DETAILED COMMENTS FOR THE WYOMING DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE POWDER RIVER BASIN OIL AND GAS PROJECT

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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, wildlife, and groundwater.

I. DRAFT EIS SURFACE WATER COMMENTS

General Comments

As was stated in our comment letter, the Preferred Alternative proposes discharging produced water without treatment to surface streams and rivers. The Draft EIS determined that if the produced water is allowed to flow to surface streams and rivers, as it would be under the Preferred Alternative, it would make the Tongue River and the Belle Fourche River unsuitable for irrigation (page 4-64). The SAR and salinity values predicted to occur in the Tongue River by the Preferred Alternative are inconsistent with the existing agricultural practices in the basin. These values are also inconsistent with our interpretation of the State of Wyoming's requirement that water quality degradation "shall not be of such an extent to cause a measurable decrease in crop or livestock production" and the requirement that downstream State's standards be met. In addition, current Wyoming Department of Environmental Quality (DEQ) policy does not allow coal bed methane produced water to be discharged to the Tongue River. If the Preferred

Alternative cannot meet water quality standards, then BLM is proposing an alternative that cannot be implemented without changes to the requirements in Wyoming and Montana.

Since, Alternatives 2a and 2b do not analyze water quality impacts, it is unknown how these alternatives would improve water quality. BLM also states that, "the difference between the effects of Alternatives 2a and 2b and Alternative 1 does not reflect or justify these additional costs." (page xxi) However, if the water management in Alternatives 2a and 2b would meet water quality standards, the predicted higher costs associated with other water management alternatives would be justified.

Since water quality was not analyzed for Alternatives 2a and 2b, there are no alternatives presented in the Draft EIS that have enough information to be able to determine if they meet water quality standards. As a result, EPA is requesting that BLM prepare an additional alternative(s) that do meet the standards along with the appropriate analysis and provide the public an opportunity to comment on the new alternatives.

The following analysis, looks at the effects of CBM discharges in various drainages. It includes a comparison of the findings in the Montana and Wyoming Draft EISs. In addition, we included our analysis using assumptions that would be consistent with permits that have been issued for the Tongue River in Montana as well. (See for example Fidelity Corporation's CX field MPDES permit issued in 2000 by Montana DEQ.) The Preferred Alternative in the Wyoming Draft EIS analysis concluded that only the Tongue and Belle Fourche Rivers would be unsuitable for irrigation. The Montana Draft EIS determined that the Tongue, Powder and Little Powder would be unsuitable for irrigation. Please coordinate the results of the analysis with the Montana BLM office in order to reconcile any differences between the Draft EISs.

Summary of BLM's Analysis

The Preferred Alterative (Alternative 1) includes an analysis of water quality impacts, but 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 framework 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, pages 9, 10 and 11 below). The MT Draft EIS, Alternative C concludes that the stream water is rendered unsuitable for irrigation after discharging the Reasonable Foreseeable Development (RFD) CBM water at all three state-line stations. In contrast, the WY 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 the 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, 14).

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 MT 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 9 and 10, 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 over that time period.

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 13, shows the projected rates of CBM well completions and abandonments in the RFD for Montana. Figure F on page 14 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 15). 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 15). 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 water quality 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 16, 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 16, 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 17, 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 17, 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 11 and 18. Discharge limits based on 7Q10 flows are shown in Table D and Figure O, pages 11 and 19. 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.

The Wyoming Draft EIS indicated that CBM produced water surface discharges to the Belle Fourche River would impair water quality. EPA has also prepared an initial analysis of the Belle Fourche watershed at the Moorecroft sampling station and the preliminary results indicate similar issues that have been found in the Powder and Little Powder River where CBM produced water discharges may change SAR and salinity values and impact irrigated agriculture. EPA's initial analysis has been transmitted to Wyoming DEQ and South Dakota Department of Environment and Natural Resources (DENR) for further discussion. We also intend to provide Wyoming DEQ and South Dakota DENR with results from an analysis of CBM discharge to the Cheyenne River.

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

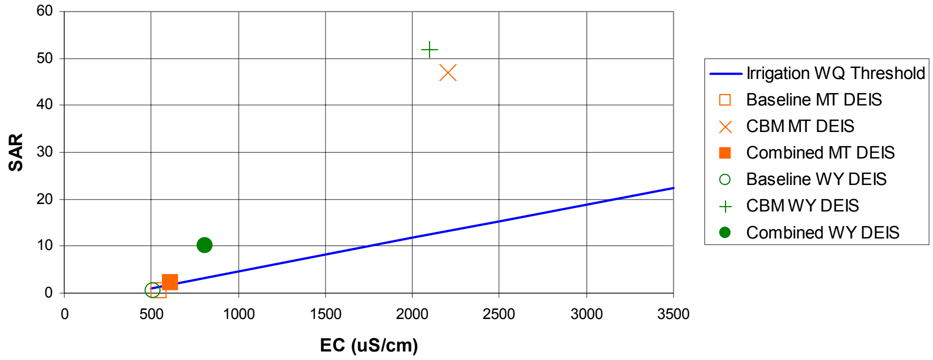


Figure B
Powder River at Moorhead
Water Quality Before and After Mixing with RFD CBM Produced Water

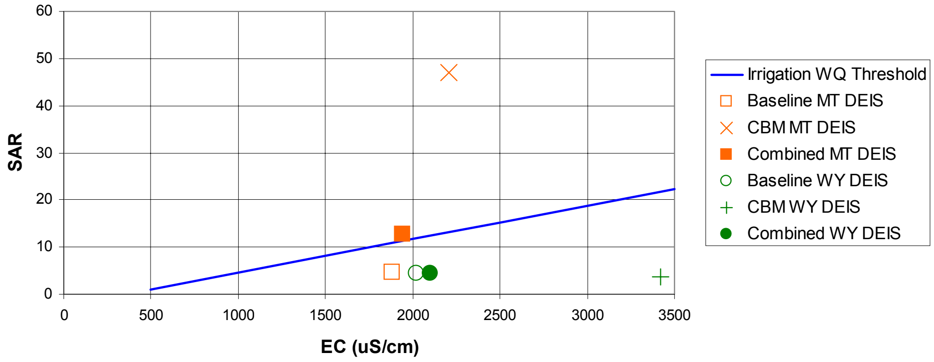


Figure C
Little Powder River at Broadus
Water Quality Before and After Mixing with RFD CBM Produced Water

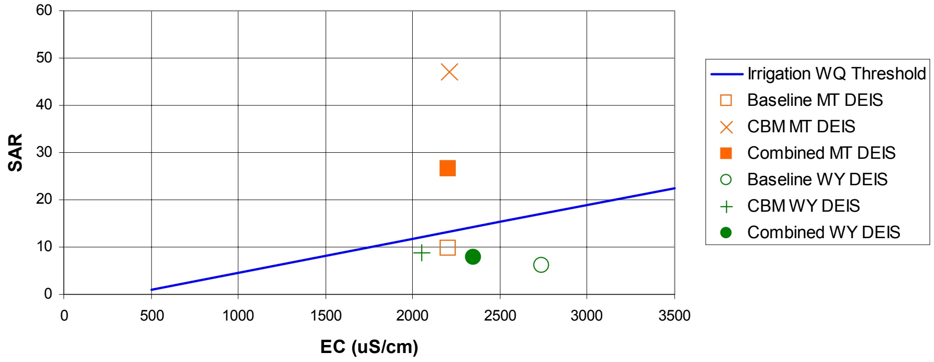


Figure D
EPA Impact Analysis
State Line Water Quality Before and After Mixing RFD CBM Produced Water with Irrigation Season Low Monthly Mean Stream Flows

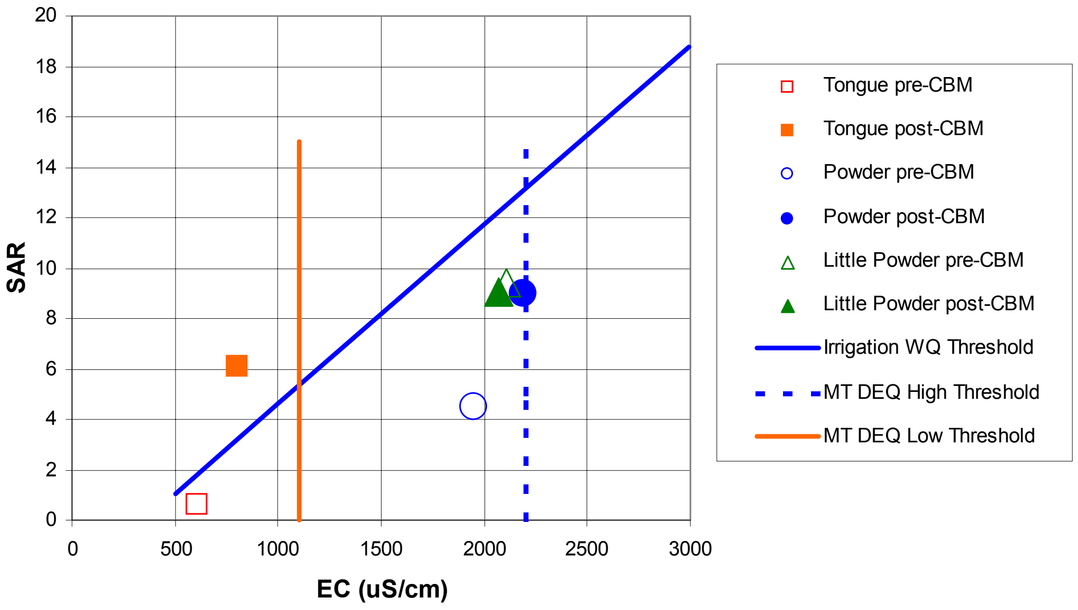


Figure E
EPA Imapct Analysis
State Line Water Quality Before and After Mixing
RFD CBM Produced Water with 7Q10 Stream Flows

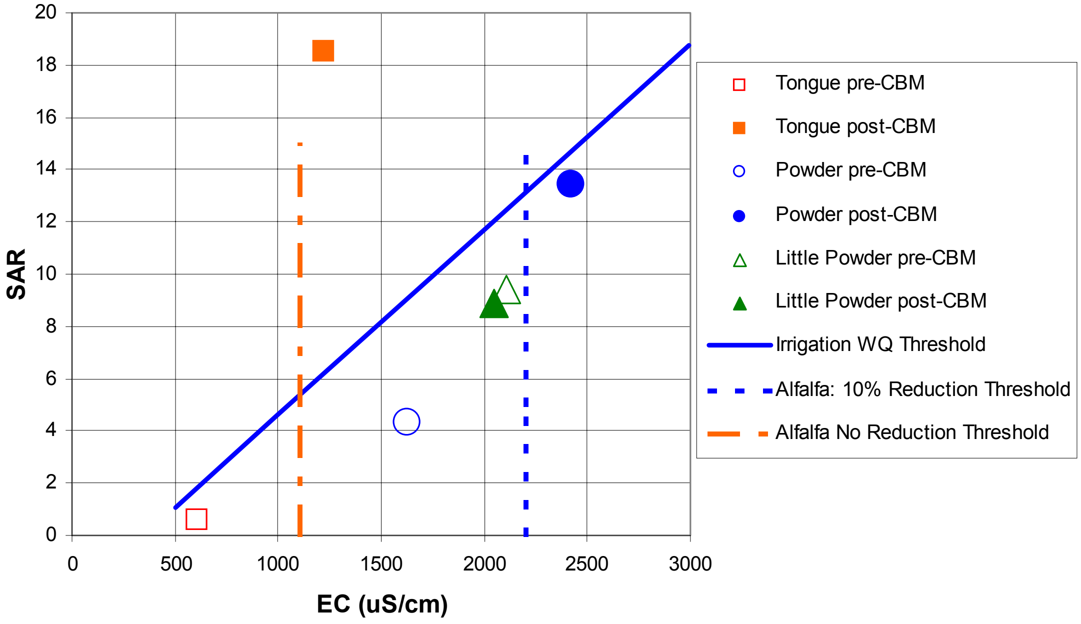


Figure F
MT Rates of CBM Well Completions and Abandonments

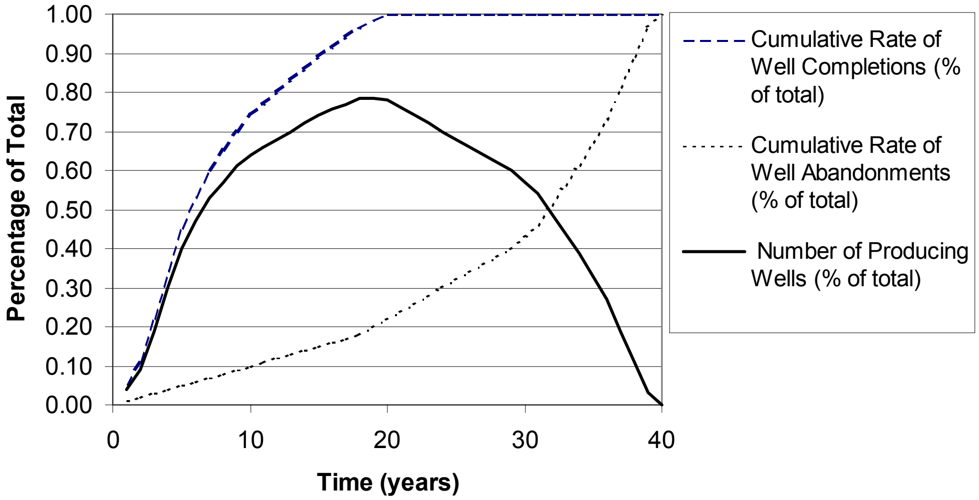
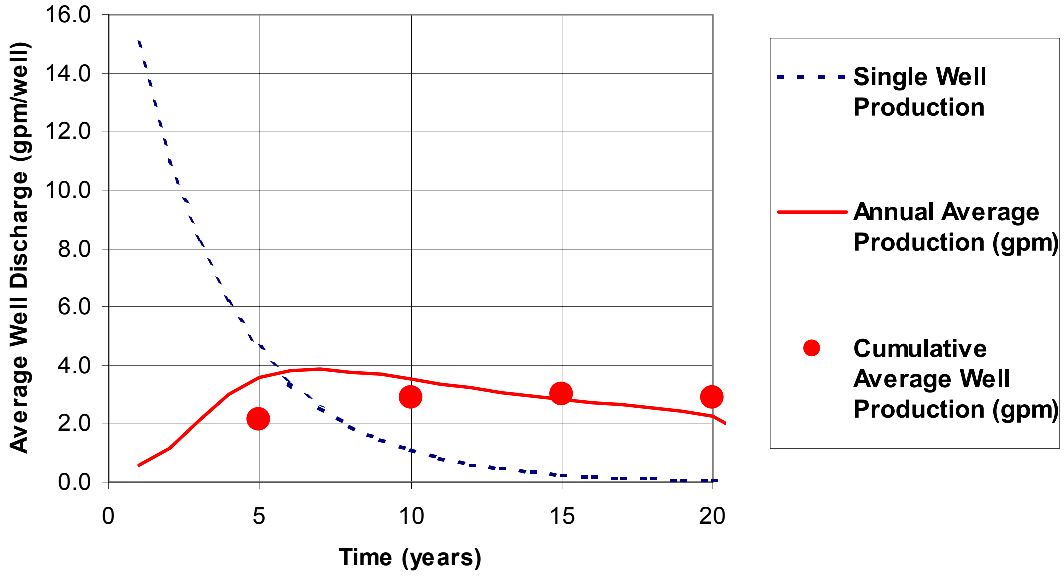


Figure G
MT CBM Well Produced Water Discharge Rates



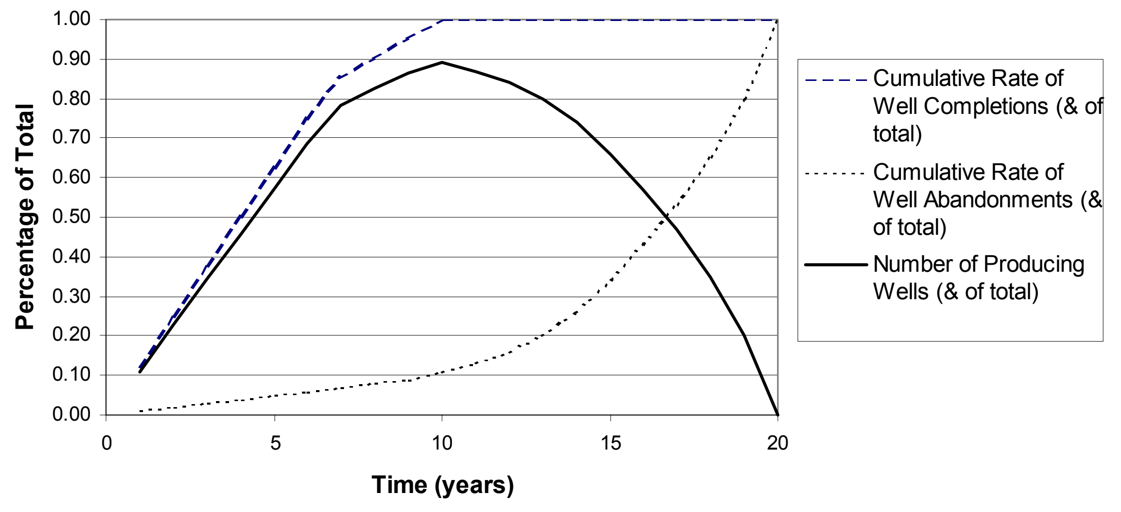


Figure H

WY Rates of CBM Well Completions and Abandonments

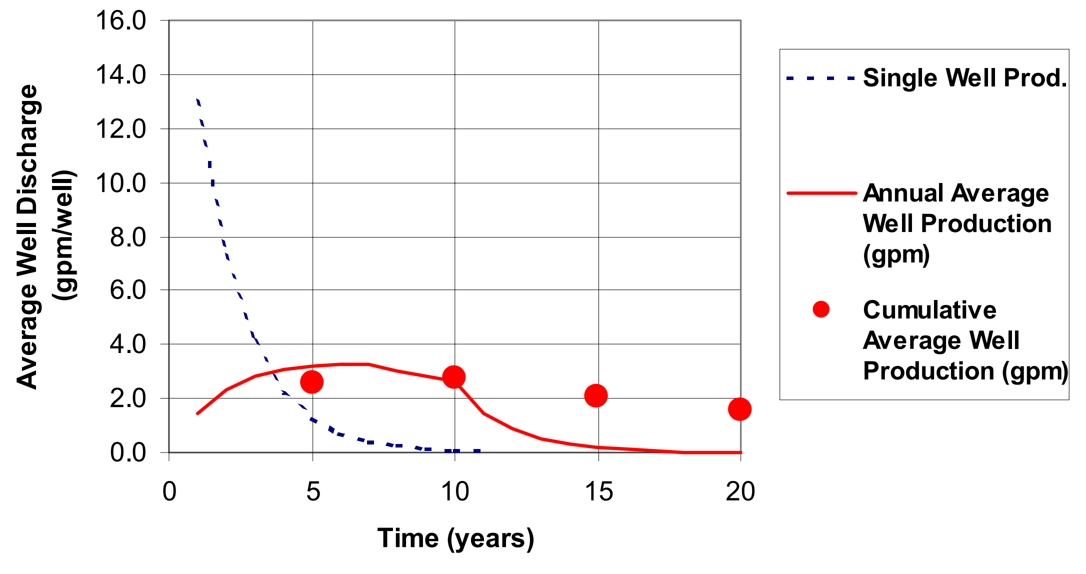
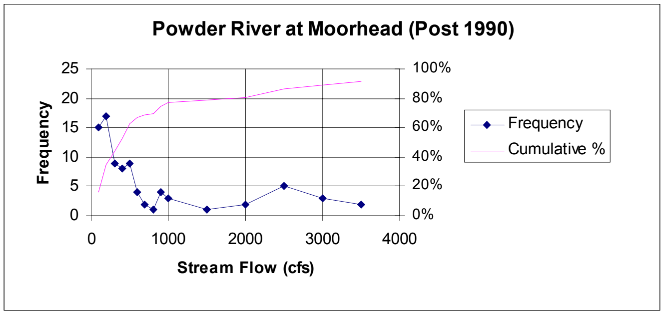


Figure I

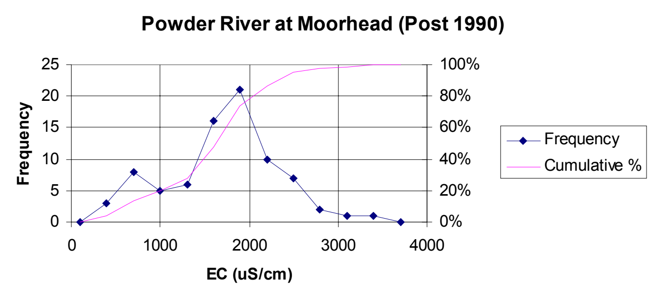
WY CBM Well Produced Water Discharge Rates

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
-

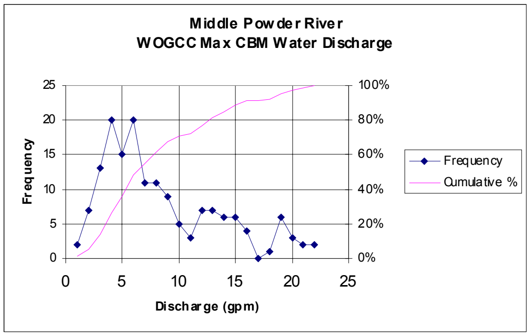


EC (uS/cm):
Fitted Distribution

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

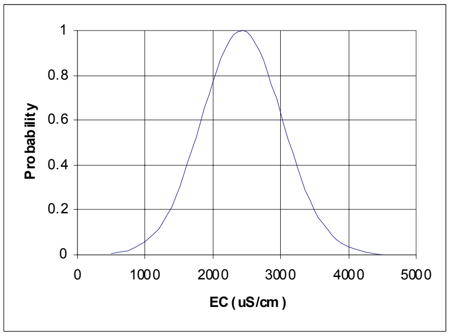
Figure K
CBM Middle Powder River
Discharge and EC - Fitted Distributions

Discharge (gpm)



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

EC (uS/cm)



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

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

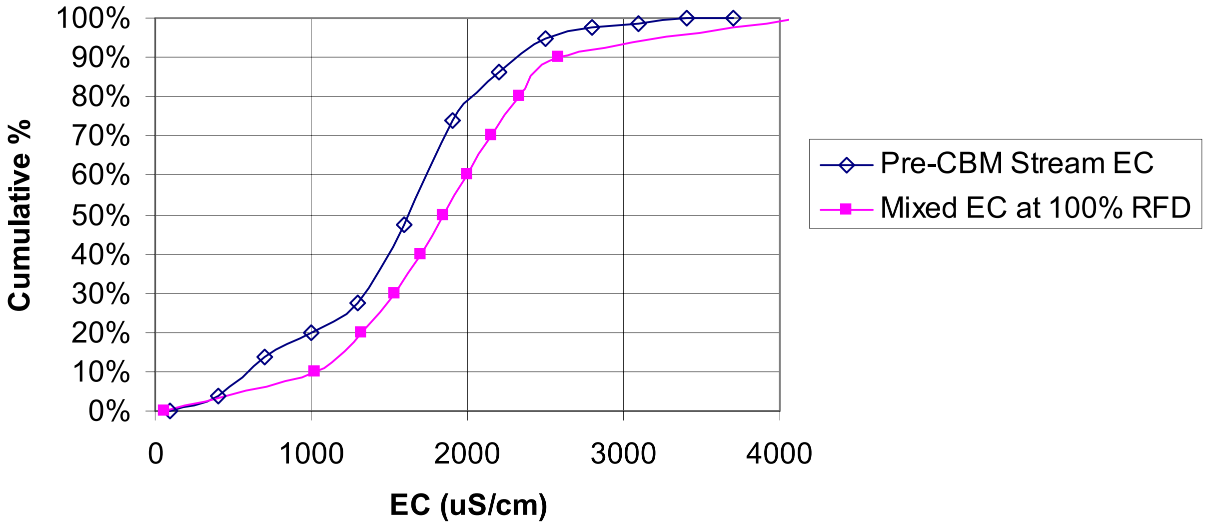


Figure M
Powder River at Moorhead (Post 1990)
Monte Carlo Distribution of Flows with EC < 1300 uS/cm

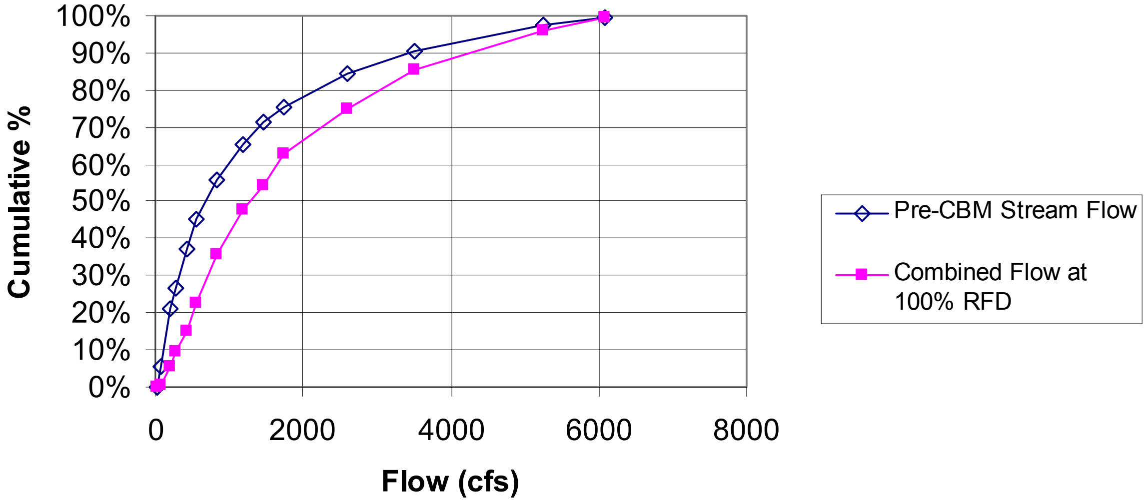
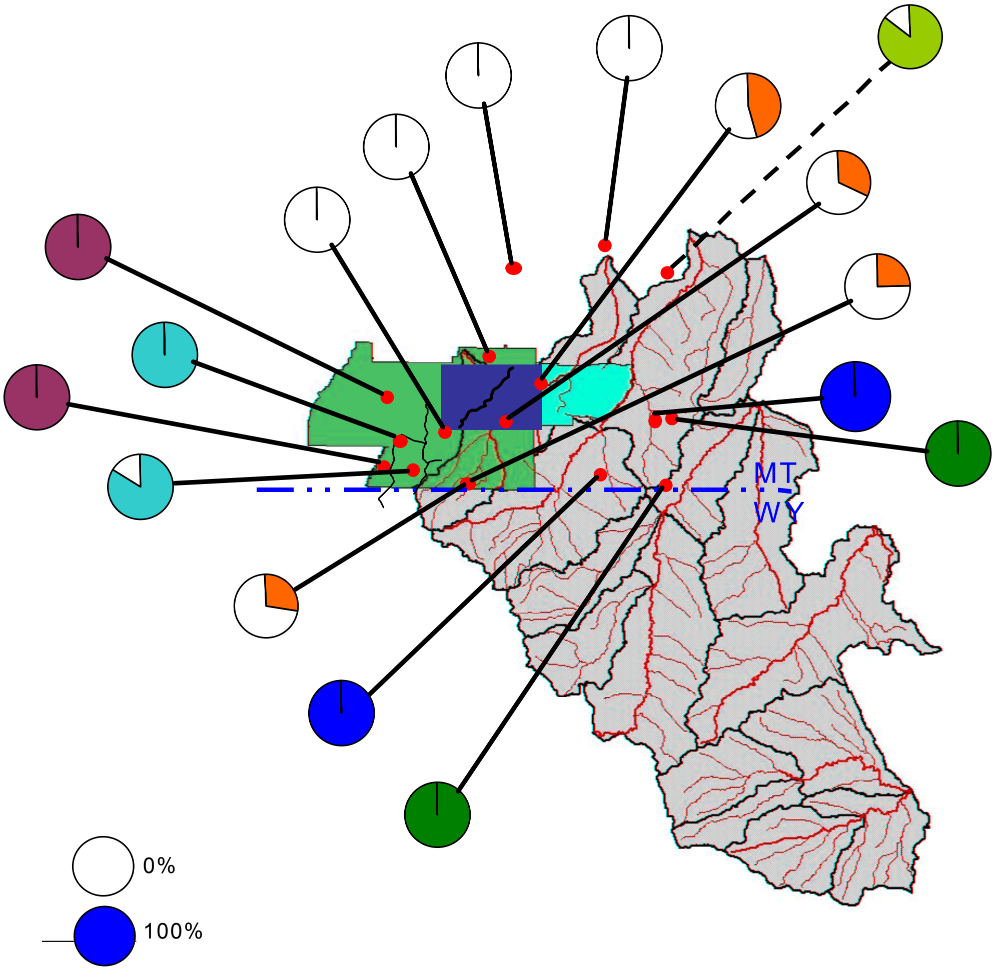


Figure N
Limits on CBM Discharge and Number of Wells

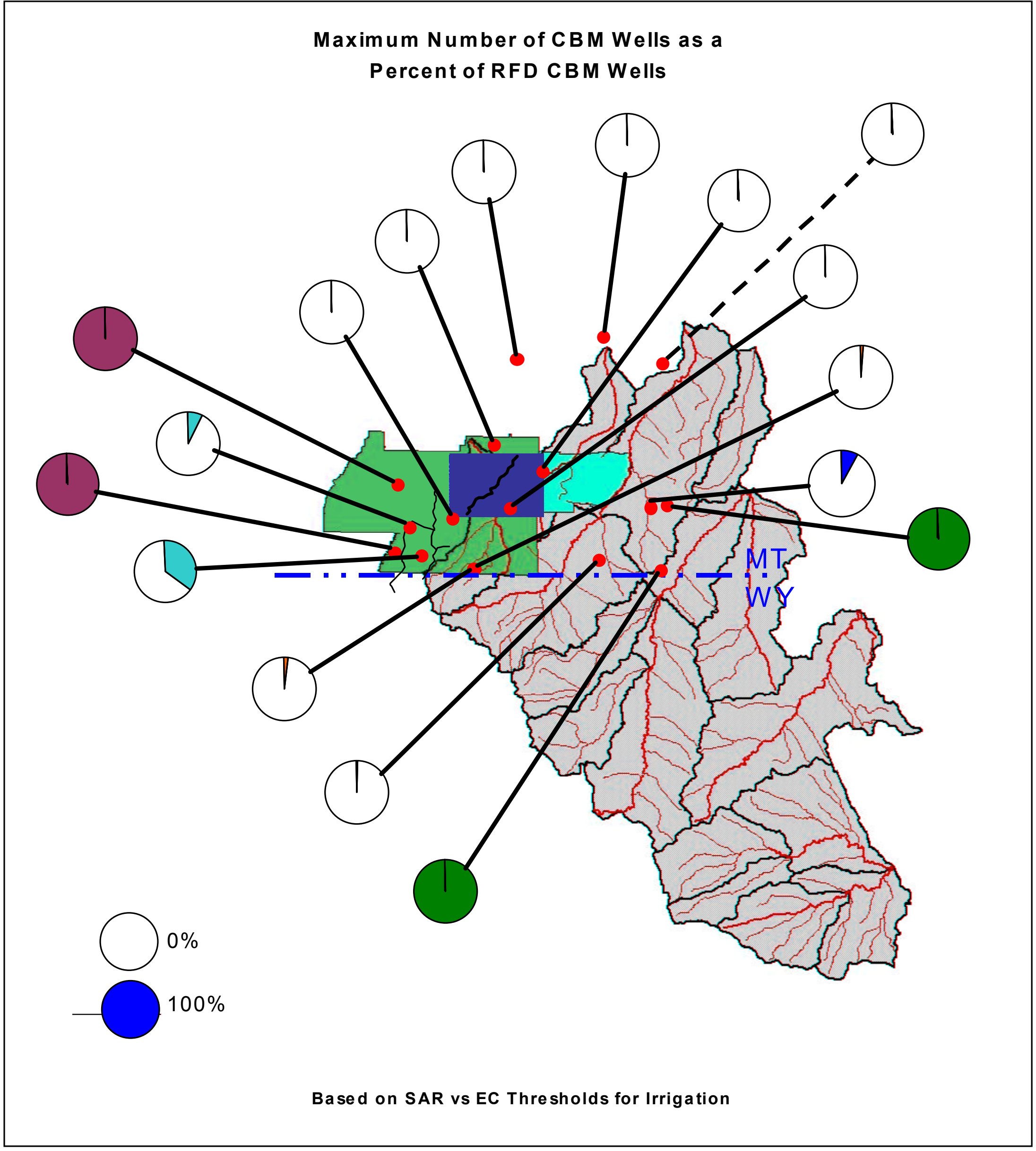
Based on EPA Impact Analysis with Irrigation Season Low Monthly Mean Flows

Maximum Number of CBM Wells as a Percent of RFD CBM Wells



Based on SAR vs EC Thresholds for Irrigation

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. ANALYSIS OF IMPACTS TO IRRIGATED AGRICULTURE AND RIPARIAN PLANTS

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.

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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.

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 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 29 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 32) 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 25-27, 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% EC_e	100% EC_w	90% EC_e	90% EC_w	75% EC_e	75% EC_w	50% EC_e	50% EC_w	0% "maximum"[3] EC_e	0% "maximum"[3] 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 29 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.

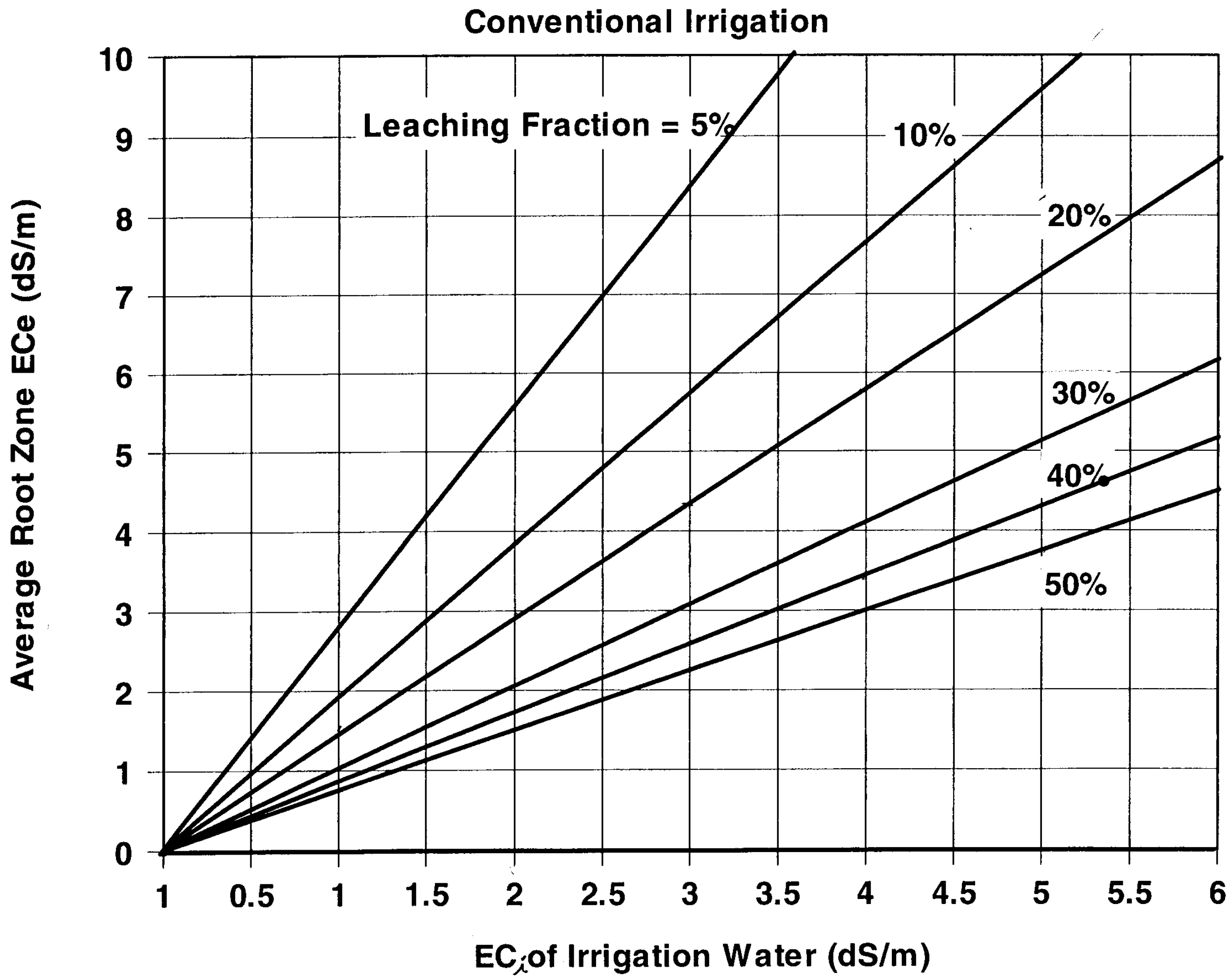

Figure 1. Assessing the maintenance leaching fraction under conventional irrigation methods.

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.

<u>Development of salinity threshold values</u>

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 29.

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.

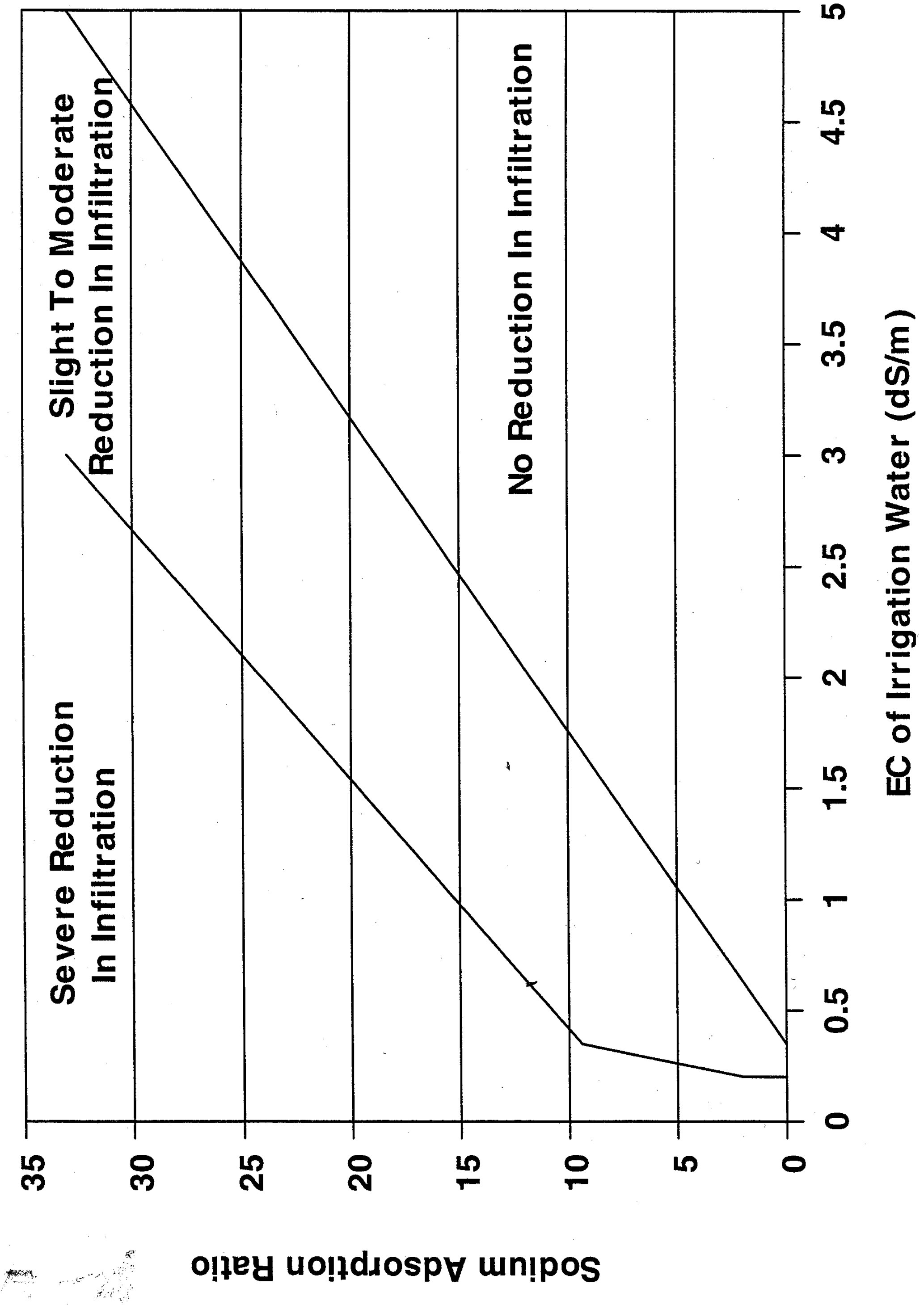

Figure 3. Assessing the effect of salinity and sodium adsorption ratio on infiltration rate.

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. COMMENTS ON THE GROUND-WATER FLOW MODELING REPORT

Ground-water Flow Modeling General Discussion

The comments under this section refer to the Ground-Water Technical Report.

The ground-water flow model developed for use in evaluating the CBM development alternatives was a 17-layer, three-dimensional MODFLOW simulation using steady-state and transient-state calibrations. The transient-state calibration was adapted and used in an attempt to predict the impacts of the various CBM development scenarios on the ground-water flow systems while the steady-state calibration looked to be only for assistance in developing the transient-state calibration. The model grid has 377 rows and 259 columns for a maximum of 97,643 cells per layer. With data sets for multiple input parameters for each layer, the magnitude of this modeling effort was enormous. There are a number of issues that developed in reviewing the modeling efforts discussed in the report.

It appears the 17-layer model may have been based on the conceptual model of the hydrogeology of the Powder River Basin and, in particular, the available field data for development of a numerical model. Based on the information provided in this report, a number of model layers had little to no actual field data available for model input parameters. When such is the case, it is best to simplify the numerical model to the extent possible rather than expanding the modeling effort with estimated data sets.

In specific regard to the use of 17 layers a major question was the fact that confining layers – siltstone/claystone units – are established in the model as layers 3, 5, 7, 9, 11, 13, and 15 (see Table 4-2). MODFLOW allows for confining layers to be simulated through a vertical conductance term that is input as an array with the data sets for the (aquifer) layer that overlies a confining layer. In this case, there were potentially 683,501 cells (7 layers x 97,643 cells/layer) requiring multiple input data sets for these confining layers. We are uncertain what field data existed for any model input parameters, aside from vertical hydraulic conductivity, for any of these nodes. Following standard numerical modeling protocols, the confining layers should have been simulated through the vertical conductance term that is assigned to other model (ie., aquifer) layers. This approach would have reduced the numerical model to a still formidable 10 layers.

A glance at Figure 5-1 of the subject report shows the monitoring well network over the Wyoming Powder River Basin that was utilized in the model calibration process; there are less than 100 stations depicted with some of these having multiple wells to monitor the various coal and sand units. Averaged over the model domain, there was one monitoring station for about every 1000 cells of the model; it appears that actual field data was in short supply here. The only water-level data provided in the report are for the upper Fort Union coal (see Figure 2-3), which in the numerical model consists of up to 4 layers (see Table 4-2). However, in reviewing Table 2-2 of the report, it is difficult to determine what this data really represents – potentiometric surface of the uppermost coal seam, potentiometric surface of multiple coal seams averaged within monitoring wells completed over multiple seams, potentiometric surface of multiple coal seams from various monitoring wells completed within a given seam, etc. No evidence is given in the report that starting head data for any of the other layers that are represented in the numerical model existed. As such, the model calibration focused only on the upper Fort Union coals, while predictive simulations also considered potential impacts from CBM development to the Wasatch sands.

No information is provided regarding calibration of the model to a water balance developed for the Powder River Basin. With the limited field data available for the various model layers, some attempt should have been made to calibrate the model to estimated basin outflows. Without such efforts, the calibrated hydrogeologic parameters may not fall within the realm of actual field values. This concern is exacerbated in the transient-state simulations as the storativity values have a major impact in predictive simulations.

While in the course of developing a 17-layer numerical model with limited data, the modelers took various changes in course in regard to detail verses simplicity. For example, the effort to establish the various geologic units within the Powder River Basin as layers in the model started well; as much accuracy was used in establishing the land surface as the uppermost datum from extrapolation of USGS DEMs for the area. After that, all efforts in this aspect of the model exercise became very conceptual as the thicknesses assigned to the various model layers seemed generic. Aside from the thicknesses of coals which were based on numerous study results, no hydrogeologic data was provided for the other model layers to confirm whether the thicknesses assigned are close to actual minimum, average, and/or maximum values for the actual formations in the Powder River Basin. Contradictions in effort of such variety were numerous in the numerical model development process.

Another interesting attempt in model development was in regard to the sands of the Wasatch Formation. It is reasonable based on the conceptual model of the geology of the Powder River Basin to attempt to assign hydrogeologic parameters representative of mixed sandstones and siltstones/claystones to Wasatch discontinuous sand layers. However, the coal seams can be thin and in diverse, discontinuous layers. Based on the cross-sections in Appendix A, the idea of four seams as presented in the report is misleading as there are a number of thin coal layers merging into thicker coal layers with primarily claystones and siltstones adjacent to the coal seams at pinchouts. However, there was no attempt made to model this complex hydrogeological setting; in fact, the coals hydrogeology was simplified in the modeling efforts. The coal seams are the units for which the greatest amount of data was available and there was no indication in the report that information was available to model the Wasatch sands with intermixed siltstones/claystones as attempted. The modeling approach is questioned since data were available to more realistically model the coal seams.

Two factors will have a major influence on how the coals seams respond to stress in various areas with in the Powder River Basin. The coals are said to have significant fracture porosity and as such ground-water flow will be anisotropic; media with secondary porosity also tend to have less storage capacity. This would raise the potential for dewatering which is said to be occurring in the Marquiss CBM field (see Section 6.3.1). Also, the coal seams are discontinuous in nature and look to pinchout primarily into claystone/siltstone units in areas. As such, the impacts of extraction of ground water from the coals can cause significant drawdown of the potentiometric surface due to these combined hydrogeologic properties of the units. If a coal seam is discontinuous and pinchouts into a lower permeability unit, then the effective drawdown on the potentiometric surface would increase due to an impermeable boundary condition. Neither of the conditions stated here have been taken into account in the modeling efforts and it is unknown if this is possible.

Ground-water Flow Model Summary

With a minor monitoring network that looks to focus on the upper Fort Union coals, there is a need to simplify the other layers to the extent possible and, aside from the confining layers issue addressed above, this seems to have been the case here. Such a conceptual model is best applied for use in predictive simulations where the relative differences between the effects of various development scenarios on the ground-water flow systems are compared. However, the numerical model developed here was used as a tool in an attempt to project the impacts of various CBM development alternatives and quantitative projections of drawdown on the potentiometric surface of various model layers are provided in this report and the Draft EIS. Also, projections are made as to the recovery of stated drawdowns post-CBM development. In regard to evaluating the potential impacts in a relative sense between development alternatives, no such effort is provided as the model projects minimal differences between the four CBM development alternatives according to the report and the Draft EIS.

Ground-water flow modeling is a tool with limited usefulness in regard to 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 of the results of modeling simulations to evaluate various scenarios.

The numerical modeling work performed to date for the Powder River Basin are very conceptual in nature due to limited data for numerical model development. The resulting estimates of impacts due to proposed ground-water extraction from CBM development are presented as quantitative predictions. These predictions can be confusing to the public who might believe that a greater level of confidence can be applied to the results of a computer-generated projection as presented on a colorful figure when in fact only ground-water monitoring over time can accurately assess the impacts of the proposed CBM development.

For comparison the Montana Draft EIS provides a simple quantitative estimate of ground-water depletion in the Upper Tongue watershed based on conceptual estimates of ground water in storage in the coals and projected CBM extraction rates. With the conceptual level of data available for the Powder River Basin ground-water systems aside possibly from the coals, such depletion estimates may be the best attainable quantitative projections for presentation in the Draft EISs. This provides an estimated depletion within an aquifer (sub-basin) area which can be used to prioritize monitoring and/or mitigation efforts

To accomplish such projections, an approach might be as follows:

1) Development of a conceptual model of the overall ground-water system in the Powder River Basin in Montana and Wyoming. A key element of this conceptual model would be to correlate the coals seams to the extent possible throughout the Basin and determine the interconnections between potential and/or proposed CBM development areas on either side of the state line.

2) Development of a conceptual water budget for the entire Powder River Basin. Once again, much of this effort may be complete for some areas of the Basin but a full-scale assessment is needed. A key component of the water budget is the regional ground-water flow from the Wyoming portion of the Powder River Basin into Montana and what the ultimate fate of this flow might be.

3) Assessment of all ground-water monitoring data and all aquifer testing data available over the entire Powder River Basin to determine the interconnectivity of the hydrogeologic units potentially impacted by extraction of ground water from the coal seams at various locations within the Powder River Basin. This assessment would demonstrate to the extent possible whether adjacent units would be affected and could be used to assign a potential risk to adjacent units where potential impacts may affect water users.

4) Assessment of all ground-water data and all aquifer testing data for the coal seams 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 on the overall water budget and assign a risk to the sub-basins for monitoring/mitigation efforts.

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

6) Development of triggers to enact mitigation measures should CBM development result in impacts to water users and to ecological resources (eg., springs, surface water, etc.).

IV. SPECIFIC COMMENTS ON THE GROUND-WATER TECHNICAL REPORT

Section 2.3.2, Page 2-13 – "A significant portion of deeper ground-water flow in the Powder River Basin probably discharges farther north, into the Yellowstone River drainage basin." This reiterates reason for the need to evaluate the Powder River Basin as a whole, both conceptually and quantitatively for proposed CBM development in Wyoming and Montana.

Section 2.3.2, Page 2-17, Figure 2-4 – What are the huge drawdown areas in the western portion of the figure attributed to?

Section 4.4, Pages 4-4 to 4-10 – The thicknesses assigned to the various model layers are very generic. Aside from the thicknesses of coals which were based on study results, no hydrogeologic data is provided for the other layers to confirm whether the thicknesses assigned are close to actual minimum, average, and/or maximum values for these formations in the Powder River Basin. This is an extremely conceptual approach. Also, in using this approach, how were the dips of the various basin geologic units reflected in the model? All cross sections, especially those provided for the coal seams in Section 2 and Appendix A, show dips from east to west across the Basin.

Section 4.4, Pages 4-4 & 4-9 – It is reasonable based on the conceptual model of the geology of the Powder River Basin to attempt to assign hydrogeologic parameters representative of mixed sandstones and siltstones/claystones to Wasatch Formation discontinuous sand layers. However, the coal seams can be thin and in diverse, discontinuous layers. There are a number of thin layers merging into thick layers with primarily claystones and siltstones adjacent to the coal seams at pinchouts.

Section 4.4, Table 4-2 – Confining layers – siltstone/claystone units – are established in the model as layers 3, 5, 7, 9, 11, 13, and 15. MODFLOW allows for confining layers to be simulated through a vertical conductance term that is input as an array with the data sets for the overlying layer. The reason for modeling confining layers, which tend to have minimal hydraulic data collected aside from (possibly) vertical hydraulic conductivity, as a distinct layer is unclear. In this case, there were potentially 683,501 nodes (7 layers x 97,643 nodes/layer) requiring multiple input data sets for these confining layers. It is questioned as to whether any field data existed for model input parameters for any of these nodes. The confining layers should have been simulated through the vertical conductance term that can be assigned to other model layers; this would have reduced the model to a still formidable 10 layers.

Section 4.4, Page 4-9 – For the coals where field data show merging of seams, this thick coal was defined equally over multiple model layers. This approach is questioned. MODFLOW allows for model cells to be set as inactive (ie., a no-flow boundary condition) where layers do not exist (ie. pinchout, outcrop, merge, etc.). Why was this more realistic approach not employed here where the coal seams merged? What numerical concerns developed in model convergence due to setting coal parameters in layers 9 and 11 (confining units) in cells adjacent to confining unit parameters? Once again, this modeling approach is questioned.

Section 4.4, Page 4-10 – The discussion describing model issues with outcropping basin formations is questioned. MODFLOW allows for cells to be set as inactive. Where a layer (geologic unit) outcrops, boundary conditions can be established in the cells at this location within the model grid and adjacent cells where the layer no longer exists can be set as inactive. Was this modeling approach not employed here? The discussion in Section 4.5.1 suggests that it was. If this is so, the entire discussion here regarding thicknesses in the model layers is not clear. If model cells for a given layer are established as inactive, it is only the active cells adjacent to the boundary and within the model that would have thicknesses assigned to them and this would be done in an input data set, not assigned in some manner by the model.

Section 4.5.1, Page 4-15 – Why were "no-flow cells designated in river areas, especially where the river elevation was below the base of any given layer"? We understand that in such conditions, the unit simulated by a given layer had ceased to exist and boundary conditions would need to be established in the area of pinchout.

Section 4.5.2, Pages 4-15 & 4-16, Figure 4-5 – Recharge looks to be input areally into layer 1 within the given sub-basins defined on the figure. However, in Alternative 1 – the only alternative for which modeling simulation results are fully discussed in the Draft EIS – the range of recharge via surface discharge is from 23 to 49 percent. This surface discharge would occur to defined drainages within each of the sub-basins. Is it appropriate to assign such magnitudes of recharge over the entire sub-basin when it probably would occur through seepage along the various defined drainages? What effects would such seepage from drainages have on shallow ground-water flow and possible discharge to downgradient drainages versus the input of areal recharge over a sub-basin?

Section 4.5.5, Page 4-22 – The logic behind assigning CBM wells as drains is reasonable. However, the magnitude of ground-water flow to and out of the drains would be based in part on the gradient between the cell hydraulic heads and the assigned elevation of the drain. The drain elevation was "set at about 50 feet above the top elevation of the coal unit being developed." What is the basis for this datum? How do the drain discharge rates at various times in model simulation (ie., CBM development) compare with industry-projected ground-water extraction rates? What if the potentiometric surface for a given cell during predictive simulations declines below the set elevation of the drain? Please consider that the elevation of the drains should be calibrated based on some reasonable rate of ground-water extraction at various times in CBM development.

Section 4.6, General – There is considerable exchange of units within the discussion of aquifers properties. It is recommended to use either English or metric units and not switch between.

Section 4.6.1, Page 4-32 – How were the range of vertical permeability values used in the model based primarily on matching to steady-state and transient-state conditions.

Section 4.6.2, Page 4-32 – The lack of reliable data on storage coefficients for the units within the Powder River Basin adds concern to the reliability of the model developed.

Section 5.1, Page 5-1 – "Evaluate the overall global water balance to assess if the model reasonably predicts flow into and out of the system." No such evaluation is provided. This omission coupled with no discussion on calibration of the models for any units other than the upper Fort Union Formation leaves doubt into the reasonableness of the calibrated models.

Section 5.1.1, Pages 5-1 to 5-7 – Why is the upper Fort Union Formation cited here and in the figures as the potentiometric surface calibrated in the model defined? The upper Fort Union Formation consists of (at least) seven of the model layers based on Table 4-2. Which layer is the target layer for model calibration? What were the starting heads employed for each upper Fort Union layer and how was this determined? What about the other ten layers? Were any calibration targets established based on field data and accomplished in the modeling for any of the other layers? In the Draft EIS significant discussions are provided regarding the potential impacts from CBM development to the deep sands of the Wasatch Formation; there is no indication provided in the report that there were either starting head data based on field values or calibration targets for this layer. Therefore, the model projections for the other units look to be questionable and potentially unuseable.

Section 5.1.2, Page 5-7 – A steady-state calibration was accomplished and said to be within reason based on historical data for the upper Fort Union Formation. Why then during transient-state calibration would the hydraulic conductivities be altered when there was a comfort with this parameter in the steady-state calibration? It would be best to hold the hydraulic conductivities as defined by the steady-state calibration and for the transient-state calibration alter recharge – an annually changeable term – and storativity – which has a lack of reliable data for this calibration. There seem to be too many calibration parameters in the transient-state model.

Section 5.1.3, Page 5-13 – The drain elevation was set at about 50 feet above the top elevation of the coal unit being developed. What is the basis for this datum? How do the drain discharge rates at various times in model simulation (ie., CBM development) compare with industry-projected ground-water extraction rates? What if the potentiometric surface for a given cell during predictive simulations declines below the set elevation of the drain? The use of drains is reasonable in concept but one would think that the elevation of the drains should be calibrated based on some reasonable rate of ground-water extraction at various times in CBM development. Based on this discussion, the 50 feet above the coal unit value was set and not altered.

Section 6.0, Page 6-1 – "The primary purpose of the numerical flow modeling was to project the ground-water impacts of the CBM development in the Powder River Basin." "Modeling was necessary because of the large extent and variability of the cumulative stresses imposed by mining and CBM development on the aquifer units of the Powder River Basin." Both of these statements infer that the modeling was done to look at the impacts within the entire Powder River Basin. However, as stated above, there is no indication that the models developed and calibrated were done so with concern for any aquifers besides the upper Fort Union Formation coals.

Section 6.2.2, Page 6-16 – The magnitude of recovery of water levels in the coals will be based on a number of factors. The coals are fractured and have anisotropic flow patterns; fractured media do not tend to have storage capacities of the magnitude inferred here. The magnitude of ground water projected to be withdrawn during CBM development is great (totaling > 4 million acre-feet). The alternatives evaluated assume a recharge rate of 55 to 67 percent of the ground water withdrawn. However, recharge will occur to shallow ground-water resources and will take decades to centuries (if ever) to provide significant recharge to the coals at depth. Even with such recharge over time, the deficit in the water budget based on the loss of 33 to 45 percent (or more) of the ground water produced will result in overall declines in hydraulic heads. A change in climatic conditions resulting in an increase in recharge rates from precipitation will be the only factor that can result in rebound approaching pre-development conditions.

All other sections of the Technical Report (except Chapter 8 and 9) are included verbatim in the Draft EIS and specific comments were previously provided on that document; Chapters 8 and 9 were not reviewed due to time constraints and lack of citation of this information in the Draft EIS.

V. DRAFT EIS GROUND-WATER COMMENTS

Chapter 2, Page 2-42 – What is the areal coverage considered in developing the ground-water monitoring network (ie., "x" monitoring well pairs within "y" square miles, etc)? The figures provided in Chapter 4 show little to no coverage in many areas in the Powder River Basin. How is a determination made as to how many monitoring well pairs are necessary within a given development area? Should an effort be made to place monitoring wells in different basin hydrologic settings?

Chapter 3, Page 3-1 – "Coal aquifers in the Powder River Basin contain significant secondary porosity." As such, these units will respond to stress as a fractured media and will tend to have anisotropic flow patterns – the degree of fracturing has a role in the level of anisotropy verse behavior as a porous media. Ground-water flow modeling using MODFLOW may underestimate
the effects of ground-water withdrawls on the potentiometric surface within the coals as flow is

anisotropic and ground-water storage in a fractured media is limited.

Chapter 3, Pages 3-9 & 3-10 – The discussion regarding water yields from the various units is confusing. Wide ranges of well yields are provided (eg., 3 gpm up to 500 gpm). On page 3-10 water yields from the Lebo confining layer of 10 gpm are mentioned followed by yields from the Tullock aquifer of less than 10 gpm where confined. This discussion brings into question the effectiveness of the Lebo confining layer; what type of confining layer is this when it yields 10 gpm as does the underlying Tullock aquifer? The general impression provided by the geology/hydrogeology discussion to this point is that the Lebo unit will isolate the underlying hydrogeologic units from any impacts due to methane (and water) production within the overlying Fort Union coals. Is this a correct assessment since this discussion on water yields raises doubts on the confining effectiveness of the Lebo unit? Also, what are the ranges of values for the various hydraulic parameters for these geologic units? Water yields are not a common method of describing the hydraulic aspects of an aquifer as they are highly dependent on well design, construction, and usage. The Draft EIS does not provide any values for the hydraulic parameters for the geologic units of concern.

Chapter 4, Pages 4-1 & 4-2 – This write-up on expected impacts to hydraulic heads has some statements that are questionable. The impact to hydraulic heads due to the potential vertical leakage of ground water from sands overlying and/or underlying the coal units are expected to be minimized due to potential recharge from infiltrated production waters. However, the potential recharge by infiltrated production waters to lower units over the time of development may be limited due to the impeding effects of overlying confining units (see discussion on Page 4-4). After development, some rebound in confined coal units should be rapid to an extent but could be much slower in overlying and/or underlying units depending on the nature of the confining layers and the storativity of the sands (see discussion on Pages 4-4 & 4-7). Because of the magnitude of water withdrawls proposed, the pre-development water balance within the Basin will be dramatically altered; the potential effects of CBM development within the ground-water systems in the Powder River Basin are not fully addressed in this write-up.

Chapter 4, Page 4-3 – For the studies performed to look at conveyance losses within stream courses with produced water, were any estimates of loss made during the winter season when ET is not occurring and soil temperatures are lower? In the modeling efforts was the flow model designed such that a portion of the conveyance losses could eventually move with shallow ground-water flow and discharge to surface-water bodies if a flow gradient was established with time? Such a situation is being considered in evaluation in the Montana Powder River Basin Draft EIS.

Chapter 4, Page 4-3 – For the infiltration rate of 8 ft/yr or 0.26 in/d, is this value reasonable based on the final infiltration capacities for typical soils found in the Powder River Basin?

Chapter 4, Page 4-4 – Please explain why it is valid to assume that injection would be only to deeper units? With the costs involved, why would only deeper units be looked at as reservoirs for injection? Have any geologic units with capacity for injection been identified?

Chapter 4, Page 4-10 –.If standing water develops in areas and causes adverse impacts to land usage, what mitigation measures will be employed to alleviate this disruption of land use? Also, what would be the ultimate fate of any wetland areas developed through the discharge of production water once development ceases? Finally, what measures can be put in place to assist the City of Gillette in dealing with potential increases in ground water within the Donkey Creek alluvium? These are potential impacts that can have a negative effect on human and/or ecological resources and should be under consideration for the development and implementation of mitigation measures.

Chapter 4, Page 4-12 – The figure cited in the text as Figure 4-5 does not provide water-level recovery data over time as stated here; Figure 4-4 provides this model projected information for four monitoring wells. Is Figure 4-4 the correct figure for this citation ? Also, what is the source of the water that will allow for recovery from development conditions to within 95% (20 feet) of pre-development conditions? In no case (see Table 4-1) is the recharge rate of production water to the ground-water system greater than 75% during development and this recharge is introduced to shallow ground-water resources with vertical migration limited. With this rate occurring only during the development period and the onset of “normal” conditions post-development, one would anticipate a significant deficit in the post-development water budget to result.

Chapter 4, Page 4-18 – Figure 4-4 shows the projected drawdown with time for monitoring wells AHA and MP22C. Are these the monitoring wells in the Caballo Creek area? There seems to be some confusion regarding this figure.

Chapter 4, Page 4-23 – Figure 4-10 shows projected water-level changes in the deep Wasatch sands in year 2030, not 100 years following production. The drawdowns shown over large areas of the development area in the figure far exceed those discussed in the text here (ie., >50 feet on the figure verse <50 feet in the text) for this time period following production.

Chapter 4, Page 4-24 – Full recovery of water levels in the deep Wasatch sands, even after many years is not expected due to the amount of water removed from the ground-water systems over the development period. In no case (see Table 4-1) is the recharge rate of production water to the ground-water system greater than 75% during development. With this rate occurring only during the development period to the shallow ground-water system and the onset of “normal” conditions post-development, one would anticipate a significant deficit in the post-development water budget to result.

Chapter 4, Page 4-29 – Will routine methane monitoring be required in the instances suggested here (ie., wells within two miles of development areas)?

Chapter 4, Page 4-31 – “The ground-water resources of the Powder River Basin are vast.” Have estimates been performed comparing the total usable ground water in the basin verse the amount to be withdrawn during this development? The Montana Powder River Basin Draft EIS provides such an estimate. It is recommended that estimates be made of the sustainability limits of the ground-water resources within the basin. With the magnitude of the overall ground-water production for this development, some term within the basin water budget will be negatively impacted for the long term.

Chapter 4, Page 4-32 – The ground-water discharge to the Powder River could be terminated for some time due to the removal of water from the ground-water systems. In many areas of the West, ground-water development has resulted in declines in the potentiometric surface such that artesian wells have ceased to flow and springs have dried up. There is no guarantee that the potentiometric surface will reestablish to the present conditions that provide this ground-water discharge to the Powder River in a short time after development ceases. Once development is through, the loss of this water will no longer be made up by discharges from production wells into the watershed. The lag time for the ground-water systems to re-establish this discharge may be long (if ever).

Chapter 4, Page 4-33 – If standing water develops in areas and causes adverse impacts to land usage, what mitigation measures will be employed to alleviate this disruption of land use? Also, what would be the ultimate fate of any wetland areas developed through the discharge of production water once development ceases? These are potential impacts that can have a negative effect on human and/or ecological resources and should be under consideration for the development and implementation of mitigation measures.

Chapter 4, Page 4-37 – The potential drawdowns from production within discontinuous coal seams simulated by the predictive ground-water flow model as continuous could potentially be greater in magnitude and, as such, cause more effects within overlying and/or underlying sand units. Depending on the relative hydraulic conductivity of the adjacent units at pinchout zones, the boundary effects within the coal seams will be either impermeable or recharge in nature. If the boundaries tend to be impermeable, then the drawdowns will be of greater magnitude within the coal seams. Conversely, if the boundaries are recharge units, the opposite could occur. Adding together questions regarding the boundary conditions of pinchouts, the fractured nature of the coals, and the limited field data, the numerical modeling performed is but a simplistic model of the ground-water systems within the Powder River Basin.

Chapter 4, Page 4-38 – Complete recovery of water levels may never fully occur due to the changes production will induce within the ground-water systems. Also, ground-water discharge to the Powder River may be negatively affected for the long term as the potentiometric surface is depressed and there will be no additions to river flow through surface discharges in the area to augment this loss after CBM production is terminated.

VI. DRAFT EIS AIR QUALITY COMMENTS

General Comments

The air quality analysis contains extensive information on the types and amounts of air emissions and their resulting impacts to health and the environment. References to “reasonable but conservative” air quality impacts may be misleading to the public and the decision-maker. For EIS’s, the most likely scenario for each alternative should be analyzed so that the public can make meaningful comments, and the decision-maker will have the best analytical data upon which to make a decision. Statements such as “... predicted impacts represent an upper estimate of potential air quality impacts which are unlikely to actually be reached” and “All emission sources were assumed to operate at their reasonably foreseeable maximum emission rates simultaneously throughout the life of the project” do not give the decision-maker a basis on which to compare and evaluate the significant environmental impacts from each alternative presented in the EIS. Modeling maximum potential emission rates are required for new source review permitting whereas the NEPA analysis should represent an emission rate that will likely occur. The report should identify the ranges of uncertainty in emissions/modeling calculations as well as "best estimates."

PM-10 Impacts

The report identifies the maximum impact of construction as 97 ug/m3, which is the sum of a 42 ug/m3 background plus 55 ug/m3 of new impact (see page 44 of the Air Report). This calculation is performed for a receptor 200 meters from the road. Since one would expect much high concentrations closer to the road, why was the model receptor placed so far away? Current measured PM_{10} concentrations in the area are in excess of 200 ug/m3; thus, it appears that the report is underestimating potential impacts. There are a number of uncertainties in the estimation of effects including activity and emissions factors and air quality modeling. The report should identify the ranges of uncertainty in emissions/modeling calculations as well as "best estimates."

Impacts on Regional Visibility

The number of days per year that visibility is impacted at several sensitive receptors is calculated using both "screening" and "refined" procedures. (The refined procedures are never described.) The results are summarized in Tables 7-9 and 7-10 on pages 55 and 57 of the Air Report. The impacts are potentially large: 63 days with deciview impacts greater than 1 (10% change in visual range or light extinction coefficient) for Wind Cave National Park, a mandatory Class I area. (This impact reduces to 4 days per year with the undefined refined analysis.) The level of acceptable change (LAC) is never defined, although 0.5 and 1.0 deciview values are discussed. Impacts at Northern Cheyenne Indian Reservation, an area redesignated as PSD Class I in 1977, are also large: 54 days with dv > 1 (10 days with the refined analysis). The worst impacts occur at close-in and downwind Devil's Tower National Monument, which is PSD Class II, but with unique scenic beauty. Here the regional haze impacts are estimated to be 139 days with dv > 1 (12 days with the refined analysis). The nearly order of magnitude difference between the screening and refined analysis needs to be explained. Both analyses show impacts above the LAC. The refined analysis is not documented, verified with field data, or apparently consistent with the protocol adopted by Federal Land Managers (FLM) for Class I areas.

Regional Haze Goal

As summarized above, the predicted visibility impacts of the proposed development are quite large. However, even if impacts were never greater than 1 dv, significant impacts might occur if the State of Wyoming could not demonstrate that reasonable progress was not being made toward the nation's regional haze goal, codified in EPAs regional haze regulations. This goal includes a "glide path" determined by the state for the first planning period (2003-2018) that will, if extrapolated, achieve natural conditions in 2063. This goal requires a 25% reduction in human caused regional haze within the first of four 15-year planning periods. Certainly an increase in haze is not consistent with the regional haze rule. Thus, new growth in emissions would have to be offset by the control of existing regional sources so that the regional haze would be improved. The report does not demonstrate how these offsets will be achieved.

Plume Blight

The proposed action would involve large new emissions of NOx, a gas which converts in the atmosphere to yellow-brown NO2, which causes a "blight." Such brownish hazes can be observed in urban areas and downwind of large power plants (or large ANFO explosions in the Powder River Basin). The proposed action would result in an annual release of 14,414 tons of NOx (when averaged over the 10-year period). This is the equivalent of what a large coal-fired power plant (900 MWe) emits. It is also 10% of the NOx emissions from the entire Denver metropolitan area (EPA AIRS, 1999). Projected NO2 concentrations > 4 ug/m3 over at least a 100-km swath (see Figure 7-1, page 43) are also about 10% of annual average NO2 measured in Adams County (in the metro Denver area). On the basis of this and because emissions will occur close to the ground where the air is relatively stable, I believe that yellow-brown atmospheric discoloration (plume blight) will be observed over the development area, especially on clear, calm, and stable mornings. Plume blight impacts result from an integrated effect: NO2 concentration times the length of the line of sight affected. Thus, even though emissions are distributed over a wide area, significant effects can be observed. Plume blight may also be visible 50-100 km away from the development area.

Specific Comments:

1. Page. 3-54, Existing Air Quality. This section needs to be revised to present the latest results from the PM_{10} monitoring sites run by several of the coal mines in the Powder River Basin. Over the last year, there have been numerous exceedances of the 24-hour PM_{10} standard recorded at several of these sites, such that several of the monitors are violating the Wyoming and National Ambient Air Quality Standards.

2. Figures 3-7 and 3-8, pages. 3-57 and 3-58. These figures are essential for an

understanding of the variability of visibility with respect to time.

3. Table 3-13, page. 356. Recommend that the term "Background Concentration" be defined.

4. Page. 4-101, Air Quality and Climate. Recommend that the section discussing impacts to the climate include a short paragraph stating that any development of oil and gas contributes to the release of greenhouse gas emissions both from the project itself and by the act of producing fuels that will ultimately be burned. Carbon dioxide and methane gas are the two largest global contributors to greenhouse gases which play a role in climate change.

5. Page. 4-102, Second full paragraph discussing permitting of facilities. The individual compressors associated with CBM development will not be permitted as PSD sources. However, their cumulative impact would have to be considered in the permitting of other PSD major sources in the Powder River Basin. The CBM cumulative emissions would have to be tracked as part of the PSD increment consumption analysis for other development in the region.

6. Page. 4-102, Third paragraph discussing the technical support document. Recommend that a sentence be added at the end of the paragraph stating that the technical support document presents the types and magnitude of impacts that can be expected from the development of the Powder River Basin. By weighing public comments and reviewing the cost/benefits of mitigation, the decision maker can recommend allowable emissions resulting from the development of federal minerals.

7. The statements on page. 4-103 and 4-107, "Significant air quality impacts would not occur under this Alternative", are unsubstantiated. Table 4-14 shows cumulative visibility impairments (visibility impacts greater than 1 deciview) of 1 to 10 days per year in Class I areas. The statement on the bottom of page. 4-111 states "... that a 1.0 deciview "just noticeable change" would be a reasonably foreseeable significant adverse impact, although there is no applicable state, tribal or Federal regulatory visibility standards." Even though there is no Federal visibility standard, the Regional Haze Rule does require each state to develop a "glide path" showing a 25% reduction in human caused regional haze within the first planning period of 2003 - 2018. This EIS is predicting just the opposite visibility trend, and therefore, these impacts are significant. In addition, under the FLAG protocol, Federal Land Managers consider significant visibility impairment at 1 deciview impairment more than 1 day per year.

8. Page. 4-103, Fourth paragraph. This paragraph states that the natural gas does not contain sulfur compounds which contradicts the third paragraph on page.100 which states that methane migration could affect soils by driving oxygen out and producing toxic levels of sulfur. Recommend that the sulfur issue be clarified.

9. Page. 4-103, Fifth paragraph. This paragraph should also discuss not only fugitive dust from construction activities, but also fugitive dust generated during production. The most efficient mitigation for fugitive dust from unpaved roads is to set and enforce the speed limits or to pave or gravel roads.

10. Page. 4-103, Alternative 1, fifth paragraph. "The control efficiency of the dust suppression was computed at 50 percent during construction. Are there other available practices that would improve dust suppression? Will this efficiency be stated in the Record of Decision?

11. Page. 4-107, Alternatives 2A and 2B. Recommend that the incremental costs of electrical compression (from traditional or renewable energy sources) versus natural gas compression be discussed in this section so that the public and the decision-maker can fairly evaluate these alternatives.

12. Page. 4-107, Table 4-11. This table lists $PM_{10}/PM_{2.5}$ with WAAQS for $PM_{2.5}$. If all of the emissions from a generator are expected to be in the $PM_{2.5}$ range, then this table could be simplified by removing the mention of PM_{10}.

14. Page. 4-108, Table 4-12. This table does not include the predicted concentrations of PM_{10} and $PM_{2.5}$ in Class I areas. This information is listed in the Technical Support Document and it should be listed in Table 4-12. This PM data should have also been included as input data for visibility modeling.

15. Page. 4-109, last sentence in first paragraph. Refer to comment #5 above.

16. Page. 4-112, Table 4-15. Recommend a footnote for the table indicating that impacts are listed according to the meteorology of the given year.

17. Page. 4-122, first paragraph. The cumulative analysis for all sources in the Powder River Basin predicted impacts below threshold limits. However, there was no information presented on the recent 24-hour PM_{10} standard violations, which would also likely contribute to PSD Class II increment consumption. Since the analysis does not predict these events, it appears that the cumulative analysis should be revised to include the data and revise the predictions in this section.

VII. COMMENTS ON POWDER RIVER BASIN AIR TECHNICAL SUPPORT DOCUMENT

1. The cumulative air quality impact analysis should have included the development of coal-bed methane in Montana. These sources in Montana are reasonably foreseeable.

2. For visibility impacts, the document does not define what the "level of acceptable change" or what is considered a significant impact to visibility. What are the

uncertainty bars for visibility impairment?

3. Appendix D's title is confusing. "Procedures for Predicting Maximum and Daily Visibility Impairment". Should the title be referring to "maximum daily visibility impairment"? Also, this section needs to do a better job of describing the "screening" and "refined" modeling analyses.

4. Due to the cumulative annual NO_x emissions of 14,414 tons/year, the air quality analysis should discuss the role of plume blight originating from a large number of sources of NO_x during periods of atmospheric stability. Nitrogen oxide is a gas which converts in the atmosphere to a yellow-brown NO_2, which causes a "blight." Such brownish hazes can be observed in urban areas and downwind of large power plants (or large ANFO explosions in the Powder River Basin). The proposed action would result in an annual release of 14,414 tons of NOx (when averaged over the 10-year period). Projected NO_2 concentrations $> 4\ \mu g/m^3$ over at least a 100-km swath (see Figure 7-1, page 43) are also about 10% of annual average NO_2 measured in Adams County (in the metro Denver area). On the basis of this analogy and because emissions will occur close to the ground where the air is relatively stable, some yellow-brown atmospheric discoloration (plume blight) will likely be observed over the development area, especially on clear, calm, and stable mornings. Plume blight impacts result from an integrated effect: NO_2 concentration times the length of the line of sight affected. Thus, even though emissions are distributed over a wide area, significant effects may be observed. Plume blight may also be visible 50-100 km away from the development area.

5. Wind roses are provided in Figure 4-3 (page 27 of the Air Report). We suggest adding wind roses (from MM4 calculations) for the center of the development region (and perhaps some of the key receptors, e.g., N. Cheyenne, Devils Tower, and Wind Cave.

6. Page 30, Table 4-5 is misleading. The table provides the distance from the center of the Project Area. A more useful distance would be the distance between the receptor and the closest boundary of the project area. Many receptors are very close to the project area.

7. Page. 35, paragraph starting with "Other CALPUFF...". Recommend deleting the word "rate" which implies an entity divided by time.

8. Page. 42, Table 7-1 provides model calculations of annual average NO_2 concentrations. Recommend that maps for the highest daily average NO_2 be included.

VIII. DRAFT EIS VEGETATION COMMENTS

General Comments

Nonnative Plants and Weed Control. Nonnative weeds and other plants may reduce biological diversity and threaten sensitive fish and wildlife species populations. Highly flammable weeds can alter natural fire regimes and fire itself can lead to the spread of native plants by disturbing soils adjacent to weed-infested areas. Managing and preventing invasive species problems on BLM lands, regional or nationwide will require specific practices and monitoring to prevent further degradation of forage and ecosystem functions. BLM data indicated that there were 8.5 million acres of BLM lands infested by noxious weeds in 1995, and affected acreage was expanding at the rate of 14% annually, or nearly 5,000 acres per day (based on information in Partners Against Weeds: An Action Plan for the Bureau of Land Management (January, 1996)). Data shows that acreage of noxious weeds quadrupled on public lands between 1985 and 1995 (www.sagebrushsea.org). Leafy spurge infests at least three million acres of rangeland and tamarisk represents a major threat to riparian woodlands throughout the Western United States. Cheatgrass is an extensively distributed noxious weed that creates risks of fire and results in the further spread of it and other noxious weeds. Spotted knapweed and other pervasive weeds are economically and environmentally damaging to BLM lands. Weeds should be prevented, controlled, and eradicated, following the goals and practices outlined in Partners Against Weeds.

EPA strongly supports preventive practices to avoid and/or eradicate nonnative weeds and other plants, including the commitment to control the causes of noxious plant invasions. Weeds usually are introduced on lands by soil disturbances from various land uses – livestock grazing; road building and associated land uses such as exploration and extraction of oil, gas, timber, and minerals; off-road vehicle use on both designated and (especially) unauthorized lands; logging and mining activities themselves; and other activities that disturb soils and/or introduce the seeds of plants into native ecosystems. Practices implemented to halt the spread of weeds without restricting activities that introduce and distribute nonnative plants are unlikely to succeed on a local or regional scale. Prevention of nonnative weeds is both cheaper and more effective than restoration practices, particularly in areas where land uses are allowed to continue that are incompatible with stated ecosystem protection and restoration goals.

Nonnative, palatable plant species for cattle and other livestock should not be introduced. Nonnative plants have been introduced for livestock forage and for environmental restoration and enhancement projects by State and Federal agencies and non-government organizations. Even well-intentioned introductions of nonnative plant species reduce biological productivity and can lead to serious degradation of ecosystems. We encourage BLM to use only plant species native to specific ecosystems for restoration and enhancement activities. EPA would be happy to further discuss the nonnative species for which we have concerns. For references about invasive weed species, please refer to the following resources: (1) Federal Interagency Committee for the Management of Noxious and Exotic Weeds document, Invasive Plants: Changing the Landscape of America, Fact Book (1998); and (2) BLM's Partners Against Weeds.

EPA encourages BLM to identify areas where noxious weeds are most prevalent and to set priorities for protection and restoration activities. Both local ecosystem objectives and landscape objectives should be supported by the Plan Amendment's decisions. Environmental challenges and opportunities should be identified along with the analyses that are necessary to establish human, fish and wildlife, and other priorities. Since the direct impacts to vegetation from roads and well pads will be very large, BLM should look at opportunities to get the oil and gas industry to help with other vegetation issues such as vegetation restoration in priority areas.

The Draft EIS should evaluate the efficacy of land management practices in protecting lands from noxious weeds and other nonnative plants and in restoring ecosystem functions in areas that previously have been degraded by nonnative species. Specific objectives are needed to provide the greatest human and fish and wildlife benefits. Address strategies to prevent all of the causes of noxious weed spread. These strategies should include the use of weed-free certified hay, weed-free certified fill for road repair, weed-free certified seed for replanting, and education and other strategies.

Consider all plants with the best available science to be invasive in ecosystems under BLM management, not merely those officially designated as "noxious weeds." A goal should be to minimize the use of herbicides on BLM lands and to use newer or less-damaging herbicides.

IX. DRAFT EIS WETLAND/RIPARIAN COMMENTS

General Comments

The Draft EIS projects 7,306 acres of wetland/riparian would be directly disturbed in the short-term. BLM predicts that 3,434 acres or about 1.4 percent of the total wetland/riparian vegetation would remain under a long-term disturbance. Long-term disturbance would remain over the life of the project. (page 4-133). BLM should further elaborate on how impacts to wetlands would be authorized.

The Executive Summary for the General Permit (GP) states " Issuance of GP 98-08 could result in temporary disturbance of 37 acres and filling of 73 acres of wetlands per year on an average if 1,152 gas wells, and 2,042 gas wells, and 34,560 CBM wells are completed in the next 5 years and if GP 98-08 is used for all authorizations." The executive Summary goes on to say; "The issuance of the GP 98-08 complies with the 404 (b)(1) Guidelines. The issuance of GP 98-08 will not have a significant impact on the quality of the human environment and an environmental impact statement is not required." This establishes that the authorization in this permit did not analyze the cumulative impacts of wetlands disturbance or filling.

The GP for the entire state, only evaluated potential impacts to 110 acres of wetlands per year or 550 acres over 5 years. Therefore, the environmental assessment conducted for this GP in 1998 and again in 2000 falls short of the development intentions of the CBM industry for the Powder River Basin. The EPA believes that the potential of impacts to the quality of the human environment is very real. The CBM gas well industry is moving at such a fast pace that the impacts and potential impacts caused by this industry were not fully known at the time the GP was approved.

The GP states that, "the permittee must submit a Statement of Compliance to the Corps within 30 days after completion of authorized activities that are approved by the BLM or FS and for hazardous waste cleanup projects," discussions with BLM and the Corps determined that this does not appear to be happening. Perhaps the permittee has not reached the point within the projects that required them to do so, but with the number of wells currently on the ground within the Powder River Basin, this does not seem to be likely. It appears that BLM, FS and the Corps need to reevaluate the administering and compliance of the GP.

The Draft EIS needs to:

1) Identify wetlands that meet the Army Corps of Engineers definition of wetland areas;

2) Determine the amount of wetland areas within the Army Corps of Engineers jurisdiction;

3) Explain under what processes jurisdictional wetland impacts are allowed;

4) Discuss the conditions of the General Permit, such as the number of cumulative acres of wetlands impacts; and

5) Compare the potential acres of wetland impacts should be compared to the total number of wetland impacts allowed under the General Permit.

Page 4-132 in the Vegetation Section states that the life of a CBM well is 12 to 20 years. This does not match up with a 7 year life stated in the Reasonable Foreseeable Development Scenario (RFD) in Appendix A and other sections of the Draft EIS.

X. DRAFT EIS WILDLIFE COMMENTS

Raptor Comments

As we stated in the cover letter, the discussion of wildlife protection in the Draft EIS is inadequate. During the last year 76 golden eagles were reported to have been electrocuted by overhead power lines. Not only did the Draft EIS omit information as to how such deaths may be avoided, it also did not disclose if these deaths had occurred as a consequence of CBM development. This information was not included in the Draft EIS on page 4-164 in the discussion in the Raptor Collisions and Electrocutions section.

BLM has standards for overhead power line construction. If it is determined that those requirements are not effective in reducing raptor deaths, then other mitigation requirements will be necessary. BLM needs to work closely with U.S. Fish and Wildlife and Wyoming Game and Fish Department staff to remediate this issue, including retro-fitting existing overhead powder lines to eliminate raptor electrocutions.

Habitat Fragmentation

The Draft EIS does not assess the potential effects of habitat fragmentation. This analysis should at least be done for Threatened and Endangered Species habitat. Since the Wyodak EIS and the Drainage Environmental Assessment, there should be information on Threatened and Endangered Species habitat impacts. This planning document should use information that has been collected under the past documents and project future impacts that would result from the proposed actions.

XI. COMMENTS ON THE RESONABLE FORESEEABLE DEVELOPMENT SCENARIO (RFD)

General Comments

The overriding issue is the inconsistencies between the methods of determining the RFD in the Montana Draft EIS and the Wyoming Draft EIS. EPA recommends that BLM could avoid this very confusing approach of having two incongruent RFD analysis by coordinating the RFD analysis between Montana and Wyoming and issuing a single RFD document to which both Draft EIS refer.

The basic analysis of determining the recoverable gas discussion in the Wyoming RFD analysis seems plausible for both the Wyoming and the Montana areas of the Powder River Basin. However, the Montana Draft EIS and RFD present a completely different method of analysis and therefore, result in vastly different amount of recoverable gas. This information in the RFD ultimately feeds into the analysis of impacts that result from the number of wells, water production, roads, well pads etc. It may be difficult for the public to discern which information regarding development projection is most relevant for the analysis.

EPA suggests presenting one comprehensive analysis for the entire Powder River Basin. If disagreements exist between BLM offices, those disagreements should be worked out within BLM.