltration.) The affected rivers include the Tongue River and Rosebud Creek, which flow through Tribal lands.

This environmental impact does not appear to be consistent with the existing agricultural practices or with EPA's interpretation of the State's requirement to protect these streams for irrigation uses. (See Montana's Surface Water Quality Standards and Procedures, Sub-Chapter

6, ARM Section 17.30.637, which states: "... surface waters must be free from substances attributable to ... industrial ... practices or other discharges that will create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life." See also ARM Section 17.30.611, classifying the Tongue River from the Wyoming boundary to Prairie Dog Coulee as B-2 and from Prairie Dog Coolee to the Yellowstone as B-3, and ARM Sections 17.30.624(1) and 17.30.625(1), stating that waters classified as B-2 or B-3 are to be suitable for, among other things, agricultural uses.)

Because the Preferred Alterative (Alternative E) does not include an analysis of water quality impacts, it is unknown if it would ensure compliance with water quality standards. The Draft EIS did not include any alternative with a defined watershed management program that specifies a mix of water treatment practices that would meet water quality standards and be possible for industry to implement. EPA sees the lack of such an alternative as a major deficiency in the Draft EIS.

The BLM's two Draft EISs present significant differences in approach and conclusions regarding impacts to surface water quality. The WY Draft EIS uses considerably higher stream and CBM produced water flow rates and lower CBM SAR values (except for the Tongue) than does the MT Draft EIS. These differences are demonstrated by the results of the impact analyses at the state-line river stations common to both states (Figures A, B, and C, page 11 below). The Montana Draft EIS, Alternative C concludes that the stream water is rendered unsuitable for irrigation after discharging the RFD CBM water at all three state-line stations. In contrast, the Wyoming Draft EIS, Alternative 1 concludes that the impacts to water quality with respect to irrigation are minimal at the Powder and Little Powder River stations and unacceptable at the Tongue River.

Considering these differences, it is not possible to confidently conclude from two Draft EISs that the cumulative impacts of CBM development on surface quality in the Powder River Basin (PRB) are fully understood. Because the PRB spans both states, a comprehensive cumulative watershed analysis should be performed with an agreement between the two states as to appropriate flow and water quality parameters to use in the analysis. Had there been such a comprehensive analysis incorporated in a single disclosure statement covering CBM development throughout the two-state basin, these discrepancies might have been avoided.

Summary of EPA's Analysis

EPA's preliminary analysis provides data summaries sufficient to determine the effects of CBM discharges in various drainages. This preliminary analysis is subject to modification. It currently includes a comparison of the findings in the Montana and Wyoming Draft EISs, focusing on the state-line river stations common to both states. In addition, EPA's analysis was based on assumptions consistent with permits that the Montana Department of Environmental Quality (Montana DEQ) has issued for Tongue River in Montana. (See Fidelity Corporation's CX field MPDES permit issued in 2000 by Montana DEQ.)

EPA performed an independent cumulative impact analysis using the most comprehensive and watershed-specific information available. EPA compiled data from the two Draft EISs as well as additional data from the Wyoming Oil and Gas Conservation Commission database to provide a consistent set of input parameters.

Under a development scenario equivalent to Alternative C in the MT Draft EIS and Alternative 1 in the WY Draft EIS, EPA has concluded that the suitability of the Tongue River for irrigation is likely to be compromised under any reasonable set of input parameters (including 7Q10 flows or irrigation season low monthly flows and conveyance losses ranging from 50% to 80%) (Figures D and E, page 12).

EPA's analysis indicates that on average the water quality in the Powder and Little Powder Rivers, which naturally are characterized by high EC and SAR, is likely to remain suitable for irrigation when untreated CBM produced water is discharged to the rivers. This is contrary to the finding in the Montana Draft EIS, primarily due to the fact that the CBM produced water is not as saline in the Powder and Little Powder Rivers drainages as reported in the Draft EIS. These rivers could receive the amount of discharge associated with the RFD of CBM development without significantly changing current EC and SAR levels and without impacting irrigation, at least for less sensitive crops such as alfalfa. This result is corroborated by a probabilistic analysis of the surface water quality impacts at the Powder River state-line station. The probabilistic analysis used distributions rather than single values as input for flow and water quality in order to evaluate the likelihood that irrigation water quality thresholds may be violated when median input parameters indicate they are not. This analysis suggests that the frequency of flows with EC below 1300 uS/cm (the no reduction threshold for alfalfa production) may decrease. At the same time, there is likely to be an increase in the volume of flow with salinity suitable for alfalfa due to mixing CBM discharge with river flows.

Comparison of Input Parameters

Tables A and B on pages 8 and 9, list the input parameters used in the two Draft EISs to evaluate the impact of CBM development on surface water quality. The tables compare Alternative C in the Montana Draft EIS to Alternative 1 in the Wyoming Draft EIS. Table A lists CBM-related parameters. Table B provides flow and water quality for baseline stream conditions, CBM-produced water, and resultant stream conditions after discharge of the CBM water. Only the data from the state-line river stations are tabulated. For comparison, the input parameters used in the Montana DEQ Water Quality Technical Report (Water Quality Impacts from Coal Bed Methane Development in the Powder River Basin, Wyoming and Montana, December 10, 2001), as well as the input parameters EPA used to develop a cumulative impact analysis, are also included.

Both tables show significant differences in the input parameters used in the two Draft EISs. In general, the Wyoming Draft EIS uses considerably higher stream base and lower CBM SAR values (except for the Tongue River) than does the Montana Draft EIS. These differences result in marked differences in the estimated impact to water quality in the state-line stations (Figures A, B, and C). In most cases, the Montana Draft EIS estimates more severe impacts than does the Wyoming Draft EIS. The impact analysis performed in the Montana Draft EIS suggests that water quality at all stations is rendered unsuitable for irrigation. In contrast, the Wyoming Draft EIS projects impacts only for the Tongue River with little to no impacts estimated for the Powder and Little Powder Rivers.

Two additional impact analyses are shown in Tables A and B: Montana DEQ (December 2001) and EPA Impact Analysis (May 2002). Both these impact analyses estimate significant impacts to the Tongue River and minimal impacts to the Powder and Little Powder Rivers. Both impact analyses use a cumulative watershed-based approach for estimating impacts to surface water quality, but they differ slightly in that EPA uses (1) updated watershed-specific discharge rates for CBM wells based on information in the database of the Wyoming Oil and Gas Conservation Commission, (2) updated CBM water quality parameters based on the more comprehensive information provided in the Wyoming Draft EIS, and (3) both irrigation season monthly low flows and 7Q10 flows. The impacts to water quality estimated by the EPA impact analyses are shown in Figures D and E.

Note that the Montana Draft EIS assumes that baseline stream flow is characterized by the low mean monthly flows, whereas the Wyoming Draft EIS assumes average annual flows. Either assumption provides for dilution of discharged CBM effluent in modeling projected impacts (or lack of impacts) associated with CBM development. EPA believes another appropriate critical flow assumption would be the 7Q10 flow – the lowest flow during 7 consecutive days with a 10-year recurrence interval. Montana DEQ has used this flow basis calculating effluent limits. (See for example Fidelity Corporation's CX field MPDES permit issued in 2000 by Montana DEQ.) Applying the 7Q10 as a modeling assumption, the predicted SAR and EC concentrations are considerably higher and in a range that would be inconsistent with current agricultural practices in the basin and that appear to be inconsistent with Montana's requirements. EPA believes that this alternative flow assumption needs to be explained in the EIS. (Information is provided in the Draft EIS on resultant SAR values for Alternative C based on 7Q10 flow conditions, but this information is not mentioned in the text. See Draft EIS, Table 4-6 on page 4-48.)

CBM Discharge Rate

The Montana Draft EIS assumes that the rate of water production for an individual well follows an exponentially decreasing trend, that the life of an individual well is 20 years, and that it takes 20 years to drill and complete all the CBM wells in the RFD scenario. Approximately 10% of the drilled wells are expected to be dry. The planning period is 40 years.

To obtain a 20-year average well production rate, the Montana Draft EIS authors fit a decreasing exponential function to 20 months of water production data from CBM wells at the CX Ranch, extrapolated to 20 years, and calculated an arithmetic average of 2.5 gpm/well.

EPA has reevaluated this approach by calculating average production rates using the range of possible scenarios presented in the two Draft EISs. The Wyoming Draft EIS estimates the life span of an individual well is seven years, compared to Montana EISs' twenty years as indicated above. This leads to a large difference in the anticipated lifespan of the CBM development project. EPA's analysis assumes conservatively that the life span of a well is ten years but takes into account the projected rate of well completions and abandonments (which effectively reduces average well production rates). This analysis suggests that the five-year average production rates yield a reasonable conservative estimate. EPA's calculated average well production rates are approximately double the value used in the Montana Draft EIS and range from 4 to 6 gpm/well, depending on the watershed.

Figure E on page 12 shows the projected rates of CBM well completions and abandonments in the RFD for Montana. Figure F on page 13 shows the single-well production rate, the corresponding annual average well production rate considering the projected rate of completions and abandonments, and the cumulative average well production rate in five-year increments. This analysis shows that the twenty-year cumulative average is 2.9 gpm/well. The ten-year cumulative average also is 2.9 gpm/well. Water production rates peak at 3.9 gpm/well in the 7th year of development. The peak five-year average production is 3.7 gpm/well, which occurs in the 9th and 10th years of production.

Data for CBM wells in Prairie Dog Creek (Tongue River) downloaded from the Wyoming Oil and Gas Conservation Commission show that maximum daily production rates range from 5 (10%) to 25 (90%) gpm/well and are log normally distributed with a median of 13 gpm/well and an arithmetic mean of 14 gpm/well. These values are slightly lower than the 15 gpm used in the Montana Draft EIS. Applying the median value of CBM discharge in Prairie Dog Creek to the model of CBM discharge described above yields median values slightly lower than those calculated above. The median 20-year average is 2.8 gpm/well with a range of 2.2 (10%) to 3.3 (90%) gpm/well. The peak five-year average is 3.6 gpm/well with a range of 2.8 (10%) to 4.3 (90%) gpm/well.

In contrast with the Montana Draft EIS, the Wyoming Draft EIS assumes the life of an individual well is only 7 years (as opposed to 20 years), and that it takes only 10 years (as opposed to 20 years) to drill and complete all the CBM wells in the RFD scenario (Figure H, page 14). The average well production rate used in Wyoming's assessment of surface water impacts is 10 gpm/well, based on production rates in the WOGCC database. The Wyoming Draft EIS states that an individual well's water production rate declines with time, but no quantitative assessment of the decline is made. The well completion and abandonment scenario used in the Wyoming Draft EIS has a total life span of 20 years, as opposed to 40 years as in the Montana Draft EIS.

If a shorter well life span (10 years) and shorter development plan life span (20 years) are coupled with exponentially decreasing rates of production for individual wells initially discharging at 15 gpm, the following average production rates are obtained (Figure I, page 14). The twenty-year cumulative average is lower (1.8 gpm/well as compared to 2.9 gpm/well), but the ten-year cumulative average is higher (3.2 gpm/well as opposed to 2.9 gpm/well). The peak water production is similar (3.8 gpm/well as compared to 3.9 gpm/well). The peak five-year average production also is similar (3.6 gpm/well as compared to 3.7 gpm/well).

Production data in the WOGCC database indicates that water discharge rates vary by watershed. For example, the median discharge rate varies from 8 to 13 gpm/well in the Tongue River watersheds, from 10 to 21 gpm/well in the Powder River watersheds, and is approximately 24 gpm/well in the Little Powder River watersheds. If the median discharge rate is 13 gpm/well, the peak five-year average is 3.2 gpm/well in the 20-year development plan and 3.6 gpm/well in the 40-year development plan. If the median discharge rate is 24 gpm/well, the peak five-year average is 5.8 gpm/well in the 20-year development plan and 4.4 gpm/well in the 40-year development plan.

Based on the above analyses, the 2.5-gpm/well rate of production used in the Montana Draft EIS is low and should be replaced with a more conservative estimate. In contrast, the well production rate used in the Wyoming Draft EIS is overly conservative and is likely to overestimate impacts to surface water flow and quality. Considering the variability in water production rates, a reasonably conservative analysis should use peak five-year average values as input to estimate the cumulative impact of CBM discharge on surface water quality. Based on this information, EPA recommends that a value of approximately 4 gpm/well should be used in the Tongue River watersheds, 5 gpm/well in the Powder River watersheds, and 6 gpm/well in the Little Powder River watersheds.

Conveyance loss

Based on a study of infiltration and evaporation (Meyer 2000), the Wyoming Draft EIS concludes that the conveyance loss in overland flow is 80%, whereas the Montana Draft EIS concludes that the conveyance loss is 70%. It is not clear why different values were used. The study performed by Meyer suggests that less than 10% (>90% loss) of CBM discharge water reaches the two streams investigated, Caballo Creek and Belle Fourche River. However, this study is flawed in that no stream flow data for the winter months is reported and no formal trend analysis of stream flow, precipitation, evaporation, etc., was performed.

Neither report provides an analysis of the amount of water infiltrating to shallow groundwater systems that subsequently discharge to surface water bodies. After years of infiltration, the alluvial aquifers may become saturated and facilitate transport of infiltrated CBM water to the main stem streams. There may be little to no infiltration during the winter months when the ground is frozen. In some cases, as for the CX wells, the discharge is piped directly to the main stem stream, in which case there can be no losses due to infiltration or evaporation.

To validate the assumed conveyance loss, water balance calculations should be performed and verified with field monitoring. In lieu of adequate analysis of infiltration losses over time and subsurface water flow, more conservative estimates of conveyance loss should be used.

Coal Bed Methane-Produced Water Quality

As mentioned above, the two Draft EISs use markedly different SAR values to evaluate impacts of CBM discharge on surface water quality. These differences are partly responsible for the diametrically opposed conclusions of the two reports. (The other main factor is the CBM discharge rate.) Existing available data, such as provided in the WOGCC database, and individual flow rates for each stream should be used to develop representative SAR and EC values for each watershed. This summary is provided for some watersheds in the Wyoming Draft EIS and should be used in a comprehensive watershed analysis of the entire Powder River Basin.

The impacts of overland flow on water quality of the CBM water that eventually reaches the main stem stream should also be evaluated. Montana Draft EIS suggests that CBM water quality may worsen as it flows overland due to dissolution of minerals. Wyoming Draft EIS states that little impact on CBM WQ is expected during conveyance. The Wyoming tributary study provides some information on the observed changes in water quality – generally EC worsens, but SAR decreases. This information should be used to select conservative estimates of EC and SAR at the point the discharge reaches the main stem streams.

Baseline Stream Flow and Water Quality

The Montana Draft EIS uses the low monthly mean stream flow in the impact analysis. These values are representative of base flow conditions. In contrast, the Wyoming Draft EIS uses the annual mean stream flow, which generally is considerably higher than the low monthly mean. Both the Montana Draft EIS and the Wyoming Draft EIS use average values of EC and SAR in their impact analyses.

The Montana DEQ (December 2001) impact analysis uses median values of stream flow, which generally are higher than base flow rates but lower than annual mean flow rates. Median values of EC and SAR also are used. Median values were selected to ensure stream flow – water quality relationships are maintained in the input parameters.

Water quality in most watersheds varies inversely with flow rate. In other words, both EC and SAR tend to be elevated during low flow periods and decrease during high flow periods. Median values of flow rate, EC and SAR values tend to fall within the distributions of observed values, whereas average values typically do not. Thus, median stream flow rates coupled with median EC and SAR values provide a more representative and consistent set of input parameters.

Probabilistic Analysis of Powder River Water Quality and Flow

EPA performed an impact analysis for the Powder River in which flow and water quality parameter distributions are considered, known as a Monte Carlo probabilistic analysis. Figure J, page 15, shows the distribution of post-1990 stream flow and EC data for the Powder River at Moorhead used as input in this analysis. Figure K, page 15, shows the distribution of CBM EC and maximum produced water discharge for the Middle Powder River. The EC distribution and the five-year average discharge rates (calculated as described in the section on CBM discharge) corresponding to the maximum CBM water discharge were used as input in this analysis. Figure L, page 16, shows that the frequency of flows with EC below 1300 uS/cm (the no reduction threshold for alfalfa production) may decrease from approximately 30% to approximately 20%. At the same time, there is likely to be an increase in the volume of flow, as shown in Figure M, page 16, due to mixing CBM discharge with river flows.

Limits on CBM Discharge to Meet Irrigation Water Quality Thresholds

EPA's impact analyses also includes a calculation to determine limits on CBM discharge to ensure that the receiving streams meet the irrigation water quality criteria defined in terms of the EC-SAR relationship as well as any crop-related limits on salinity. Discharge limits based on irrigation season low monthly stream flows are shown in Table C and Figure N, pages 10 and 17. Discharge limits based on 7Q10 flows are shown in Table D and Figure O, pages 10 and 18. Under either flow assumption, discharge to the Tongue River would need to be limited to a small fraction of the discharge projected in the RFD of CBM development. Discharge to the Little Powder would not need to be limited under either flow assumption. Discharge to the Powder River would not need to be limited under the irrigation season low monthly flow assumption, but would need to be limited to a small fraction under the 7Q10 assumption.

Table A
Comparison of Coal Bed Methane Parameters
Used to Evaluate Impacts to Surface Water Quality

CBM Parameter	MT DEIS Alt. C	WY DEIS Alt. 1	MT DEQ WQ Tech Report 12/10/2001	EPA Impact Analysis
CBM Discharge Rate: Average (gpm)	2.5	9.5 - 12	5	4 - 6
CBM Well Production Life (years)	20	7	20	10
Conveyance Loss (%)	70	80	50	50 - 70
Beneficial Use (%)	20	N/A	10	0
CBM SAR MT DEIS uses same value for all watersheds. WY DEIS uses watershed-specific values.	47	3.7 – 52	15 - 40	8.9 - 47
CBM EC (uS/cm) MT DEIS uses same value for all watersheds. WY DEIS uses watershed-specific values.	2207	2048 - 3423	1655 - 2207	2048 - 2428

Table B
Comparison of Stream Flow and Water Quality Parameters At the Wyoming-Montana State-Line River Stations

Watershed / Parameter	MT DEIS	WY DEIS	MT DEQ WQ Tech Report 12/10/2001	EPA Impact Analysis
Tongue at Stateline				
Baseline Flow (cfs)	180 (Low Monthly Mean)	460 (Annual Mean)	272 (Median)	182 (Irrigation Low Monthly Mean), 42 (7Q10)
Baseline EC (uS/cm)	544 (Average)	513 (Average)	610 (Median)	610 (Median)
Baseline SAR	0.5 (Average)	0.5 (Average)	0.6 (Median)	0.6 (Median)
CBM Discharge (gpm/well)	2.5	10	5	4
CBM Flow (cfs)	7.3	67.3	27.6	24.5
CBM EC (uS/cm)	2207	2099	2207	2207
CBM SAR	47	52	40	47
Resultant Flow (cfs)	187	527	300	206
Resultant EC (uS/cm)	609	811	757	799
Resultant SAR	2.3	10.2	4.2	6.1
Powder near Moorhead				
Baseline Flow (cfs)	149 (Low Monthly Mean)	463 (Annual Mean)	260 (Median)	149 (Irrigation Low Monthly Mean), 0.9 (7Q10)
Baseline EC (uS/cm)	1883 (Average)	2023 (Average)	1950 (Median)	1630 (Post-1990 Median)
Baseline SAR	4.6 (Average)	4.4 (Average)	4.5 (Median)	4.3 (Post-1990 Median)
CBM Discharge (gpm/well)	2.5	10	5	5
CBM Flow (cfs)	35.6	359	134	148
CBM EC (uS/cm)	2207	3423	2735	2428
CBM SAR	47	3.7	22	13.5
Resultant Flow (cfs)	185	479	393	297
Resultant EC (uS/cm)	1945	2103	2216	2188
Resultant SAR	12.8	4.4	10.5	9
Little Powder near Broadus				
Baseline Flow (cfs)	3.7 (Low Monthly Mean)	22.3 (Annual Mean)	21 (Median)	7 (Irrigation Low Monthly Mean), 0 (7Q10)
Baseline EC (uS/cm)	2202 (Average)	2737 (Average)	2110 (Median)	2110 (Median)
Baseline SAR	9.7 (Average)	6.1 (Average)	9.4 (Median)	9.4 (Median)
CBM Discharge (gpm/well)	2.5	10	5	6
CBM Flow (cfs)	3.1	18.8	11.6	15.5
CBM EC (uS/cm)	2207	2048	1655	2048
CBM SAR	47	8.9	15	8.9

Resultant Flow (cfs)	6.8	41	33	23
Resultant EC (uS/cm)	2204	2346	1948	2068
Resultant SAR	26.7	7.7	11.4	9.1

Table C
Limits on CBM Discharge and Number of Wells Based on EPA Impact Analysis with Irrigation Season Low Monthly Mean Flows

Limits for Each State if Fraction of Assimilative Capacity Allocated to MT is 50 % at State Line

River	Location	WY Allowed Discharge (cfs)	WY Allowed Number CBM Wells	WY Allowed Fraction of RFD CBM Wells or Discharge (%)	MT Allowed Discharge (cfs)	MT Allowed Number CBM Wells	MT Allowed Fraction of RFD CBM Wells or Discharge (%)
Little Powder	Little Powder River above Dry Creek	No Limit	2035	100			
	Little Powder River near Broadus				No Limit	278	100
Powder	Powder River near Moorhead	No Limit	26598	100			
	Powder River near Broadus				No Limit	3167	100
Mizpah	Mizpah Crk nr Mizpah				1.1	191	85
Tongue	Tongue River at Stateline	3.3	730	28	3.3	730	25
	Tongue River nr Birney				4.2	933	32
	Tongue River at Ashland				5.3	1179	45
	Tongue River at Miles City				0.0	0	0
Rosebud	Rosebud Crk at Res. Bndy nr Kirby				0.0	0	0
	Rosebud Crk ne Colstrip				0.0	0	0
	Rosebud Crk at Mouth nr Rosebud				0.0	0	0
Little Bighorn	Little Bighorn R bl Pass Cr nr Wyola				2.4	439	84
	Little Bighorn River nr Hardin				No Limit	525	100
Bighorn	Lower Bighorn River nr St. Xavier				No Limit	600	100
	Lower Bighorn River nr Bighorn				No Limit	600	100

Based on irrigation season low mean monthly flows.

Table D
Limits on CBM Discharge and Number of Wells Based on EPA Impact Analysis with 7Q10 Flows

Limits for Each State if Fraction of Assimilative Capacity Allocated to MT is 5 Percent at Stateline

River	Location	WY Allowed Discharge (cfs)	WY Allowed Number CBM Wells	WY Allowed Fraction of RFD CBM Wells or Discharge (%)	MT Allowed Discharge (cfs)	MT Allowed Number CBM Wells	MT Allowed Fraction of RFD CBM Wells or Discharge (%)
Little Powder	Little Powder River above Dry Creek	No Limit	2035	100			
	Little Powder River near Broadus				No Limit	278	100
Powder	Powder River near Moorhead	1.5	265	1			
	Powder River near Broadus				1.5	265	8
Mizpah	Mizpah Crk nr Mizpah				0.0	0	0
Tongue	Tongue River at Stateline	0.2	52	2	0.2	52	2
	Tongue River nr Birney				0.0	0	0
	Tongue River at Ashland				0.0	0	0
	Tongue River at Miles City				0.0	0	0
Rosebud	Rosebud Crk at Res. Bndy nr Kirby				0.0	0	0
	Rosebud Crk ne Colstrip				0.0	0	0
	Rosebud Crk at Mouth nr Rosebud				0.0	0	0
Little Bighorn	Little Bighorn R bl Pass Cr nr Wyola				0.9	185	35
	Little Bighorn River nr Hardin				0.2	40	8
Bighorn	Lower Bighorn River nr St. Xavier				No Limit	600	100
	Lower Bighorn River nr Bighorn				No Limit	600	100

Based on 7Q10 flows.

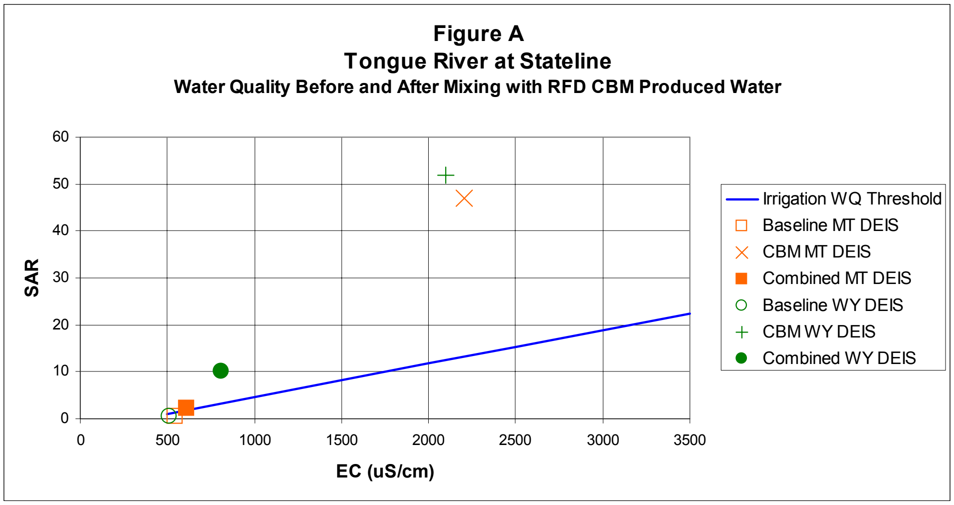


Figure A
Tongue River at Stateline
Water Quality Before and After Mixing with RFD CBM Produced Water

Figure B
Powder River at Moorhead
Water Quality Before and After Mixing with RFD CBM Produced Water

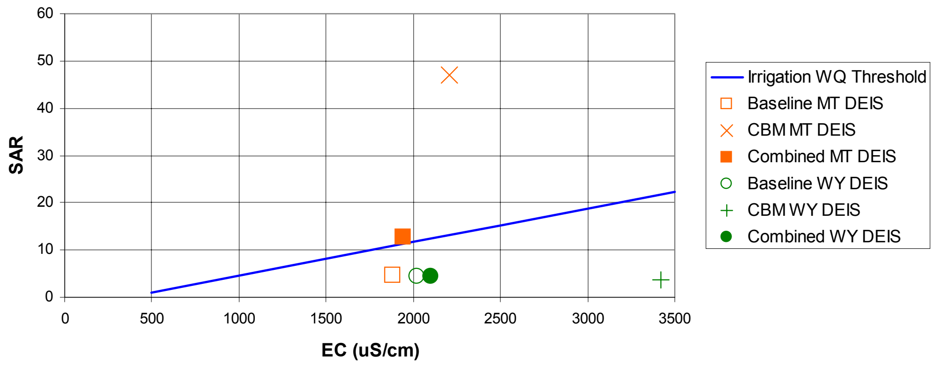


Figure C
Little Powder River at Broadus
Water Quality Before and After Mixing with RFD CBM Produced Water

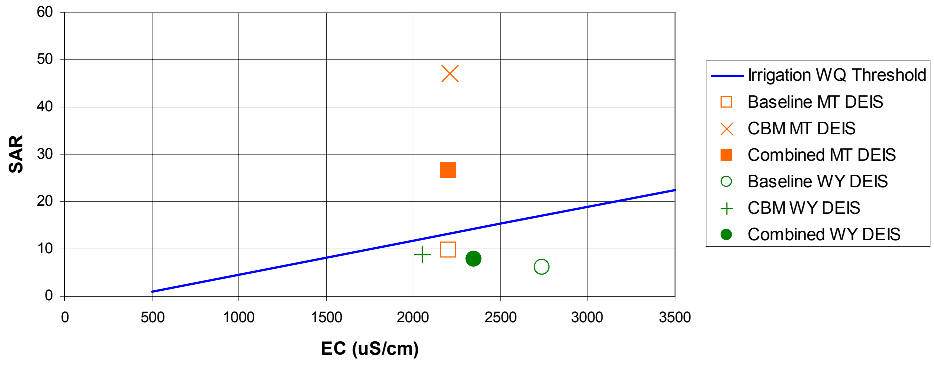


Figure D

EPA Impact Analysis

State Line Water Quality Before and After Mixing RFD CBM Produced Water with Irrigation Season Low Monthly Mean Stream Flows

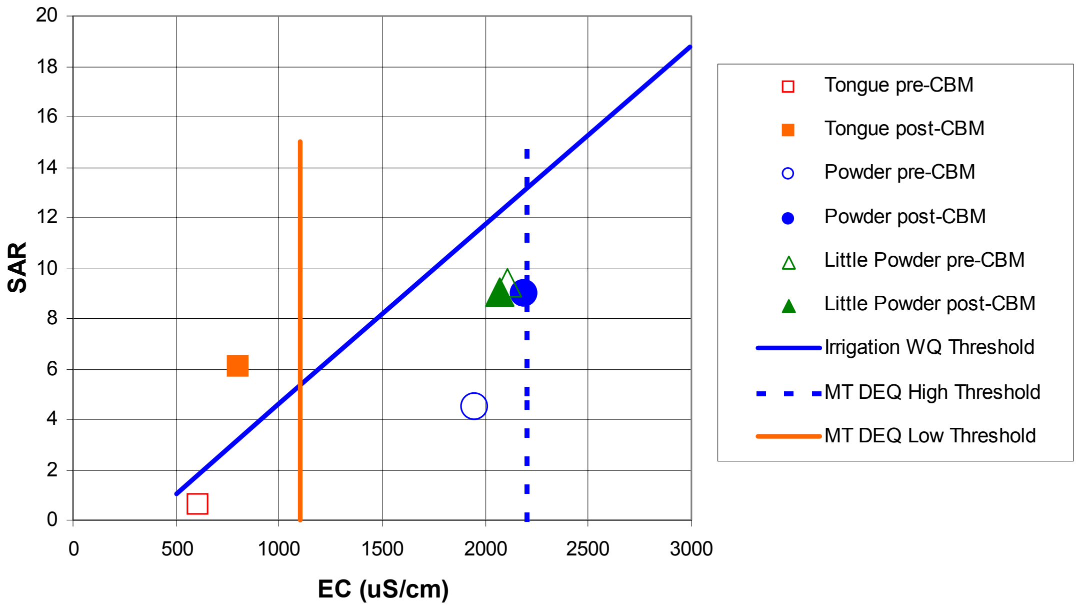


Figure E

EPA Imapct Analysis

State Line Water Quality Before and After Mixing RFD CBM Produced Water with 7Q10 Stream Flows

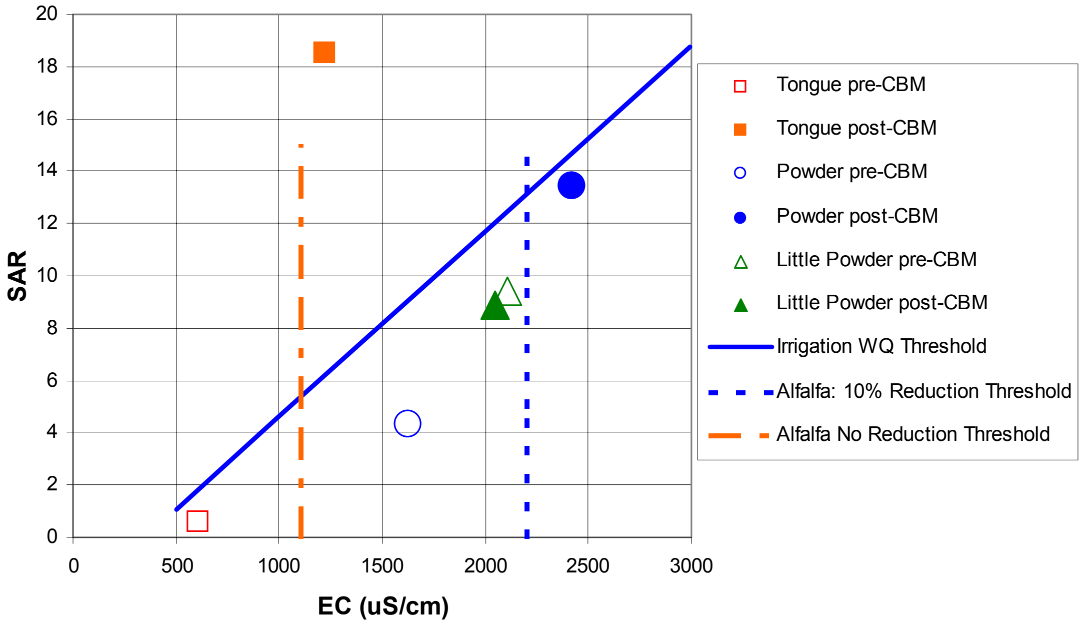


Figure F
MT Rates of CBM Well Completions and Abandonments

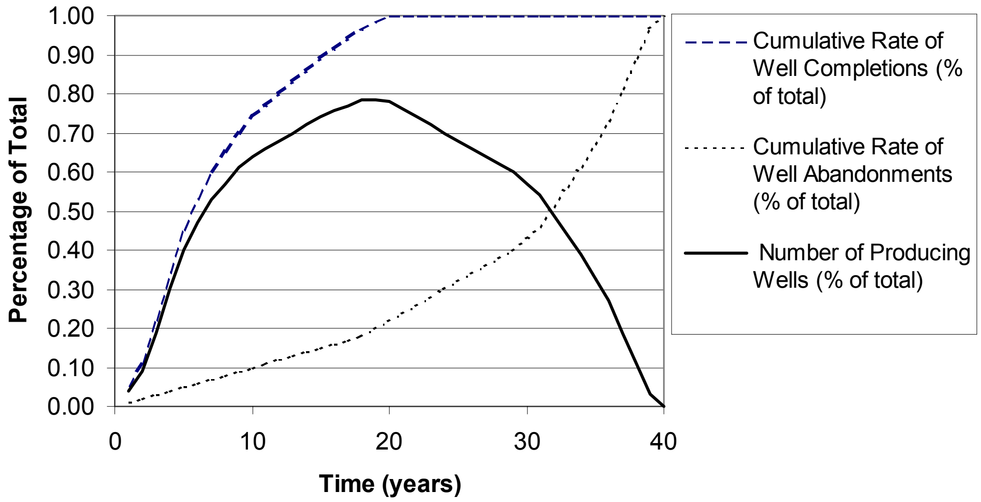


Figure G
MT CBM Well Produced Water Discharge Rates

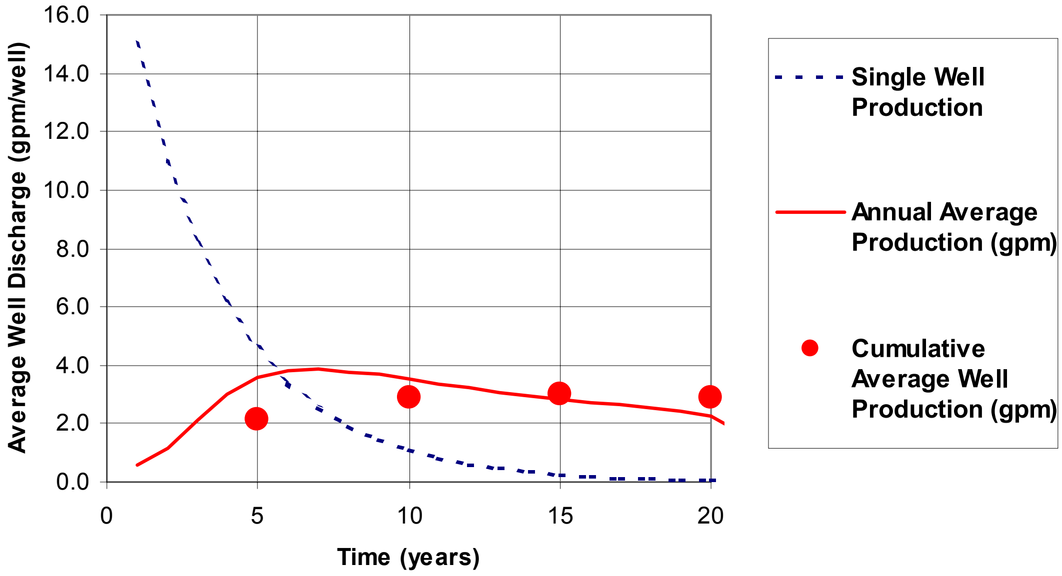


Figure H
WY Rates of CBM Well Completions and Abandonments

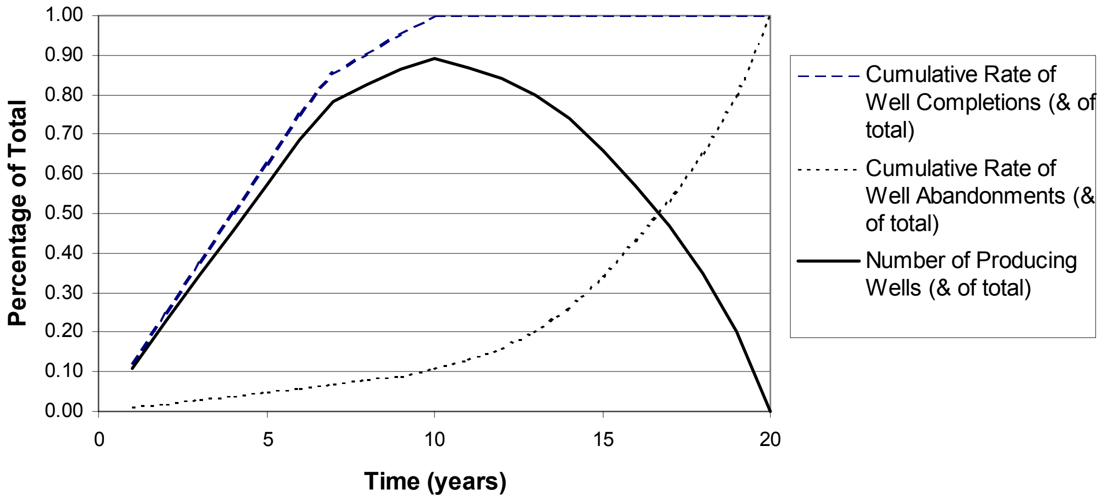


Figure I
WY CBM Well Produced Water Discharge Rates

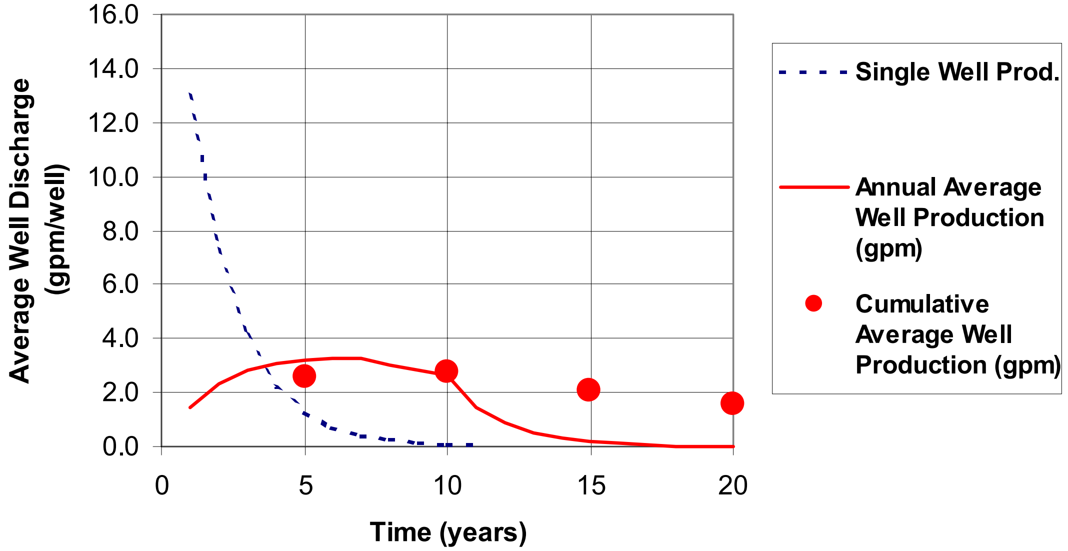
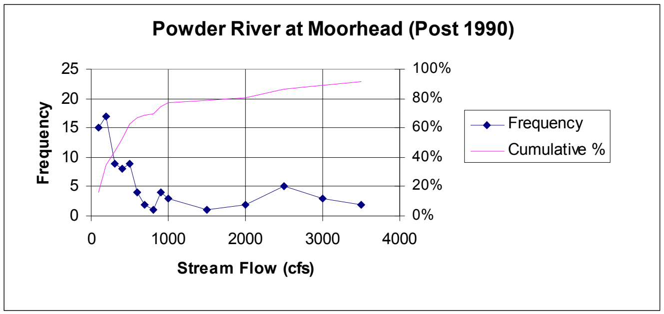


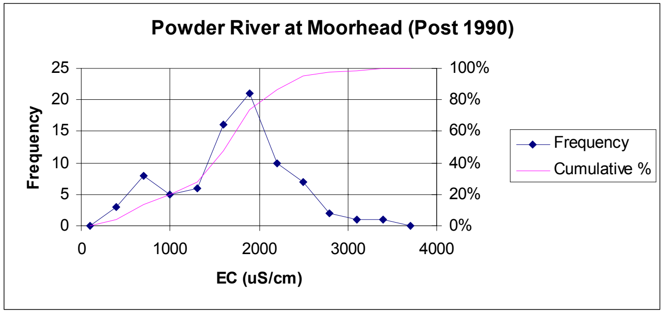
Figure J
Powder River at Moorhead
Stream Flow and EC - Fitted Distributions



Stream Flow (cfs):

Fitted Distribution

- Median = 340
- Mean= 1420
- Stand. Dev. = 5740
- 10% = 40
- 90% = 2970
-



EC (uS/cm):

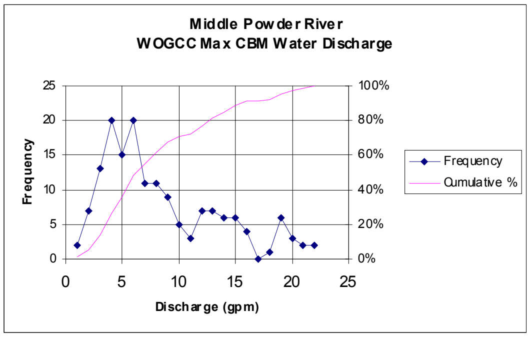
Fitted Distribution

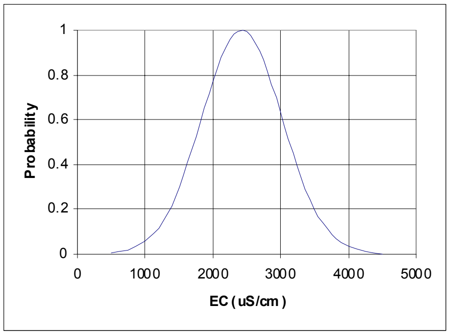
- Median = 1630
- Mean = 1570
- Stand. Dev. = 640
- 10% = 810
- 90% = 2450
- R = -0.44

Figure K
CBM Middle Powder River
Discharge and EC - Fitted Distributions

Discharge (gpm)

EC (uS/cm)





Statistic	Maximum CBM Water Discharge (gpm)	Corresponding Five Year Average (gpm)
10 Percentile	5.1	1.3
Median	12.2	3.1
Mean	21.1	5.1
90 Percentile	38.4	9.6

Statistic	EC (uS/cm)
Mean	2438
Stand. Deviation	600

Figure L
Powder River at Moorhead (Post 1990)
Monte Carlo Distribution of EC

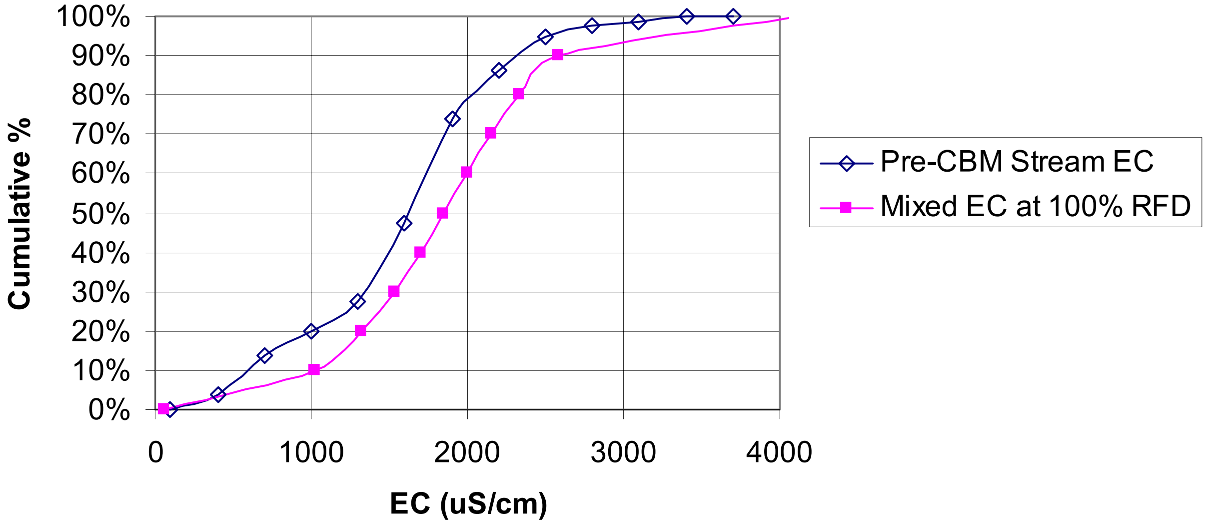


Figure M
Powder River at Moorhead (Post 1990)
Monte Carlo Distribution of Flows with EC < 1300 uS/cm

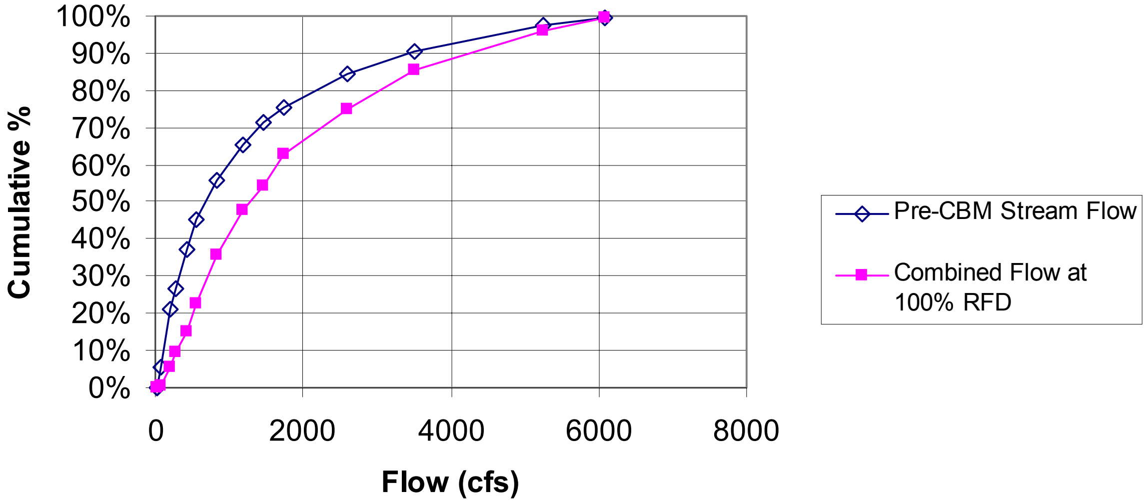


Figure N
Limits on CBM Discharge and Number of Wells
Based on EPA Impact Analysis with Irrigation Season Low Monthly Mean Flows

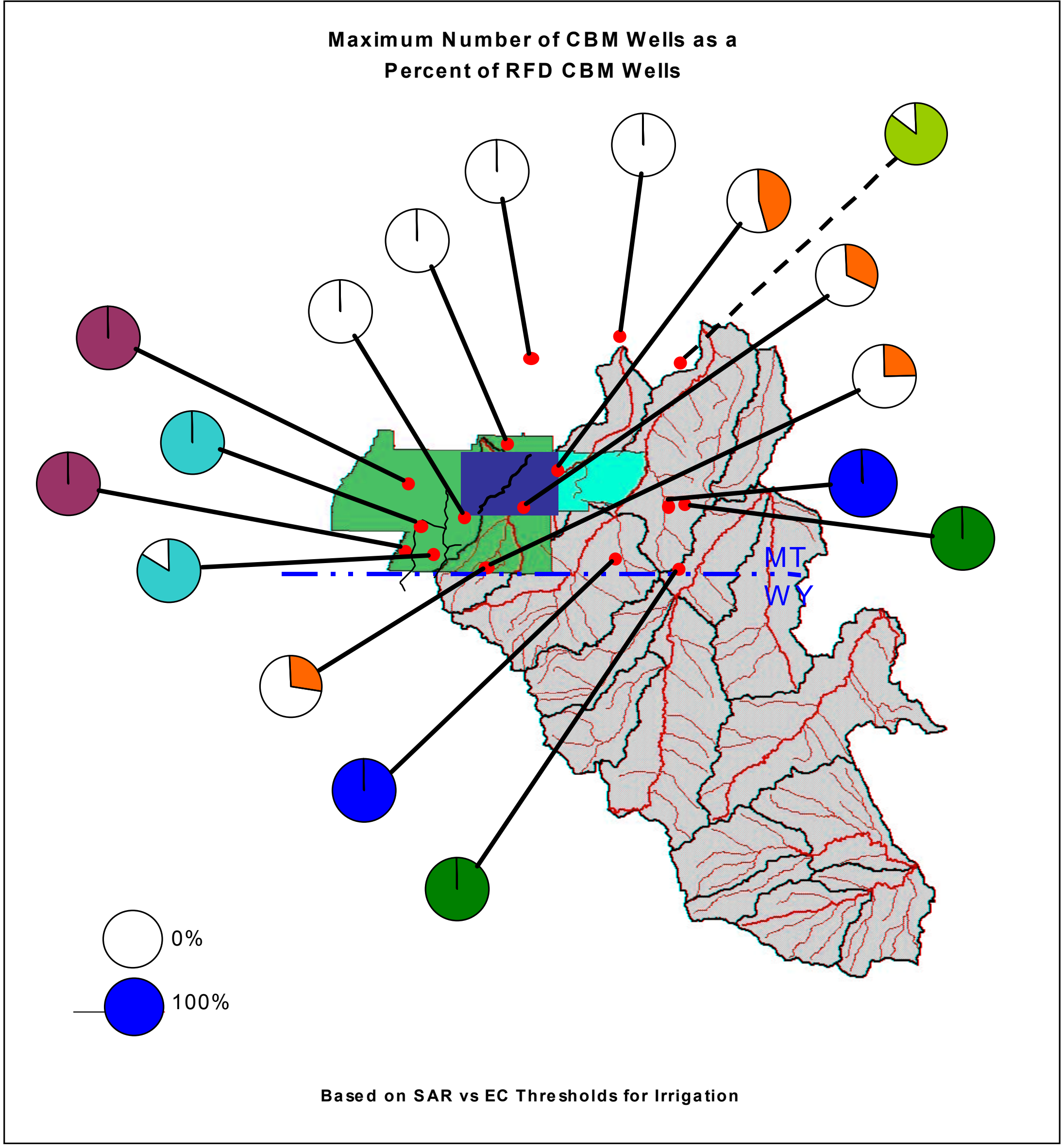
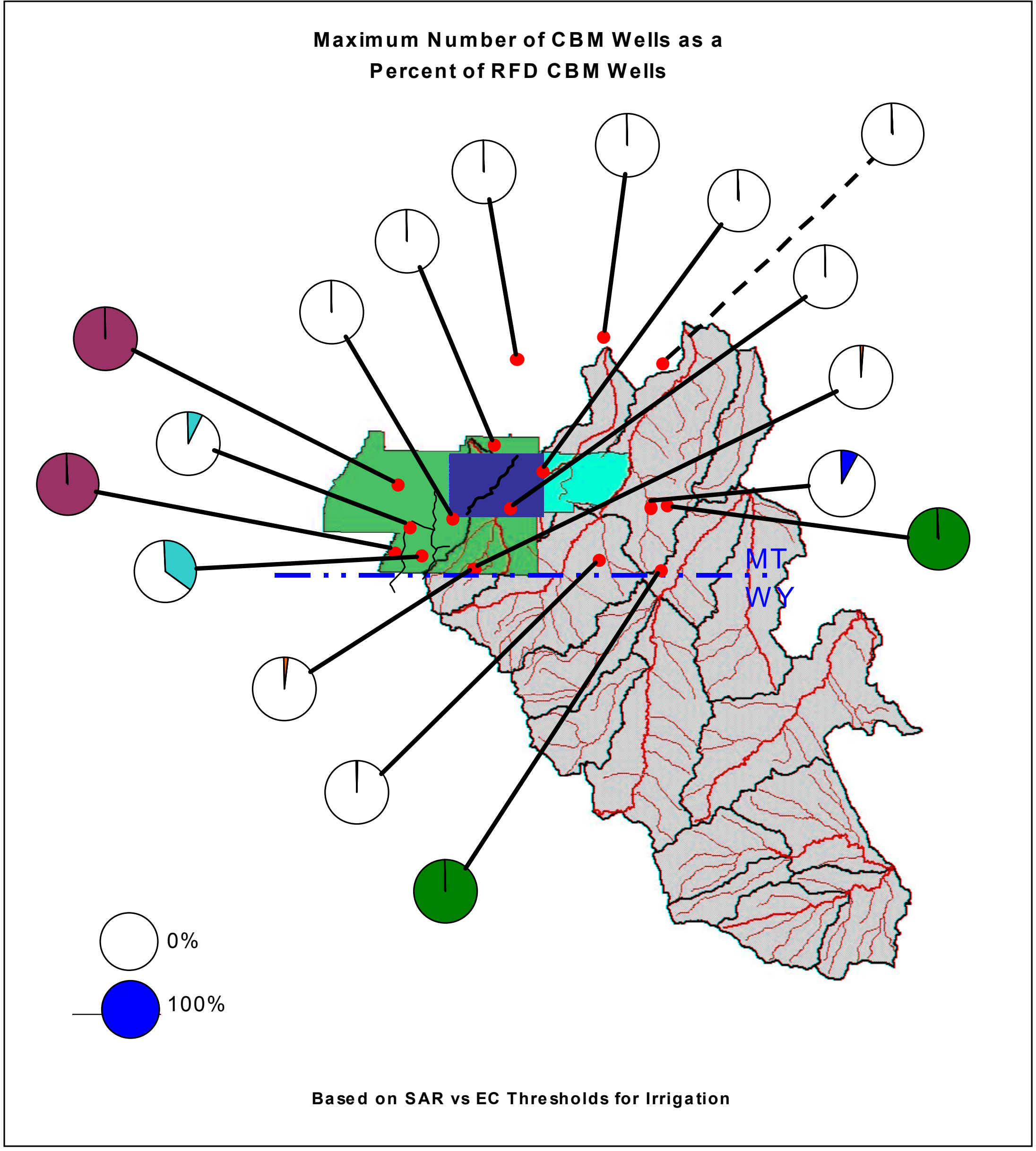


Figure O
Limits on CBM Discharge and Number of Wells Based on EPA Impact Analysis with 7Q10 Flows



We recommend the following information be included in its entirety in a revised or supplemental Draft EIS, subject to modifications as appropriate. The text that we recommend incorporating into the revised Draft EIS is the remaining portion of this part, i.e., the text up to the heading "III. Air Quality Analysis."

II. Impacts to crops and soils from CBM-produced water

In order to evaluate impacts resulting from the effects of CBM discharges from wells in Wyoming and Montana, an analysis of their cumulative effects on water quality, irrigation, and riparian plant communities is needed. Since contaminants in CBM discharges, if undiluted, are known to have adverse effects, the question is what amount of CBM produced water will cause an unacceptable adverse impact to these uses.

To assess this impact, it is necessary to establish, scientifically, the threshold values[1] for the significant effects of certain contaminants found in CBM discharges.

Irrigation uses

In establishing SAR and salinity thresholds for protection of irrigated agriculture and/or land application of discharge water, a number of interrelated factors should be considered, including: the crop and/or native plant species that will be irrigated or exposed to these conditions, the texture of the irrigated soils, predominant clay mineralogy, soil chemistry, water management practices, and the chemistry of the irrigation water. SAR destroys the texture of clayey soils, and montmorillonite clays are particularly sensitive to the effects of elevated SAR. Montmorillonite clays are common in the river basins that will be potentially impacted by CBM development, and, because of the complexity of the soil associations, with several soil types possible within a single field, the allowable SAR and salinity thresholds must be protective of the most sensitive circumstance, the occurrence of montmorillonite clays.

Development of allowable SAR and salinity thresholds is further complicated by the relationship between SAR and salinity and by the direct toxicity of sodium and salinity to certain plants. There is a well-recognized relationship between SAR and salinity, with the potential impacts of SAR being less severe as salinity increases. That is, as the electrolyte concentration of the soil water increases, the effect of sodium-induced changes in soil structure is reduced. Although this might initially suggest that SAR impacts could be managed by artificially

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[1] See establishing significance thresholds to assess resource degradation in: Considering Cumulative Effects under the National Environmental Policy Act, Executive Office of the President, Council on Environmental Quality, January 1997. Also note that BLM's land use planning guidance calls for establishing status, trends, risks, and opportunities similar to these CEQ guidelines regarding cumulative impact analysis. See BLM Land Use Planning Handbook, H-1601-1, November 22, 2000, page III-2.

increasing the salinity of the irrigation water, there are several factors that weigh against such an approach. First, there is a point at which salinity itself becomes an issue. Salinity concerns are especially important for plants at the germination, emergence and seedling stages. The potential direct sodium toxicity argues for an upper bound on the allowable SAR threshold value as well. Finally, and perhaps more importantly, because of the interactive relationship between SAR and salinity, an appropriate SAR threshold needs to be paired with a corresponding salinity value. That is, the relationship between SAR and salinity is a dynamic one, and as the salinity concentration changes, so must the allowable SAR. And, because of the high risk of permanent destruction of a sensitive soil exposed to an elevated SAR with a salinity concentration below the level that would ameliorate sodium-induced effects, there must be an upper limit to the SAR/salinity paired thresholds. As explained in more detail below, these factors should be considered in developing the allowable SAR and salinity "effect thresholds" used in this EIS.

The characteristics of the soils, especially the amount of clay present in the soils, are important factors in evaluating the effects of EC and SAR. Significant amounts of clay restrict the amount of leaching that can occur, and leaching is an important factor in determining the effects of salinity on crop production. In addition, soils with a large amount of clay are more susceptible to damage from elevated levels of SAR than soils with little clay.

These factors and their interactions have been principally summarized from two primary scientific sources. They are, Hansen, B.R., S. R. Gratton, and A. Fulton. *AGRICULTURAL SALINITY AND DRAINAGE. University of California Irrigation Program.* University of California, Davis. Revised 1999, and, Ayers, R. S. and D. W. Westcot, 1985. *Water Quality for Agriculture.* FAO Irrigation and Drainage paper 29 (Rev 1), Food and Agriculture Organization of the United Nations.

The table below, adapted from Ayers and Westcot, gives guidelines for water quality for irrigation. The reader should bear in mind that these are guidelines and not absolute values. The reader should also read the footnotes and the basic assumptions carefully.

Table 1- Adapted from Ayers and Westcot

GUIDELINES FOR INTERPRETATIONS OF WATER QUALITY FOR IRRIGATION'

		Degree of Restriction on Use		
Potential Irrigation Problem Salinity *(affects crop water availability)*[2]	Units	None	Slight to Moderate	Severe
EC	dS/m	< 0.7	0.7 - 3.0	> 3.0
(or)				
TDS	mg/l	<450	450 - 2000	> 2000
Infiltration *(affects infiltration rate of water into the soil Evaluate using EC_w and SAR together)*[3]				
SAR = 0 - 3 and EC_w =		>0.7 0.70.7	- 0.2	< 0.2
= 3 -6 =		>1.2 1.21.2	- 0.3	< 0.3
= 6 - 12 =		>1.9 1.91.9	- 0.5	< 0.5

= 12-20	=	>2.9	2.9 - 1.3	< 1.3
= 20-40	=	>5.0	5.0 - 2.9	< 2.9

[1] Adapted from University of California Committee of Consultants 1974.

[2] ECw means electrical conductivity, a measure of the water salinity, reported in deciSiemens per meter at 25 degrees C (dS/m) or in units of millimhos per centimeter (mmho/cm). Both are equivalent. TDS means total dissolved solids, reported in milligrams per liter (mg/1).

[3] SAR means sodium adsorption ratio. SAR is sometimes reported by the symbol RNs. See Figure 1, adapted from Hansen (on page 27 of this document) for the SAR calculation procedure. At a given SAR, the infiltration rate increases as water salinity increases. Adapted from Rhoades 1977 and Oster and Schroer 1979.

The water quality guidelines in Table 1 are intended to cover the wide range of conditions encountered in irrigated agriculture. Several basic assumptions (given below) have been used to define their range of usability. If the water is used under greatly different conditions, the guidelines may need to be adjusted. Wide deviations from the assumptions might result in inaccurate judgments on the usability of a particular water supply, especially if it is a borderline case. Where sufficient experience, field trials, research or observations are available, the guidelines may be modified to fit local conditions more closely.

The basic assumptions in these guidelines are:

Yield Potential: Full production capability of all crops, without the use of special practices, is assumed when the guidelines indicate no restrictions on use. A "restriction on use" indicates that there may be a limitation in choice of crop, or special management may be needed to maintain full production capability. A "restriction on use" does not indicate that the water is unsuitable for use.

Site Conditions: Soil texture ranges from sandy-loam to clay-loam with good internal drainage. The climate is semi-arid to arid. Rainfall does not play a significant role in meeting crop water demand or leaching requirement. (In a monsoon climate or areas where precipitation is high for part or all of the year, the guideline restrictions are too severe. Under the higher rainfall situations, infiltrated water from rainfall is effective in meeting all or part of the leaching requirement.) Drainage is assumed to be good, with no uncontrolled shallow water table present within 2 meters of the surface.

Methods and Timing of Irrigations: Normal surface or sprinkler irrigation methods are used. Water is applied infrequently, as needed, and the crop utilizes a considerable portion of the available stored soil-water (50 percent or more) before the next irrigation. At least 15 percent of the applied water percolates below the root zone (leaching fraction [LF]=15 percent). The guidelines are too restrictive for specialized irrigation methods, such as localized drip irrigation, which results in near daily or frequent irrigations, but are applicable to subsurface irrigation if surface applied leaching water satisfies the leaching requirements.

Water Uptake by Crops: Different crops have different water uptake patterns, but all take water from wherever it is most readily available within the rooting depth. On average about 40 percent is assumed to be taken from the upper quarter of the rooting depth, 30 percent from the second quarter, 20 percent from the third quarter, and 10 percent from the lowest quarter. Each irrigation leaches the upper root zone and maintains it at a relatively low salinity. Salinity increases with depth and is greatest in the lower part of the root zone. The average salinity of the soil-water is three times that of the applied water and is representative of the average root zone salinity to which the crop responds. These conditions result from a leaching fraction of 15-20 percent and irrigations that are timed to keep the crop adequately watered at all times.

Salts leached from the upper root zone accumulate to some extent in the lower part but a salt balance is achieved as salts are moved below the root zone by sufficient leaching. The higher salinity in the lower root zone becomes less important if adequate moisture is maintained in the upper, "more active" part of the root zone and long-term leaching is accomplished.

Restriction on Use: The "Restriction on Use" shown in Figure 3 (adapted from Hansen, page 31) is divided into three degrees of severity: none, slight to moderate, and severe. The divisions are somewhat arbitrary since change occurs gradually and there is no clearcut breaking point. A change of 10 to 20 percent above or below a guideline value has little significance if considered in proper perspective with other factors affecting yield. Field studies, research trials and observations have led to these divisions, but management skill of the water user can alter them. Values shown are applicable under normal field conditions prevailing in most irrigated areas in the arid and semi-arid regions of the world.

Salinity

Salinity refers to the amount of dissolved solids in water and is generally expressed as parts per million (ppm) total dissolved solids (TDS). Electrical Conductance (EC) can also be used as a measure of salinity and is considerably cheaper and easier to measure and monitor. EC will be used in this discussion.

It is important to note that soil scientists express EC in terms of deciSiemens per meter (dS/m) while water quality results are expressed as microSiemens per centimeter (uS/cm). One dS/m equals 1000 uS/cm.

Crop productivity effects

Plants expend energy to extract water from soil. As the salinity of the water in the soil increases the energy needed to extract water also increases. At some point, which varies with the type of crop, increases in salinity will result in a decrease in crop production.

The composition of the soil, the salinity of the irrigation water, and the amount of irrigation water (and precipitation) that passes through the soil determine the salinity of the water in the soil. Due to the arid conditions in the Powder River Basin, the effects of precipitation on the irrigated areas are generally insignificant and will not be discussed.

Salts in the water may be precipitated in the soil and the water in the soil may dissolve salts in the soil. These processes are determined primarily by the composition of the soil. However, due to the complexities and site specific nature of these processes, they will not be discussed here except to note that overall, the total concentration of salts in the soil water is likely to be increased by contact with the soil.

The percentage of applied water that passes through the soil is called the leaching fraction. The salinity of the irrigation water and the leaching fraction are the most important factors affecting the salinity of the soil water. The salinity of the soil water is important since salt in the soil water, rather than the salinity of the irrigation water itself, is the critical factor resulting in any decrease in crop yield. Continued irrigation will result in the salinity of the soil water coming into equilibrium with the salinity of the irrigation water. The actual relationship will be dependent on the average salinity of the irrigation water and the actual leaching fraction.

The relationship between soil water salinity and crop yield will be discussed first and then the relationship between irrigation water salinity and soil water salinity will be discussed.

Table 4 from Ayers, pages 24-26, can be used to estimate the expected yields for selected crops that are grown using water with differing levels of salinity.

Table 4 CROP TOLERANCE AND YIELD POTENTIAL OF SELECTED CROPS AS INFLUENCED BY IRRIGATION WATER SALINITY (EC_w) OR SOIL SALINITY (EC_e)[1]

YIELD POTENTIAL[2]

FIELD CROPS	100%		90%		75%		50%		0% "maximum"[3]	
	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w
Barley *(Hordeum vulgare)*[4]	8.0	5.3	10	6.7	13	8.7	18	12	28	19
Cotton *(Gossypium hirsutum)*	7.7	5.1	9.6	6.4	13	8.4	17	12	27	18
Sugarbeet *(Beta vulgaris)*[5]	7.0	4.7	8.7	5.8	11	7.5	15	10	24	16
Sorghum *(Sorghum bicolor)*	6.8	4.5	7.4	5.0	8.4	5.6	9.9	6.7	13	8.7
Wheat *(Triticum aestivum)*[4,6]	6.0	4.0	7.4	4.9	9.5	6.3	13	8.7	20	13
Wheat, durum *(Triticum turgidum)*	5.7	3.8	7.6	5.0	10	6.9	15	10	24	16
Soybean *(Glycine max)*	5.0	3.3	5.5	3.7	6.3	4.2	7.5	5.0	10	6.7
Cowpea *(Vigna unguiculata)*	4.9	3.3	5.7	3.8	7.0	4.7	9.1	6.0	13	8.8
Groundnut (Peanut) *(Arachis hypogaea)*	3.2	2.1	3.5	2.4	4.1	2.7	4.9	3.3	6.6	4.4
Rice (paddy) *(Oriza sativa)*	3.0	2.0	3.8	2.6	5.1	3.4	7.2	4.8	11	7.6
Sugarcane *(Saccharum officinarum)*	1.7	1.1	3.4	2.3	5.9	4.0	10	6.8	19	12
Corn (maize) *(Zea mays)*	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10	6.7
Flax *(Linum usitatissimum)*	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10	6.7
Broadbean *(Vicia faba)*	1.5	1.1	2.6	1.8	4.2	2.0	6.8	4.5	12	8.0
Bean *(Phaseolus vulgaris)*	1.0	0.7	1.5	1.0	2.3	1.5	3.6	2.4	6.3	4.2
VEGETABLE CROPS										
Squash, zucchini (courgette) *(Cucurbita pepo melopepo)*	4.7	3.1	5.8	3.8	7.4	4.9	10	6.7	15	10
Beet, red *(Beta vulgaris)*[5]	4.0	2.7	5.1	3.4	6.8	4.5	9.6	6.4	15	10
Squash, scallop *(Cucurbita pepo melopepo)*	3.2	2.1	3.8	2.6	4.8	3.2	6.3	4.2	9.4	6.3
Broccoli *(Brassica oleracea botrytis)*	2.8	1.9	3.9	2.6	5.5	3.7	8.2	5.5	14	9.1
Tomato *(Lycopersicon esculentum)*	2.5	1.7	3.5	2.3	5.0	3.4	7.6	5.0	13	8.4
Cucumber *(Cucumis sativus)*	2.5	1.7	3.3	2.2	4.4	2.9	6.3	4.2	10	6.8
Spinach *(Spinacia oleracea)*	2.0	1.3	3.3	2.2	5.3	3.5	8.6	5.7	15	10
Celery *(Apium graveolens)*	1.8	1.2	3.4	2.3	5.8	3.9	9.9	6.6	18	12
Cabbage *(Brassica oleracea capitata)*	1.8	1.2	2.8	1.9	4.4	2.9	7.0	4.6	12	8.1
Potato *(Solanum tuberosum)*	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10	6.7
Corn, sweet (maize) *(Zea mays)*	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10	6.7
Sweet potato *(Impomoea batatas)*	1.5	1.0	2.4	1.6	3.8	2.5	6.0	4.0	11	7.1
Pepper *(Capsicum annuum)*	1.5	1.0	2.2	1.5	3.3	2.2	5.1	3.4	8.6	5.8
Lettuce *(Lactuca sativa)*	1.3	0.9	2.1	1.4	3.2	2.1	5.1	3.4	9.0	6.0
Radish *(Raphanus sativus)*	1.2	0.8	2.0	1.3	3.1	2.1	5.0	3.4	8.9	5.9
Onion *(Allium cepa)*	1.2	0.8	1.8	1.2	2.8	1.8	4.3	2.9	7.4	5.0
Carrot *(Daucus carota)*	1.0	0.7	1.7	1.1	2.8	1.9	4.6	3.0	8.1	5.4
Bean *(Phaseolus vulgaris)*	1.0	0.7	1.5	1.0	2.3	1.5	3.6	2.4	6.3	4.2
Turnip *(Brassica rapa)*	0.9	0.6	2.0	1.3	3.7	2.5	6.5	4.3	12	8.0

Table 4 (continued)

YIELD POTENTIAL

FORAGE CROPS	100%		90%		75%		50%		0% "maximum"[3]	
	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w
Wheatgrass, tall *(Agropyron elongatum)*	7.5	5.0	9.9	6.6	13	9.0	19	13	31	21
Wheatgrass, fairway crested *(Agropyron cristatum)*	7.5	5.0	9.0	6.0	11	7.4	15	9.8	22	15
Bermuda grass *(Cynodon dactylon)*[7]	6.9	4.6	8.5	5.6	11	7.2	15	9.8	23	15
Barley (forage) *(Hordeum vulgare)*[4]	6.0	4.0	7.4	4.9	9.5	6.4	13	8.7	20	13
Ryegrass, perennial *(Lolium perenne)*	5.6	3.7	6.9	4.6	8.9	5.9	12	8.1	19	13
Trefoil, narrowleaf birdsfoot[8] *(Lotus corniculatus tenuifolium)*	5.0	3.3	6.0	4.0	7.5	5.0	10	6.7	15	10
Harding grass *(Phalaris tuberosa)*	4.6	3.1	5.9	3.9	7.9	5.3	11	7.4	18	12
Fescue, tall *(Festuca elatior)*	3.9	2.6	5.5	3.6	7.8	5.2	12	7.8	20	13
Wheatgrass, standard crested *(Agropyron sibiricum)*	3.5	2.3	6.0	4.0	9.8	6.5	16	11	28	19
Vetch, common *(Vicia angustifolia)*	3.0	2.0	3.9	2.6	5.3	3.5	7.6	5.0	12	8.1
Sudan grass *(Sorghum sudanense)*	2.8	1.9	5.1	3.4	8.6	5.7	14	9.6	26	17
Wildrye, beardless *(Elymus triticoides)*	2.7	1.8	4.4	2.9	6.9	4.6	11	7.4	19	13
Cowpea (forage) *(Vigna unguiculata)*	2.5	1.7	3.4	2.3	4.8	3.2	7.1	4.8	12	7.8
Trefoil, big *(Lotus uliginosus)*	2.3	1.5	2.8	1.9	3.6	2.4	4.9	3.3	7.6	5.0
Sesbania *(Sesbania exaltata)*	2.3	1.5	3.7	2.5	5.9	3.9	9.4	6.3	17	11
Sphaerophysa *(Sphaerophysa salsula)*	2.2	1.5	3.6	2.4	5.8	3.8	9.3	6.2	16	11
Alfalfa *(Medicago sativa)*	2.0	1.3	3.4	2.2	5.4	3.6	8.8	5.9	16	10
Lovegrass *(Eragrostis sp.)*[9]	2.0	1.3	3.2	2.1	5.0	3.3	8.0	5.3	14	9.3
Corn (forage) (maize) *(Zea mays)*	1.8	1.2	3.2	2.1	5.2	3.5	8.6	5.7	15	10
Clover, berseem *(Trifolium alexandrinum)*	1.5	1.0	3.2	2.2	5.9	3.9	10	6.8	19	13
Orchard grass *(Dactylis glomerata)*	1.5	1.0	3.1	2.1	5.5	3.7	9.6	6.4	18	12
Foxtail, meadow *(Alopecurus pratensis)*	1.5	1.0	2.5	1.7	4.1	2.7	6.7	4.5	12	7.9
Clover, red *(Trifolium pratense)*	1.5	1.0	2.3	1.6	3.6	2.4	5.7	3.8	9.8	6.6
Clover, alsike *(Trifolium hybridum)*	1.5	1.0	2.3	1.6	3.6	2.4	5.7	3.8	9.8	6.6
Clover, ladino *(Trifolium repens)*	1.5	1.0	2.3	1.6	3.6	2.4	5.7	3.8	9.8	6.6
Clover, strawberry *(Trifolium fragiferum)*	1.5	1.0	2.3	1.6	3.6	2.4	5.7	3.8	9.8	6.6
FRUIT CROPS[10]										
Date palm *(Phoenix dactylifera)*	4.0	2.7	6.8	4.5	11	7.3	18	12	32	21
Grapefruit *(Citrus paradisi)*[11]	1.8	1.2	2.4	1.6	3.4	2.2	4.9	3.3	8.0	5.4
Orange *(Citrus sinensis)*	1.7	1.1	2.3	1.6	3.3	2.2	4.8	3.2	8.0	5.3
Peach *(Prunus persica)*	1.7	1.1	2.2	1.5	2.9	1.9	4.1	2.7	6.5	4.3
Apricot *(Prunus armeniaca)*[11]	1.6	1.1	2.0	1.3	2.6	1.8	3.7	2.5	5.8	3.8
Grape *(Vitus sp.)*[11]	1.5	1.0	2.5	1.7	4.1	2.7	6.7	4.5	12	7.9
Almond *(Prunus dulcis)*[11]	1.5	1.0	2.0	1.4	2.8	1.9	4.1	2.8	6.8	4.5

Table 4 (continued)

YIELD POTENTIAL

FRUIT CROPS[10]	100%		90%		75%		50%		0% "maximum"[3]	
	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w
Plum, prune *(Prunus domestica)*[11]	1.5	1.0	2.1	1.4	2.9	1.9	4.3	2.9	7.1	4.7
Blackberry *(Rubus sp.)*	1.5	1.0	2.0	1.3	2.6	1.8	3.8	2.5	6.0	4.0
Boysenberry *(Rubus ursinus)*	1.5	1.0	2.0	1.3	2.6	1.8	3.8	2.5	6.0	4.0
Strawberry *(Fragaria sp.)*	1.0	0.7	1.3	0.9	1.8	1.2	2.5	1.7	4	2.7

[1] Adapted from Maas and Hoffman (1977) and Maas (1984). These data should only serve as a guide to relative tolerances among crops. Absolute tolerances vary depending upon climate, soil conditions and cultural practices. In gypsiferous soils, plants will tolerate about 2 dS/m higher soil salinity (ECe) than indicated but the water salinity (ECw) will remain the same as shown in this table.

[2] ECe means average root zone salinity as measured by electrical conductivity of the saturation extract of the soil, reported in deciSiemens per metre (dS/m) at 25°C. ECw means electrical conductivity of the irrigation water in deciSiemens per metre (dS/m). The relationship between soil salinity and water salinity (ECe = 1.5 ECw) assumes a 15-20 percent leaching fraction and a 40-30-20-10 percent water use pattern for the upper to lower quarters of the root zone. These assumptions were used in developing the guidelines in Table 1.

[3] The zero yield potential or maximum ECe indicates the theoretical soil salinity (ECe) at which crop growth ceases.

[4] Barley and wheat are less tolerant during germination and seedling stage; ECe should not exceed 4-5 dS/m in the upper soil during this period.

[5] Beets are more sensitive during germination; ECe should not exceed 3 dS/m in the seeding area for garden beets and sugar beets.

[6] Semi-dwarf, short cultivars may be less tolerant.

[7] Tolerance given is an average of several varieties; Suwannee and Coastal Bermuda grass are about 20 percent more tolerant, while Common and Greenfield Bermuda grass are about 20 percent less tolerant.

[8] Broadleaf Birdsfoot Trefoil seems less tolerant than Narrowleaf Birdsfoot Trefoil.

[9] Tolerance given is an average for Boer, Wilman, Sand and Weeping Lovegrass; Lehman Lovegrass seems about 50 percent more tolerant.

[10] These data are applicable when rootstocks are used that do not accumulate Na^+ and Cl^- rapidly or when these ions do not predominate in the soil. If either ions do, refer to the toxicity discussion in Section 4.

[11] Tolerance evaluation is based on tree growth and not on yield.

Alfalfa, a forage crop, will be used as an example to help explain the information in Table 4. In the column titled 100% and subtitled EC_e, the value for alfalfa is 1.3. This means that as long as the average EC of the irrigation water does not exceed 1.3 dS/m (or 1300 μS/cm), the salinity of the water will not cause a decrease in yield. Likewise, when the average EC of the irrigation water (EC_e) reaches 2.2 dS/m, the salinity by itself will cause a 10 percent decrease in yield and an EC_e of 5.9 will cause a 50% decrease in alfalfa yield.

Sweet corn, a vegetable crop, provides another example. In the column titled 100% and subtitled EC_e, the value for sweet corn is 1.1. This means that as long as the average EC of the irrigation water does not exceed 1.1 dS/m (or 1100 μS/cm) the salinity of the water will not cause a decrease in yield. Likewise when the average EC of the irrigation water (EC_e) reaches 1.7 dS/m, the salinity by itself will cause a 10 percent decrease in sweet corn yield and an EC_e of 3.9 will cause a 50% decrease in sweet corn yield.

Table 4 also contains values for EC_w. These values are the average concentration of the irrigation water that will result in the corresponding EC_e. Footnote 2 of Table 4 points out that these EC_w values or irrigation water electrical conductance values are based on an assumed leaching fraction of 15 to 20 percent. This means that, for alfalfa, if the EC of the irrigation water is 1,300 dS/cm or less and the leaching fraction is 20 percent, the salinity of the soil water could be 2,000 dS/cm and there would be no decrease in yield.

For alfalfa irrigated with an EC_w near 1,300 dS/cm (1.3 dS/m) then the leaching fraction must be 15 to 20 percent. In other words, if the crop needs 24 inches of water per season then 24 inches plus 20 percent (4.8) or a total of 28.8 inches of water must be applied in order to maintain maximum yield. If the irrigation water salinity is greater than 1,300 μ S/cm or the leaching fraction is less than 20 percent, yields will be decreased. There would be a 10 percent yield decrease if the average irrigation water conductivity were 2,200 μS/cm (2.2 dS/m) and a 25 percent yield decrease if the average irrigation water conductivity is 3,600 dS/cm (3.6 dS/m). In order to determine the effects of changing the leaching fraction, an extra step is required.

Figure 1, from Hansen (page 28 and shown on the next page), gives the relationship between the EC of the irrigation water, indicated as the EC in the root zone, and the EC of the soil water at various leaching fractions. Note that an irrigation water EC of 1.3 dS/m and a leaching fraction of 20% results in an "average root zone" EC of 2 dS/m. The "average root zone" EC is the same as the salinity of the soil water. Figure 1 indicates that if the EC of the irrigation is 1.3 dS/m and the leaching fraction is 5%, the resulting soil water salinity will be about 3.6 dS/m. According to Table 4, this corresponds to about a 25% reduction in yield. If the leaching fraction is 40%, then the irrigation water EC could be as high as 2 dS/m without causing decreases in yield.

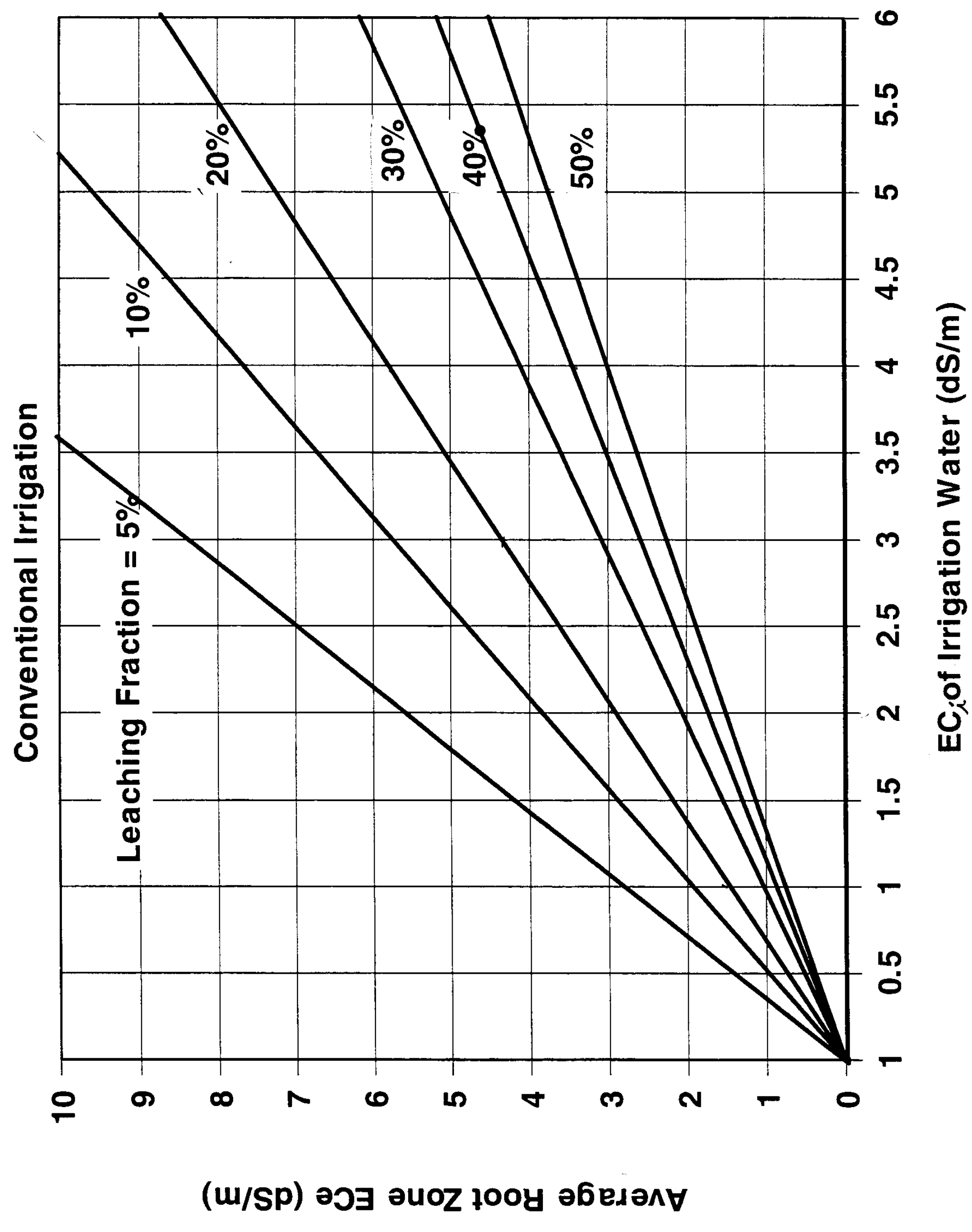

Figure 1. Assessing the maintenance leaching fraction under conventional irrigation methods.

These are all approximate values and assume that sufficient water can pass through the root zone of the irrigated soils. This should not be an issue for most soils for the lower leaching requirements. However, it may be difficult to pass sufficient water through the root zone to achieve the higher leaching fractions, especially in “heavy soils” (soils with a high content of clay). In addition, these tables assume that sufficient water is physically and legally available for the increased leaching. Increasing the leaching fraction from 20 to 40 percent would require 20% more water.

Further, while it is assumed that leaching is uniform throughout a field, in practice the leaching fraction is not uniform throughout a field. First of all, there are usually differences in the soil characteristics within a field. Thus, there are likely to be differences in the rate at which water flows through the root zone in different parts of a field because the soil texture and thus the permeability of the soils vary. Secondly, the rate at which water enters the soil at a particular point is partially determined by the water pressure or depth of water at that point. Fields are seldom level. Less water will enter the soils in the "high spots" of the field where the depth of water will be least, even a few inches can make a difference. Most importantly, the amount of leaching that occurs depends on the time that excess water is applied to the soil. During conventional flood irrigation, the soils in the upper part of a field near the ditches will be covered with water much longer than the soils at the bottom or tail end of a field.

The problems of low permeability, high spots, differences in the length of time water is applied to different parts of a field can be overcome by diking an entire field (like a rice paddy) and covering it with water for as long as necessary to achieve the desired leaching. This assumes that the crop can tolerate being submerged for a sufficient length of time and that it is physically possible to flood the entire field.

Development of salinity threshold values

Relevant factors include:

1) current irrigation practices. This includes the amount of each type irrigation, conventional flood, "complete diking", and sprinkler.

2) The crops that are grown in each sub-basin and the relative amounts of each.

3) The EC of the soil water prior to CBM development.

4) The EC of the irrigation water.

5) Evidence of salinity problems now. This includes salt spots in fields, decreased production at the tail end of fields, and salt buildup in fields with heavy clay soils. It also includes fields that were abandoned in the past due to salinity problems.

Sodium Adsorption Ratio (SAR)

The clay portion of soils consists of very small plate-like structures stacked like decks of cards. Water in soil moves, and it enters clays soils by flowing between the "stacks." The clay plates are held together primarily by calcium ions and to a lesser degree by magnesium ions. Replacement of the calcium ions between the plates with sodium ions tends to force the plates apart and in effect to break up the "stacks" or "decks."

As the stacks are broken apart, or dispersed, the rate at which water enters the soil (the infiltration) decreases. In some cases this rate may become very close to zero. This makes production of crops impractical. This effect does not occur in soils that have no clay and the size of the effect depends on the amount (and type) of clay in the soils. Almost all of the soils in the Powder and Tongue River Basins contain some clay, and most of the soils have significant amounts of clay.

The effect of sodium on soils is related to the abundance, or ratio, of sodium to the abundance of calcium and magnesium. This is called the sodium adsorption ratio or SAR. The effects are also directly related to the absolute abundance of all of the ions. As the EC of water increases a given SAR becomes less harmful. This relationship is shown in Figure 1, page 31.

Table 1 shows how SAR and EC levels restrict infiltration. For instance, if the SAR ranges from 0 - 3 and the EC is less than 0.2 dS/m (i.e. less than 200 μS/cm) there will be severe reductions in infiltration. If the EC is between 0.2 and 0.7 dS/m, there will be slight to moderate reductions in infiltration. If the EC is greater than 0.7 dS/m, there will be no reductions in infiltration. Figure 3 (from Hansen et. al.) gives these relationships in a graphical format. It is possible to derive the mathematical relationships of the lines in this figure and the resulting formula can be used to calculate the SAR values that would result in reductions in infiltration at any EC. The mathematical relationship between EC and the SAR that will result in no reduction in infiltration is: SAR = (EC times 0.0071) - 2.4754 where EC is expressed as μS/cm.

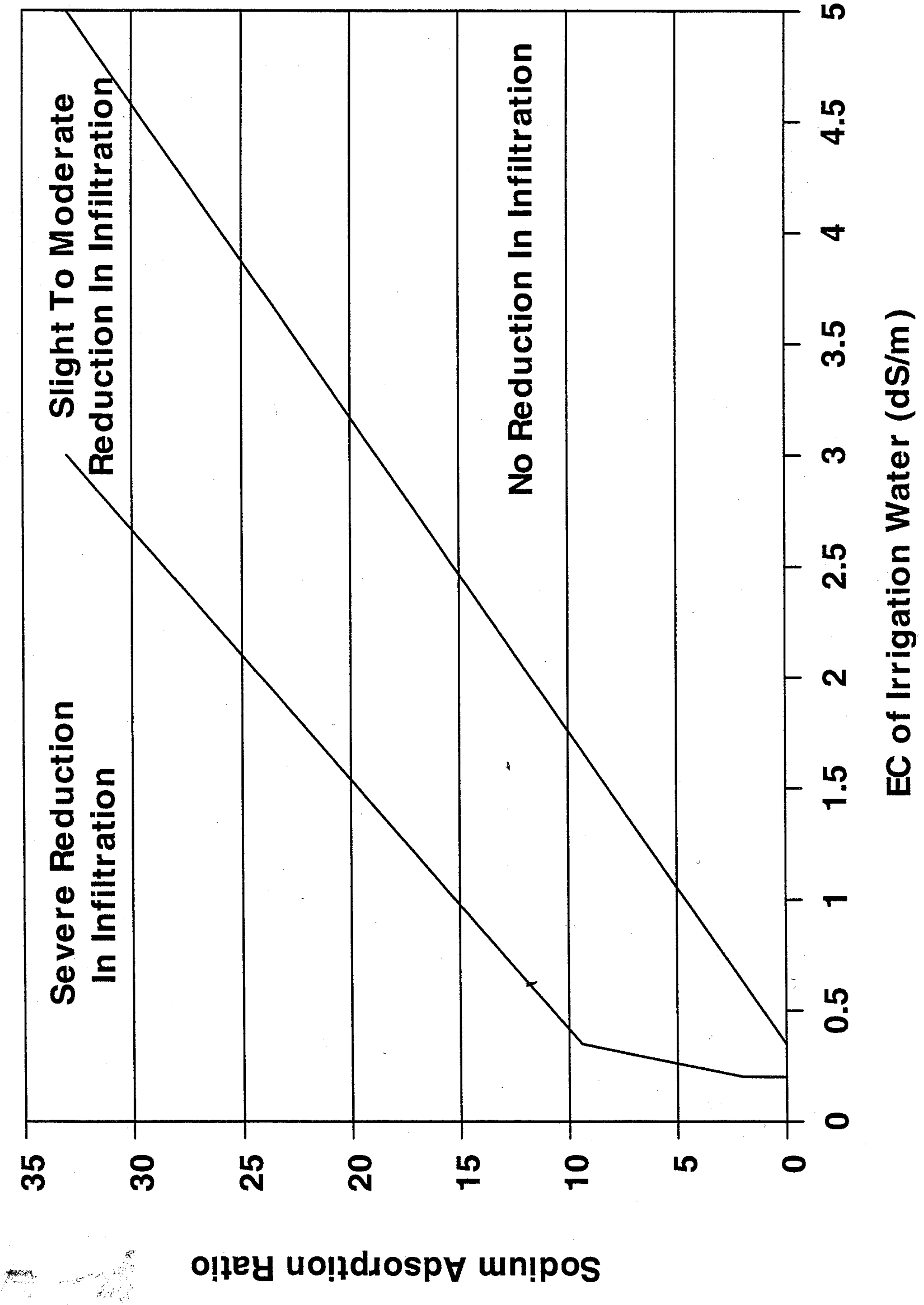

Figure 3. Assessing the effect of salinity and sodium adsorption ratio on infiltration rate.

Threshold water quality values to protect riparian plant communities

Approximately 3,500 acres of riparian habitat are potentially at risk in the CBM development area. Water moving through the alluvium provides water from plant growth in the riparian zone. Native riparian and wetland plants are sensitive to SAR and salinity as well, and soils occurring within or along ephemeral and perennial stream channels, flood plains, terraces and alluvial fans in the CBM development area include montmorillonitic clays making these soils particularly susceptible to the effects of SAR. This is significant because water moving through or flooding the alluvium, providing for growth of riparian plants, is less likely to have a seasonal aspect. This is in contrast to irrigation water, which is intentionally applied to cultivated crops under controlled conditions and only during certain times of the year.

III. Impacts to Air Quality

EPA cannot provide a meaningful set of comments on impacts to air resources until the technical study currently under preparation by Argonne Labs for BLM's use in the Final EIS is provided. EPA will provide detailed comments on air quality at a later date.

EPA is providing an extensive review of the air quality modeling information provided by Argonne National Lab for the Wyoming Powder River Basin Draft EIS that may prove useful for Argonne's preparation of the similar analysis for this Draft EIS. (See detailed comments on the Wyoming Powder River Basin EIS to Al Pierson, BLM, Wyoming State Director.) These reports should be coordinated in order to factor in the cumulative air quality impacts to the entire Powder River Basin, not just each State separately.

As noted in our cover letter, air quality conditions have changed considerably in the last several years in the Wyoming portion of the Powder River Basin. Beginning in 1999, PM_{10} particulates have been recorded above the Class II Prevention of Significant Deterioration (PSD) increment of 30 ug/m3. In 2001 and this year, 13 exceedences of the NAAQS have been recorded. This new information, available form the Wyoming DEQ and EPA Region 8 needs to be incorporated into the air quality analysis.

We note the following concerns with the brief analysis thus far provided in this Draft EIS. The air quality section in Chapter 3 mentions that there are few industrial sources in the area where CBM development is planned. There are several coal-fired power plants in the Colstrip area. Have impacts from these power plants been factored into this analysis?

The Draft EIS mentions that in order to reduce fugitive dust impacts from roads, operators could establish and enforce 15 mph speed limits. Under CEQ regulations mitigations measures are either part of a proposed action by a company or are part of a regulatory action by a government entity. (See 46 FR 18026, 18038 and CEQ "Questions and Answers," No. 40.) Merely considering some action is not adequate mitigation according to CEQ. Could operators be required to post and establish speed limits and stabilize unpaved roads on public lands pursuant to BLM's authority to prevent unnecessary and undue degradation?

Lame Deer, Montana is a moderate PM_{10} nonattainment area. CBM development is planned for areas surrounding Lame Deer. Does this EIS use any monitoring data to make the determination that there won't be any adverse PM_{10} and $PM_{2.5}$ impacts? There is no mention of any such analysis in the Draft EIS. The PM_{10} data collected at Lame Deer are available from the Northern Cheyenne Tribes' environmental office.

IV. Environmental Justice and Social Economic Analysis

EPA's comments on the preliminary Draft EIS highlighted, among other concerns, the lack of a comprehensive analysis of how the proposed action would affect minority and low income populations in the development area, the lack of sufficient information about how the depletion of natural resources would affect the Crow Tribe and the Northern Cheyenne Tribe, and the inadequate discussion of the Northern Cheyenne Tribe's request for a reservation of assimilative capacity in the Tongue River.

Concerns such as this are known as environmental justice, or EJ matters. Since the issuance of Executive Order No. 12898, "Federal Actions to Address Environmental Justice in Minority and Low Income Population" (February 11, 1994), federal agencies have been required, to the greatest extent practicable and permitted by law, to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. In these comments, communities of minority or low-income individuals will be referred to as "EJ communities."

An environmental justice assessment includes an examination of the following:

1. Demographics of the communities involved;
2. Disproportionate environmental impacts (including human health, economic, and social effects) to low-income communities or minority populations;
3. Stakeholder involvement including the level of public participation with regard to the decision making processes; and
4. Communities potentially benefitting from (or shouldering burdens from) the proposed project.

EPA's prior comments on environmental justice focused on the Northern Cheyenne and the Crow Tribes. EPA is now offering additional EJ information for the two counties in the BLM emphasis area, Rosebud County and Powder River County.

Demographics of Rosebud County

Rosebud County's total population is 10,505. Its minority population is 3075, or 29.27% of its population. This is a substantially larger percentage than the statewide minority percentage of 8.06% (64,301 minority individuals as compared to a total state population of 797,394).

Rosebud County's population living in poverty is 2103, which is 20.02% of the county's overall population. This is a greater percentage than the statewide poverty percentage, which is 15.58. Because of the high proportions of minorities and low-income individuals in Rosebud County, EPA recommends that the BLM consider any disproportionate impacts of CBM development on the population of Rosebud County.

Demographics of Powder River County

Powder River County's minority population is 80 or 3.83% of its total population, making the minority proportion of its population far less than the comparable statewide percentage. However, Powder River County's poverty population is 376 or 17.99% of the county's population, which is slightly higher than the statewide average. This may warrant a more in-depth look at any disproportionate impact CBM development may have on the population of Powder River County.

Amish Community

There is a small Amish settlement approximately ten miles north of Ashland, Montana, in Rosebud County. This population cultivates strawberries, among other sensitive vegetable crops. As seen from Table 4, page 24, above, strawberries are one of the crops most sensitive to salinity and SAR. The BLM should evaluate whether this community is low income and whether environmental impacts are likely to fall disproportionately on it. (Because the settlement was established in the mid-1990s, the earliest U.S. Census that would have covered it is the year 2000 Census.)

Cumulative Impacts

The cumulative analysis for this Draft EIS focused on impacts from oil and gas industry-related projects within the study area. In evaluating the environmental impacts of this proposed action and alternative actions in this Draft EIS, CEQ regulations (40 CFR 1508.25) require an action to be considered in light of connected actions, cumulative actions, and similar actions. By limiting the cumulative analysis to only oil and gas industry-related projects, whole areas of other negative environmental impacts are not included in this analysis. These other areas might include National Pollutant Discharge Elimination System (NPDES) discharges, which may have an effect on the water quality of the Powder or Tongue Rivers; Resource Conservation and Recovery Act (RCRA) sites which may also have negative cumulative environmental impacts in the study area; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites could also have a negative cumulative environmental impact in the study area. All of these things should be analyzed in the Draft EIS. Attached to this document is a map that looks at all of these sites, for a selected area around Ashland, Montana. Similar maps could be developed for the entire study area which would then give the reader of this document a much better feel for what environmental issues should be addressed in order to determine what the cumulative impacts might be. When identifying and developing potential mitigation measures to address environmental justice concerns, members of the affected communities should be consulted.

Stakeholder Involvement

Executive Order No. 12898 directs all federal agencies to ensure that their programs, policies, and activities substantially affecting human health or the environment do not exclude persons (including populations) from participating in the benefits of these programs, do not deny these persons from the benefits of these programs, or do not subject these persons to discrimination due to race, color, or national origin. The Executive Order also directs federal agencies to give minority and/or low-income communities opportunities for participation in, and access to public information on, matters relating to human health and the environment.

The Draft EIS indicates that it is intended to analyze "the impacts from future exploration and development of State managed oil and gas resources *statewide*." (Draft EIS, p. 1-1, emphasis added.) Any evaluation of statewide impacts should include impacts to Indian tribes throughout the State. Although Montana has numerous Indian tribes (including the Chippewa Cree, the Gros Ventre & Assiniboine, the Confederated Salish and Kootenai, the Blackfeet, and Fort Peck, in addition to the Crow and Northern Cheyenne), the Draft EIS makes no mention of any consultation with Tribes as to how future exploration and development of State managed oil and gas resources may impact their health, land and resources.

The Draft EIS provides very little information about any outreach that was done with the low income populations potentially affected by CBM development. This information needs to be included.

Benefit and Burden Analysis

The Draft EIS should analyze the burdens, direct and indirect - economic, social, cultural, environmental or health - that would come from the proposed action. It should indicate which stakeholder groups would bear these burdens and whether there would be a disproportionate impact on any low-income and/or minority populations. The goal of the Executive Order is to determine if there is an unfairness in the distribution of the benefits and burdens associated with the implementation of the Federal laws, regulations and policies involved in this action. The goal is for all segments of the society regardless of race, color, national origin, or income to share fairly in receiving the benefits from environmental protection and in shouldering the burdens of implementation of these development policies.

The study area population is largely rural, with strong ties to the land and to the many small towns in the area. Ranch and farm families live in the study area. They tend to favor traditional land uses and the preservation of intergenerational family operations. (Socioeconomic Appendix, page 1, Draft EIS.) To accommodate producers owning subsurface mineral rights, these people may be losing control over the use of their land. This burden needs to be addressed in the Draft EIS, along with the effects of the loss of potential use of the land for crops or other uses. The Draft EIS has a small discussion about some of the burdens that groups generally may have (see Draft EIS page 4-75), but it does not provide any details concerning the low-income groups specifically impacted that are in this study area.

V. Ground Water Impact Analysis

The Draft EIS cites limited ground-water flow estimates of impacts on water levels in the coal seams and overlying strata resulting from CBM and other development. No indication is given that these efforts were coordinated with and/or compared to the modeling performed for the Wyoming Powder River Basin Draft EIS. The discussions of predictive model results in the Wyoming Draft EIS mentions the effects of coalbed methane development extending north into Montana but it does not indicate whether the potential CBM development within the Powder River Basin in Montana was included within these simulations. This is a void, as all proposed coal bed methane development in the Powder River Basin will have additive effects to the projected drawdowns. EPA recommends that both conceptual and quantitative hydrogeologic models for the entire coalbed methane development area in the Powder River Basin be developed to simulate impacts to ground-water resources from the proposed activities.

Ground-water flow modeling is a tool with limited usefulness in performing the type of quantitative predictions presented in the Draft EISs. Even where significant data are available for development of a numerical flow model, predictive simulations are of limited value unless relative comparisons can be performed on the results of modeling simulations to evaluate various impact scenarios. The numerical modeling work performed to date for the Powder River Basin is very conceptual in nature due to limited data for numerical model development. The resulting estimates of impacts due to proposed ground-water extraction from coalbed methane development are presented as quantitative predictions and as such have little value.

To determine areas that may have significant impacts to wells and springs, EPA suggests the following possible approach:

1) Develop a conceptual model of the overall ground-water system in the Powder River Basin in Montana and Wyoming. Such studies should not terminate at governmental borders that are unrelated to the hydrogeologic setting. A key element of this conceptual model would be to correlate the coal seams and their facies throughout the Basin and determine the interconnections between these facie changes areas on either side of the state line.

2) Develop a conceptual water budget for the Powder River Basin establishing recharge rates balanced with natural discharge rates and production. Much of this effort may be complete for areas of the Basin, but a full-scale assessment is needed. The key components to be determined are the regional ground water flow from the Wyoming portion of the Basin into Montana and the ultimate fate of this flow.

3) Assess all ground-water monitoring data and all aquifer testing data available over the entire Basin to determine the interconnectivity of the hydrogeologic units potentially impacted by extraction of ground water from the coal seems. This assessment would demonstrate to the extent possible whether adjacent units would be affected and could be

used to determine where significant potential impacts may affect water users.

4) Assess all ground-water data and all aquifer testing data for the coals to estimate the potential water stored in these units in various sub-basins within the Powder River Basin. From this estimate an attempt can be made to quantify the impacts of CBM development within the various sub-basins based on the predicted change in the water budget. This would allow each sub-basin to be characterized regarding the amount of potential depletion and thereby selecting the sub-basins with the highest depletion potential for mitigation efforts and focusing where monitoring should occur given a finite budget.

5) Develop monitoring programs for the various sub-basins within the Powder River Basin that will assess impacts of CBM development on the coals and any interconnected units. Such monitoring should also address assessing impacts to ecological resources (e.g., springs, surface water, etc.)

6) Develop actions based on specifically monitored conditions, or triggers, that would obligate mitigation measures if CBM development results in significant impacts to water users and to ecological resources (e.g., springs, surface water, etc.).

VI. Detailed comments by page

Page S-1: It appears that pages S-1 and S-2 summarize the public and agency scoping issues rather than any results of the EIS analysis. This should be revised in each section to reflect the results of the impact analysis. For example, Surface Water could be summarized as:

> Surface Water -- High sodium adsorption ratios and elevated salinity concentrations in CBM-produced water have the potential to adversely affect irrigated agriculture and riparian plant communities if all CBM-produced water were discharged, untreated, into streams in the CBM development area. In order to protect these existing water uses, limitations on directly discharging CBM-produced water will be needed. This may be especially true for the Tongue River, where there is little capacity for assimilation of pollutant discharges.

Chapter 1, Page 1-6 first column: Under E.O. Order 13175 agencies are to provide “timely and meaningful opportunity for input by Tribal officials where the EIS would have tribal imitations.” The words “timely and” are missing for this reference to the Executive Order.

Page 2-4, Table 2-1: Although the Department of Energy and the Crow Tribe are official cooperating agencies, neither DOE’s nor the Crow Tribe’s responsibilities and authorities are listed here. Further, since the Northern Cheyenne Tribe has been invited to all lead and cooperating agency functions, its responsibilities and authorities should also be listed in this table.

The responsibilities of the several cooperating agencies are missing from Table 2-1. EPA recommends this be added:

Department of Energy

Promotes energy security, but has no permit authority or responsibilities for the oil and gas development activities. DOE has provided financial support to the Montana Oil and Gas Board for analysis of CBM activities.

Bureau of Indian Affairs

Approves/disapproves of Tribal contracts that involve trust assets such as Joint Venture Agreements under the Indian Mineral Leasing Act.

Similar explanations of the authorities and responsibilities of the Crow and Northern Cheyenne Tribal Governments should be added, with appropriate coordination with the Tribes on the wording of these statements.

Another issue is the extent of necessary government-to-government consultation needed for other potential affected Tribes in Montana. Specifically, Map 4-1 in the Draft EIS seems to indicate there is development potential for similar CBM and oil and gas development on the Fort Belknap Indian Reservation. The extent of this potential and the basis for consultation for this Tribe and any other affected Tribe in Montana needs to be clarified and presented in a revised or supplemental EIS.

Page 2-7, first column, first paragraph: This describes the possibility of establishing a buffer zone around Indian lands and active coals mines “to the extent agency authority allows...” Further explanation is needed on the legal authorities of BLM, MOBC, or BIA to impose such buffers zones.

Page 4-12: EPA recommends deleting the paragraph beginning with: “Since the direct Alternative C and cumulative air pollutant emission sources constitute many minor sources spread out over a very large area, it is unlikely the maximum potential air quality impacts ... would exceed...” The information provided is limited to emissions estimates. A quantitative analysis of the impacts of estimated emissions on the effected air sheds using an appropriate quantitative air quality impact model would be necessary to make this assertion. A quantitative air quality modeling analysis is essential to providing full disclosure under NEPA. The EIS needs to include the appropriate air quality model to sustain any conclusion regarding air quality impacts from the alternatives.

Chapter 4, Page 4-24, first paragraph: What is the basis for the statement that “producing CBM wells within 1 mile of the Crow Reservation boundary could drain CBM resources from the Reservation”? No supporting data are provided.

Chapter 4, Page 4-24, second paragraph: What is the basis for the statement that "producing CBM wells within 1 mile of the Crow Reservation boundary could drain ground water from the Reservation"? Once again, no supporting data are provided.

Chapter 4, Page 4-24 Will routine monitoring be in place to determine whether CBM is being released into domestic wells and causing a threat to public health?

Chapter 4, Page 4-24 What is the basis for the statement that "producing CBM wells within 1 mile of the Northern Cheyenne Reservation boundary could drain CBM resources from the Reservation"? No supporting data are provided.

Chapter 4, Page 4-24 What is the basis for the statement that "producing CBM wells within 1 mile of the Northern Cheyenne Reservation boundary could drain ground-water from the Reservation"? Once again, no supporting data are provided.

Chapter 4, Page 4-23 Will routine monitoring be in place to determine whether CBM is being released to domestic wells and causing a threat to public health?

Chapter 4, Pages 4-24 & 4-25 What is the basis for the 1-mile buffer zone around active coal mines and the 2-mile buffer zone along the Reservation boundary? No supporting data are provided.

Chapter 4, page 4-28. EPA recommends deleting the sentence beginning with: "The average groundwater production rate, over the estimated 20-year life of a CBM well in Montana, is expected to be 2.5 gpm (ALL 2001b)." Instead, EPA recommends including information based on the analysis presented in the first portion of these comments prepared by Helen Dawson, hydrogeologist, EPA Region 8. Based on Ms. Dawson's analysis, perhaps this could be summarized in a revised Draft EIS in the following manner:

> Production data in the Wyoming Oil and Gas Conservation Commission database indicates that water discharge rates vary by watershed. For example, the median discharge rate varies from 8 to 13 gpm/well in the Tongue River watersheds, and from 10 to 12 gpm/well in the Powder River watersheds. It is approximately 24 gpm/well in the Little Powder River watershed. If the median discharge rate is 13 gpm/well, the peak five-year average is 3.2 gpm/well in the 20-year development plan and 3.6 gpm/well in the 40-year development plan. If the median discharge rate is 24 gpm/well, the peak five-year average is 5.8 gpm/well in the 20-year development plan and 4.4 gpm/well in the 40-year development plan.
>
> Based on the above analyses, the 2.5 gpm/well rate of production used in the Montana Draft EIS was low and should be replaced with a higher estimate. In contrast, the well production rate used in the Wyoming Powder River Basin Draft EIS is overly conservative and would overestimate impacts to surface water flow and quality. Considering the variability in water production rates, a reasonably conservative analysis should use peak five-year average values as input to estimate the cumulative impact of

> CBM discharge on surface water quality. Based on this information, a value of approximately 4 gpm/well will be used in the Tongue River watershed, 5 gpm/well in the Powder River watershed, and 6 gpm/well in the Little Powder River watershed.

Chapter 4, Pages 4-28 & 4-29. The quantitative modeling efforts employed later in this Chapter use of the lifetime average produced water production rate of 2.5 gpm/well. This was based on the average of an extrapolation out to 20 years of existing well data. However, in the Wyoming Powder River Basin Draft EIS, a much higher average water production rate is often cited and employed in predictive ground-water simulations. If average production rates at a given time in Montana exceed this 2.5 gpm average per well, then the modeling predictions provided will be flawed due to this lower value. Such errors will be both in terms of ground-water discharge and potential recharge utilized as mixing waters with streamflow in the calculations. See our technical comments under the heading "Surface water quality analysis" for further information on the predicted lifetime average water production rate for the 20-year planning period.

Page 4-29 There is no information provided on the impacts for the range of SAR and EC values considered. If a range of thresholds is to be considered, the environmental, social, and environmental justice implications of such a range must be analyzed. Only a limitation on the number of wells directly discharging without treatment is analyzed for this range of SAR threshold values (see pages 4-45 and 4-46.)

Chapter 4, Page 4-35 What mitigation agreements will be put in place for private well owners? The Wyoming BLM has a well owner's agreement that is to be used for any private wells located within a certain distance of a CBM well that can be adversely impacted. The agreement anticipates mitigation by the producer if impacts to well usage should occur as a result of CBM development. Is there a similar form of well owner's agreement suitable for use by an Indian Tribe?

Chapter 4, Page 4-36 One sentence states there will be impacts to springs. The next sentence states that this is not expected as the springs are shallow features; elsewhere in the Draft EIS, it is also stated that there will be impacts to springs from CBM development. Which case regarding impacts to springs is considered most valid? An explanation of the geological conditions that may result in spring impacts and a map of springs considered at risk from CBM regional ground water drawdown would be useful.

Chapter 4, Page 4-37 It is stated that impacts to shallower ground-water systems will be minimal due to the existence of confining shale layers above the coals. However, predictive simulations using ground-water flow modeling for the Wyoming Powder River Basin Draft EIS show impacts over time to deep sands in the Wasatch Formation. It is also stated here that such impacts are hard to quantify as data are limited. This demonstrates the need to coordinate and compare
conceptual hydrogeologic models and quantitative model development and predictive simulations over the entire Powder River Basin CBM development area.

Chapter 4, Page 4-37 What will be done for mitigation in areas where CBM affects water resources that cannot be replaced? The Draft EIS suggests that ground-water depletion will occur due to CBM development. It should also explain whether and how this impact can be mitigated.

Chapter 4, Page 4-37 The Draft EIS does suggest that ground-water depletion will be a factor in the CBM development areas. Even without a change in climatic conditions and an increase in ground-water recharge over the long term, water levels may never recover to initial, pre-development conditions if depletion at these magnitudes does occur as predicted.

Chapter 4, Page 4-37 Has any research been conducted to determine whether the projected injection rates are attainable in deeper formations within the Powder River Basin in Montana?

Chapter 4, Page 4-28 There is a lack of ground-water quality information for the various coal resources within the Powder River Basin in Montana. The data provided are limited to the CX Ranch field that has been in production. Are there any other areas where ground-water monitoring has occurred? Data is available from the Powder and Little Powder Rivers in Wyoming and has been used by EPA in its water quality analysis. The results of such monitoring in the adjacent state in the same watershed should be included.

Chapter 4, Page 4-31 The ground-water modeling for the Wyoming Powder River Basin Draft EIS shows impacts from CBM development that crosses the state line, and the modeling also shows significant (i.e., exceeding 100 feet in coal seams) effects within the southern portion of the Crow Reservation. The Montana and Wyoming ground-water modeling efforts should be compared for additive effects over the Basin. This is a major void in the Draft EIS efforts for both projects.

Chapter 4, Page 4-31 Do the ground-water modeling results cited here include the potentially large impacts from the CBM development in the Powder River Basin in Wyoming? The Wyoming Powder River Basin Draft EIS modeling efforts show extensive drawdown zones in the Sheridan area just south of the state line. How was the ground-water modeling cited here accomplished? Are there any overlying aquifers that might be impacted through the CBM development activities?

Chapter 4, Pages 4-32 & 4-35 The well estimates cited here for CBM development in Wyoming are out of date. The Draft EIS for Wyoming Powder River Basin CBM development projects 15,458 (Alternative 3) to 39,367 (all other alternatives) wells, far exceeding the 6000 but fewer than the later 50,000 that are cited here. This entire discussion is out-dated and should be coordinated with the Wyoming Powder River Basin Draft EIS as the Wyoming effort predicts there will be: 1) drawdown of over 100 feet in the coal seams extending over 1 to 3 miles into Montana, and 2) the drawdown in sands of the Wasatch Formation also extending north where it exists into Montana.

Chapter 4, Page 4-35 The Draft EIS notes that the geology is different in the Montana CBM development areas of the Powder River Basin and that the ground-water flow modeling efforts for the Wyoming Powder River Basin Draft EIS may not be totally relevant. This is an argument for the need to coordinate and compare conceptual hydrogeologic models and succeeding ground-water flow models over the entire proposed Powder River Basin CBM development area. It is recommended that both conceptual and quantitative hydrogeologic models for the entire CBM development area in the Powder River Basin be developed to simulate impacts from all proposed activities.

Chapter 4, Page 4-50 Will guidance be developed regarding the minimum requirements for inclusion in a Water Management Plan? The Wyoming BLM has developed such guidance for CBM development under its purview in the Powder River Basin.

Chapter 4, Page 4-56 & 57. Here, the Draft EIS describes the impacts of Alternative E, the Preferred Alternative, which is based on avoiding damage to the watershed, and Alternative C, which is based on discharging untreated water, as being similar. This is confusing. Elsewhere, the Draft EIS describes Alternative E as having the same or less impacts than Alternative C. (Draft EIS, page 4-51.) Perhaps this confusion may be due to the alternatives not being based on SAR values known to have adverse effects. As indicated above, EPA's calculations for the Tongue River indicate that with an SAR of 2, no change in infiltration capacity of soils is expected, but with an SAR of 12, there will be an irreversible change in soil infiltration capacity. The BLM should have made use of these calculations in projecting impacts from the various alternatives.

Page 4-99 Vegetative reclamation is considered complete when 60% ground cover is obtained. It should be considered complete when ground cover is back to or greater than pre-disturbance conditions. This should be accomplished with the same vegetation type that was impacted. Soil erosion was described as a major concern due to wind, snow melt and rain fall. This can be reduced with the use of biodegradable mats, hydro-seeding and drilling seed.

For restoring or reclaiming disturbed areas, a standard for revegetation should be established. For instance the disturbed area could be revegetated with native plant species that are not classified as weedy or noxious and that cover at least 75% of the ground with non-native plants not to consist of more than 5% of all of the plant species within the reclamation area.

Pg. 4-102 The Draft EIS is not clear in describing temporary and permanent impacts. Some impacts are considered temporary because they will be reclaimed or mitigated in 20 years. If some impacts are considered temporary because they will be reclaimed in a very short time after the impact occurs, that should be explained. Temporary and permanent impacts should be more clearly described. Table 4-14 gives some of this information, but it does not explain how the Draft EIS defines temporary and permanent impacts.

Page 4-132 No activity should be allowed within a specified distance from any spring or formations (layered) of organic soils, histosol soils or Histic Epipedon (peat fen, bog or carr). The applicant should ensure that their operation will not adversely affect, directly or indirectly, any of the above described formations.

Page 4-133 De-watering - By removing all the water to the point of a dry streambed may have an adverse affect on the stream's banks, fisheries, aquatic invertebrates and their habitat. Caution should be taken to ensure the integrity of the stream system is unharmed.
Table MIN-5:

Under noxious weed control, the EIS describes pulling, biological, chemical, destroying seed heads, cleaning mud and plant debris from drilling and construction equipment before moving to a new site or by revegetating disturbed sites quickly. At what point in the growing season and stage of the plant/s is each of the described control systems used? We suggest emphasis be placed on pulling, destroying seed heads (depending of the process used), revegetating the areas quickly, and keeping the construction equipment free from plants and plant seeds.

When explaining reclamation and mitigation work; the EIS makes a statement “per BLM recommended seed mixture”, but this does not specify what that entails.

Page MIN-39
Mitigation measures are listed on MIN-39. Our comments are numbered according to which measure they address.

> 1) Impacts should be restricted to the time period immediately prior to planting (fall and spring) to reduce soil impacts and increase weed control. Or, precautions should be taken to reduce and/or prevent soil erosion; i.e ground cover or seed mats.
>
> 2 and 5) The removal of vegetation - removed/disturbed top 2-3 inches of top soil/vegetation should be stockpiled and used to restore the disturbed areas.
>
> 11) There is no surface occupancy of any gas or oil facility on jurisdiction waters of the U.S. unless approved by a permit under the CWA pursuant to Section 404.
>
> 17) We suggest this mitigation measure could be expanded to read: Proper drainage “that does not adversely affect other properties and vegetated areas”.
>
> 20) Is it clear that raptor-proofing requirements apply to all lines above ground? Apparently, the practice in Wyoming was that some private contractors building above-ground lines were not familiar with nor obligated to comply with these specific raptor-proofing guidelines.