

## **Surface Water Model Narrative** **Powder River Gas – Coal Creek POD**

### **Purpose of Model**

This was prepared in order to compare the direct, indirect and cumulative impacts to surface water quality and quantity from 3 different alternatives for the Powder River Gas (PRG) Coal Creek development. The three alternatives are the No Action by Any Agency, the No Federal Action, and the Proposed Action Alternatives.

Electrical Conductivity (EC) and Sodium Adsorption Ratio (SAR) are the parameters considered to be the water quality parameters most likely to be affected by CBNG development (BLM, 2003). For this reason only these parameters are modeled. This assumption is also consistent with the FEIS and conclusions of the MDEQ as stated in their Record of Decision (ROD) for this FEIS which states that “Water produced from coal bed methane development contains a number of constituents. Of major concern is the electrical conductivity (EC) and sodium adsorption ratio (SAR) of this water because high EC and SAR impairs the usefulness of water for irrigation.” The Statement of Basis prepared by the MDEQ for this project considers the complete set of parameters for which surface water standards exist. This statement is contained as an appendix to this report.

The existing environment was established by using historical stream flows and water chemistry, and adding in the existing permitted untreated CBNG discharge upstream from the reservoir of 3.57 cfs.

The direct impacts from the alternatives would results from the discharge of treated CBNG water to the Tongue River. For the No Action alternative, no water would be discharged from the PRG Coal Creek POD. For the No Federal Action alternative 0.56 cfs of treated CBNG water would be discharged. For the Proposed Action 1.0 cfs of treated CBNG water would be discharged.

The cumulative impacts of the proposed PRG Coal Creek Project were determined by including the proposed treated CBNG discharge upstream from the reservoir into the surface water model, and then adding in the PRG Coal Creek discharge under each alternative to the Tongue River downstream from the Dam. The No Action alternative takes into account the discharge of 3.79 cfs of proposed treated discharge upstream from the reservoir. Based upon the MPDES permit application for this discharge point, this water would have an EC of 233  $\mu\text{S}/\text{cm}$  and an SAR of 0.04. With No Federal Action the fee wells within the Coal Creek Project (10 of the 18 total proposed wells) would be drilled and tested. It is also reasonably foreseeable that that portion of the MPDES permit relating to the fee wells would be used. Since the total MPDES permit application is for 2.5 cfs, it is assumed that a total of 1.39 cfs of treated CBNG water from the PRG Coal Creek Project would be discharged cumulatively. The proposed action is for the discharge of 2.5 cfs of treated CBNG water under the proposed MPDES permit.

**Model Overview:**

A mass balance type surface water model was prepared for the analysis of the Coal Creek POD. This model conducts mixing of the Tongue River water and other applicable inputs into the Tongue River Reservoir to determine the quality of the water that will flow out of the Dam. Depending on the scenario being analyzed inputs into the Reservoir may include the quality and quantity of water entering the Reservoir from the Tongue River (including all activities in Wyoming), from the Decker Coal Mines, from untreated MT CBNG discharges, and from treated MT CBNG discharge. The model considers the Tongue River Reservoir by mixing together the water that is input from all upstream sources, and discharging the volume that is recorded at the USGS station downstream from the dam.

This model does not consider evaporation or infiltration in either the reservoir or the river. Effects of the reservoir were modeled as simple mixing, where inflows are mixed such that the outflow is less extreme than either end member. This corresponds with what is observed when comparing water quality data from above and below the dam.

This model assesses EC, Na, Ca, and Mg as conservative elements. SAR is calculated from the resultant cation concentrations. The spreadsheet model used employs a steady-state, mass-balance approach to estimate values for EC Na, Ca, and Mg after two or more inflows are mixed. This steady state approach is commonly used by states in EPA Region VIII to predict possible effects of point-source discharges on receiving waters. This approach has been endorsed in EPA guidance (EPA, 1991).

This approach does not take into account potential chemical reactions that may occur due to mixing. Equilibrium modeling of the mixed discharges was not conducted since such a model would be highly sensitive to the mineralogy of the bed and bank materials. Since the mineralogy of the materials that would come into contact with the mixed water would be quite varied due to the variations in geology, and difficult to predict on a watershed scale, such modeling was not conducted. It is felt that the simple mixing approach used is appropriate for the purpose of this analysis.

Actual variations in surface water chemistry will be monitored through the MPDES permitting process, and the USGS gauging stations on the Tongue River. If adverse monitoring results are observed, appropriate action will be taken via the MPDES process to ensure that approved surface water quality standards are met. It should also be noted that the TMDL process for the Tongue River is ongoing, and any waste load allocation developed in that process will be incorporated into existing discharge permits as necessary.

This surface water model uses existing USGS data from the State Line, Below Dam, and Birney Day School (BDS) stations on the Tongue River, along with EPA discharge data from the East and West Decker coal mines. Water quality data for the coal mines is obtained from the coal seam monitoring well data submitted to the BLM in the Decker Coal Company Annual Hydrologic Permit Report, 2002 Water Year. The quality of the water discharged from the Fidelity outfalls was obtained from the Badger Hills POD

book, and Fidelity’s MPDES permit application for the proposed treated discharges. Data on water quality and quantity for the Powder River Gas-Coal Creek POD were obtained from the Powder River Gas- Coal Creek POD book.

**Surface Water Standards**

The Montana Board of Environmental Quality has established surface water standards for EC and SAR. These standards have been reviewed and approved by the EPA, and therefore have Clean Water Act standing. The Northern Cheyenne Tribe has also adopted surface water quality standards for EC and SAR. The Northern Cheyenne Tribe has not currently been granted “Treatment as a State” status by the EPA, and therefore the EPA has not reviewed these standards. As such the Northern Cheyenne numerical standards do not have Clean Water Act standing; however they do set out the Tribe’s considered determination of the water quality needed to protect irrigated agriculture on the Reservation (BLM, 2003). Therefore the Northern Cheyenne standards provide reasonable criteria against which to compare the resulting water quality at the southern boundary of the Northern Cheyenne Reservation. These various standards are summarized in the table below and the results of the surface water analysis are graphically compared to the standards on the following charts. The standards are in terms of monthly mean values or instantaneous maximum values.

**Table 1: Surface Water Standards for the Tongue River**

	Monthly Mean	Inst. Max	Monthly Mean	Inst. Max
	SAR	SAR	EC (µS/cm)	EC (µS/cm)
MDEQ Irrigation Season Standards	3.0	4.5	1000	1500
MDEQ Non-Irrigation Season Standards	5.0	7.5	1500	2500
Northern Cheyenne Irrigation Season Standards-Southern Boundary	---	2.0	1000	2000
Northern Cheyenne Non-Irrigation Season Standards-Southern Boundary	---	2.0	1000	2000

The irrigation season specified by the MDEQ is from March 1 to October 31 while the irrigation season specified by the Northern Cheyenne is from April 1 to November 15.

For the purposes of this impact analysis the high mean monthly and low mean monthly results will be compared to the mean monthly standards, while the 7Q10 result will be compared to the instantaneous maximum standards. This is appropriate since the 7Q10 is the lowest flow that would be expected to occur for 7 consecutive days over any 10 year period. The 7Q10 flow value is much less than the mean monthly values. For example, in the Tongue River at the state line station, the 7Q10 flow is 35 cfs while the Low Monthly Mean flow is 176 cfs and the High Monthly Mean flow is 1,638 cfs. It should also be noted that this is an impact analysis, not a regulatory determination. From a regulatory point of view the instantaneous standard applies to the maximum allowable concentration from the analysis of any discrete or composite sample collected,

independent of the flow rate and duration of the sampling event. The 7Q10 analysis merely gives standard low flow numbers with which an analysis can be conducted.

**Model Calibration Using Historical Values, and Calculation of Existing Conditions:**

This mass balance model was calibrated by modeling the time period from April 1994 to September 1995, and comparing to the actual values measured during this time. Inflows during this time period include the Tongue River, the East Decker Mine, and the West Decker Mine. An initial volume in the reservoir of 38,870 Ac-ft was assumed. This is the average value reported by the MT-DEQ in the Tongue River TMDL status report. Results for the station below the dam are assumed to be the same as the reservoir water chemistry (assuming complete mixing). Using this raw data the model was run with results being generated for the Tongue River below the Dam. These results matched reasonably well with observed data, and therefore no further adjustments were made to this portion of the model. The model results were then graphed as EC vs. Discharge and SAR vs. Discharge graphs. A power trend line was determined for the modeled data, and this trend line was used to determine the EC and SAR values at 7Q10 (the lowest flow that would be expected to be seen for seven consecutive days over any ten year period) LMM (low mean monthly flow) and HMM (high mean monthly) flows. The discharge values and ambient water quality parameters used for this analysis are shown on Table 2. The modeled values were compared to the EC and SAR values for these flows based upon historical USGS data, and the analysis contained in the MDEQ’s Statement of Basis for the PRG Coal Creek MPDES permit (See Appendix B). The results at the Birney Day School Station were determined by adding the known increases in EC and SAR to the results from the station below the dam during the flows in question. The EC and SAR values were adjusted at this stage in order to match historical values at these flows. It should be noted at this point that this approach is not a regulatory compliance analysis, but rather an impact analysis. The standards in this analysis provide a context with which to gauge significance. A regulatory compliance analysis would use median chemistry, not the chemistry at particular flows.

Once the model had been calibrated vs. historical values the existing untreated discharge of untreated CBNG water was added in. This discharge is 1,600 gpm of water with an EC of 1987  $\mu\text{S/cm}$  and an SAR of 46.2. The results of this addition are shown in Table 2.

**Table 2: Comparison of Historical Surface Water Conditions to Modeled Existing Conditions**

		Historical Conditions <sup>+</sup>			Modeled Existing Conditions*		
	Flow Conditions	Discharge (cfs)	EC ( $\mu\text{S/cm}$ )	SAR	Discharge (cfs)	EC ( $\mu\text{S/cm}$ )	SAR
<b>Tongue River Below Dam</b>	7Q10	70.0	809	0.97	73.6	832	1.27
	LMM	179.0	646	0.78	182.6	664	0.98
	HMM	1429.0	392	0.49	1432.6	398	0.55
<b>Tongue River</b>	7Q10	49.0	1134	1.56	52.6	1157	1.87

<b>at Birney Day School</b>	LMM	173.0	719	1.02	176.6	737	1.23
	HMM	1119.0	377	0.56	1122.6	383	0.62

+ The historical conditions for the station Below the Dam were determined from USGS data collected from 1975-1998. Birney Day School historical conditions were determined from USGS data collected from 1978-1998.

\* The modeled existing conditions include historical values, plus modeled effects from the existing 3.57 cfs discharge of untreated CBNG water upstream from the Tongue River Reservoir.

**Direct Impacts:**

The direct impacts of the proposed Powder River Gas (PRG) Coal Creek Project were determined by adding in the Coal Creek discharge under each alternative to the Tongue River downstream from the Dam under the Modeled Existing Conditions. Based upon the statement of basis prepared by the MDEQ, the PRG discharges would have an SAR of 3 and an EC of 1,000  $\mu\text{S}/\text{cm}$ . The direct impacts under the No Action alternative would be the same as the Modeled Existing Conditions conditions, since no additional discharge would occur, and cumulative actions are not considered at this stage. With No Federal Action the state and fee wells within the Coal Creek Project (10 of the 18 total proposed wells) would be drilled and produced. Based upon the information contained within the POD book for this proposal, these wells would account for 0.56 cfs of CBNG discharge. The proposed action with all 18 wells would account for 1.0 cfs of discharge. It should be noted here that the MPDES application is for 2.5 cfs, however since this total volume would not be produced by the wells that are the subject of this proposal, this additional volume will be addressed in the cumulative impacts section rather than as a direct impact. The results for these different alternatives are shown on Table 3.

No Federal Action:

The direct impacts from the No Federal Action alternative during 7Q10 flows below the Dam, is that the discharge of the stream would increase from 73.6 cfs to 74.1 cfs, the EC would increase from 832  $\mu\text{S}/\text{cm}$  to 834  $\mu\text{S}/\text{cm}$ , and the SAR would increase from 1.27 to 1.28 (SAR is unitless). At the Birney Day School station during 7Q10 flow this alternative would increase discharge from 52.6 cfs to 53.1 cfs, the EC would increase from 1157  $\mu\text{S}/\text{cm}$  to 1159  $\mu\text{S}/\text{cm}$ , and the SAR would increase from 1.87 to 1.88.

The instantaneous surface water standards are applicable to 7Q10 flows. Neither the MDEQ nor Northern Cheyenne Standards are exceeded as a direct result of the PRG Coal Creek Project for 7Q10 flows under the No Federal Action Alternative. As shown in tables 2 and 3, the mean monthly standards are also not exceeded during mean monthly flows. Since these EC and SAR standards were expressly developed in order to protect the beneficial uses of the Tongue River, the direct impacts under this alternative are not anticipated to impact the beneficial uses of the Tongue River.

Proposed Action:

The direct impacts from the Proposed Action alternative during 7Q10 flows below the Dam, is that the discharge of the stream would increase from 73.6 cfs to 74.6 cfs, the EC would increase from 832  $\mu\text{S}/\text{cm}$  to 835  $\mu\text{S}/\text{cm}$ , and the SAR would increase from 1.27 to 1.29. At the Birney Day School station during 7Q10 flow this alternative would increase

discharge from 52.6 cfs to 53.6 cfs, the EC would increase from 1157  $\mu\text{S}/\text{cm}$  to 1160  $\mu\text{S}/\text{cm}$ , and the SAR would increase from 1.87 to 1.88.

The instantaneous surface water standards are applicable to 7Q10 flows. Neither the MDEQ nor Northern Cheyenne Standards are exceeded as a direct result of the PRG Coal Creek Project for 7Q10 flows under the Proposed Action Alternative. As shown in tables 2 and 3, the mean monthly standards are also not exceeded during mean monthly flows. Since these EC and SAR standards were expressly developed in order to protect the beneficial uses of the Tongue River, the direct impacts under this alternative are not anticipated to impact the beneficial uses of the Tongue River.

### **Cumulative Impacts:**

The cumulative impacts of the proposed PRG Coal Creek Project were determined by including the proposed treated CBNG discharge upstream from the reservoir into the surface water model, and then adding in the PRG Coal Creek discharge under each alternative to the Tongue River downstream from the Dam. With No Federal Action it is assumed that a total of 1.39 cfs of treated CBNG water would be discharged from the PRG Coal Creek Project. With the proposed action the discharge would be 2.5 cfs. The results of these analysis are shown on Table 4.

#### No Action:

The cumulative impacts from the No Action alternative during 7Q10 flows below the Dam, is that the discharge of the stream would increase from 73.6 cfs to 77.4 cfs, the EC would decrease from 832  $\mu\text{S}/\text{cm}$  to 812  $\mu\text{S}/\text{cm}$ , and the SAR would decrease from 1.27 to 1.24. At the Birney Day School station during 7Q10 flow this alternative would increase discharge from 52.6 cfs to 56.4 cfs, the EC would decrease from 1157  $\mu\text{S}/\text{cm}$  to 1140  $\mu\text{S}/\text{cm}$ , and the SAR would decrease from 1.87 to 1.83.

The instantaneous surface water standards are applicable to 7Q10 flows. Neither the MDEQ nor Northern Cheyenne Standards are exceeded as a cumulative result of the PRG Coal Creek Project for 7Q10 flows under the No Action alternative. As shown in tables 2 and 4, the mean monthly standards are also not exceeded during mean monthly flows. Since these EC and SAR standards were expressly developed in order to protect the beneficial uses of the Tongue River, the cumulative impacts under this alternative are not anticipated to impact the beneficial uses of the Tongue River.

#### No Federal Action:

The cumulative impacts from the No Federal Action alternative during 7Q10 flows below the Dam, is that the discharge of the stream would increase from 73.6 cfs to 78.8 cfs, the EC would decrease from 832  $\mu\text{S}/\text{cm}$  to 816  $\mu\text{S}/\text{cm}$ , and the SAR would decrease from 1.27 to 1.25. At the Birney Day School station during 7Q10 flow this alternative would increase discharge from 52.6 cfs to 57.8 cfs, the EC would decrease from 1157  $\mu\text{S}/\text{cm}$  to 1140  $\mu\text{S}/\text{cm}$ , and the SAR would decrease from 1.87 to 1.85.

The instantaneous surface water standards are applicable to 7Q10 flows. Neither the MDEQ nor Northern Cheyenne Standards are exceeded as a direct result of the PRG Coal

Creek Project for 7Q10 flows under the No Action by Any Agency Alternative. As shown in tables 2 and 4, the mean monthly standards are also not exceeded during mean monthly flows. Since these EC and SAR standards were expressly developed in order to protect the beneficial uses of the Tongue River, the cumulative impacts under this alternative are not anticipated to impact the beneficial uses of the Tongue River.

Proposed Action:

The cumulative impacts from the Proposed Action alternative during 7Q10 flows below the Dam, is that the discharge of the stream would increase from 73.6 cfs to 79.86 cfs, the EC would decrease from 832  $\mu\text{S}/\text{cm}$  to 819  $\mu\text{S}/\text{cm}$ , and the SAR would decrease from 1.27 to 1.26. At the Birney Day School station during 7Q10 flow this alternative would increase discharge from 52.6 cfs to 58.86 cfs, the EC would decrease from 1157  $\mu\text{S}/\text{cm}$  to 1143  $\mu\text{S}/\text{cm}$ , and the SAR would decrease from 1.87 to 1.86.

The instantaneous surface water standards are applicable to 7Q10 flows. Neither the MDEQ nor Northern Cheyenne Standards are exceeded as a cumulative result of the PRG Coal Creek Project for 7Q10 flows under the Proposed Action Alternative. As shown in tables 1 and 3, the mean monthly standards are also not exceeded during mean monthly flows. Since these EC and SAR standards were expressly developed in order to protect the beneficial uses of the Tongue River, the direct impacts under this alternative are not anticipated to impact the beneficial uses of the Tongue River.

**Summary:**

The No Action Alternative would have the least impacts to surface water quality while the Proposed Action Alternative would have the greatest impact. This is due to the increased volume of discharge under this alternative. None of the analyzed alternatives would cause the beneficial uses of the Tongue River to be impacted in terms of EC and SAR.

The MDEQ has also analyzed the effects of the Powder River Gas - Coal Cree POD discharge for all numerical and narrative surface water standards. The MDEQ has determined that with appropriate mitigation measures the 2.5 cfs discharge will not impact beneficial uses. A full copy of the MDEQ's the Statement of Basis, and the **DRAFT** MPDES permit are included as appendices to this technical report. The MDEQ must review permits to discharge at least once every 5 years. There is also a reopener provision in all permits which allows the MDEQ to alter the terms of the permit if properly documented adverse monitoring results are recorded, or if the ongoing TMDL process requires changes in existing permits.

**Table 3: Comparison of Direct Impacts to Surface Water from the Alternatives**

		Modeled Existing Conditions			No Federal Action (0.56 cfs from PRG)			Proposed Action (1.0 cfs from PRG)		
		Flow Conditions	Discharge (cfs)	EC (µS/cm)	SAR	Discharge (cfs)	EC (µS/cm)	SAR	Discharge (cfs)	EC (µS/cm)
<b>Tongue River Below Dam</b>	7Q10	73.6	832	1.27	74.1	834	1.28	74.6	835	1.29
	LMM	182.6	664	0.98	183.1	666	0.99	183.6	667	0.99
	HMM	1432.6	398	0.55	1433.1	399	0.55	1433.6	399	0.55
<b>Tongue River at Birney Day School</b>	7Q10	52.6	1157	1.87	53.1	1159	1.88	53.6	1160	1.88
	LMM	176.6	737	1.23	177.1	738	1.23	177.6	740	1.23
	HMM	1122.6	383	0.62	1123.1	384	0.62	1123.6	384	0.62

Note: The Direct result of No Action by any agency would be no discharge, thus the result would be no different than historical conditions.

**Table 4: Comparison of Cumulative Impacts to Surface Water from the Alternatives**

		Modeled Existing Conditions			No Action (0 cfs from PRG)			No Federal Action (1.39 cfs from PRG)			Proposed Action (2.5 cfs from PRG)		
		Flow Conditions	Discharge (cfs)	EC (µS/cm)	SAR	Discharge (cfs)	EC (µS/cm)	SAR	Discharge (cfs)	EC (µS/cm)	SAR	Discharge (cfs)	EC (µS/cm)
<b>Tongue River Below Dam</b>	7Q10	73.6	832	1.27	77.4	812	1.24	78.8	816	1.25	79.9	819	1.26
	LMM	182.6	664	0.98	186.4	656	0.97	187.8	659	0.98	188.9	662	0.99
	HMM	1432.6	398	0.55	1436.4	399	0.55	1437.8	400	0.55	1438.9	401	0.55
<b>Tongue River at Birney Day School</b>	7Q10	52.6	1157	1.87	56.4	1136	1.83	57.8	1140	1.85	58.9	1143	1.86
	LMM	176.6	737	1.23	180.4	729	1.21	181.8	732	1.22	182.9	735	1.23
	HMM	1122.6	383	0.62	1126.4	384	0.62	1127.8	385	0.62	1128.9	386	0.62