CHAPTER VI

HYDROLOGY

PARTS | Page

VI.A HYDROLOGIC RESOURCES AND IMPACTS

VI.A.1 GENERAL HYDROLOGIC DESCRIPTION 1

VI.A.2 GROUND WATER INFORMATION 20

VI.A.3 SURFACE WATER INFORMATION 92

VI.A.4 WATER USES, WATER RIGHTS AND ALTERNATE WATER SUPPLY INFORMATION 139

VI.A.5 SURFACE AND GROUND WATER MONITORING PROGRAMS 144

VI.A.6 CLEAN WATER ACT COMPLIANCE 156

VI.A.7 DETERMINATION OF PROBABLE HYDROLOGIC CONSEQUENCES . 161

VI.A.8 BIBLIOGRAPHY 182

VI.B SURFACE WATER MANAGEMENT

VI.B.1 OVERLAND FLOW DIVERSIONS 185

VI.B.2 SEDIMENT CONTROL 186

VI.B.3 ALTERNATE SEDIMENT CONTROL 188

VI.B.4 SEDIMENT CONTROL EXEMPTION FOR SMALL AREAS 189

APPENDICES

VI-1 GROUND WATER MONITORING - WATER QUALITY DATA . . . . .Vol. 1

VI-2 LITHOLOGIC AND GEOPHYSICAL DATA FOR MONITORING WELLS .Vol. 1

VI-3 PUMP TEST REPORTS AND PLOTS . . . . . .Vol. 1

VI-4 PERMIT RENEWAL WATER SAMPLES - BASELINE ANALYTICAL REPORTS . . . . . Vol. 1

VI-5 SURFACE WATER MONITORING - FLOW AND WATER QUALITY DATA.Vol. 1

VI-6 DRAINAGE DITCH DESIGNS . . . . . .Vol. 2

VI-7 SEDIMENTATION POND DESIGNS . . . . . .Vol. 2

VI-8 ALTERNATE SEDIMENT CONTROL DESIGNS. . . . . .Vol. 2

VI-9 HEC-1 COMPUTER ROUTINGS . . . . . .Vol. 2

VI-10 PHC Update 1990-2002 . . . . . Vol. 2

APPENDIX VI-10

PHC UPDATE 1990-2002

Emery Mine PHC Update – July 2003

Introduction

An update of the Emery Mine PHC (Probable Hydrologic Consequences) was requested by the State of Utah Department of Natural Resources, Division of Oil, Gas and Mining (letter dated April 1, 2003) because of the reactivation of the mine. The initial deadline for response to this deficiency was June 1, 2003, but an extension was granted (letter dated June 6, 2003) until August 1, 2003.

The Division of Oil, Gas and Mining is requesting specifically that "Consolidation Coal Company identify changes in hydrologic conditions sustained as a result of subsidence, drawdown of aquifers or recharge sources, and increased concentrations of stream flows and chemical constituents to receiving stream channels, within and adjacent to Emery Deep Mine".

In response to this request, all available hydrological data are presented and analyzed. This includes aquifer well levels, aquifer well quality, pump discharge quantity and pump discharge quality. A comparison is made between active mining and inactive mining in order to evaluate the effect of idle mining status on the local hydrology. In this comparison, 1989 is used as the transition period between active and inactive mining status.

Geology of Local Aquifers

Figure 1 shows the general stratigraphic relationships between the major geologic aquifer units at Emery Mine. Where present, the units from shallowest to deepest include:

- Alluvial aquifers of Christiansen Wash and Quitchupah Creek
- Bluegate Shale
- Upper Ferron sandstone (just above the I seam)
- Middle Ferron sandstone (just below the I seam; just above the A seam)
- Lower Ferron sandstone (just below the A seam)

The Bluegate shale is virtually 100 percent shale, whereas the Ferron sandstones contain mostly sandstone with interbedded shales, sandy shales and coals. A network of monitoring wells was established in the late 1970s and early 1980s, with varying numbers of wells completed in each of the above aquifers.

Aquifer Well Levels

Figures 2 through 7 are hydrographs of static water level elevations for all the wells within the monitoring network for their entire period of record. Each figure shows water levels for a different aquifer. Generally speaking, idling of the mine in the 1989 time frame would not be expected to impact ground water levels because pumpage of water

from the mine continued during the idle period. No major areas of the mine were allowed to flood.

Christiansen Wash Alluvial Aquifer. Figure 2 shows water level elevations for four monitoring wells completed in the Christiansen Wash alluvial aquifer. There has been generally little sustained change in water level in these wells, with the exception of SM1-2 which showed a 5-10 ft decline in water level from April 1988 until April 1995, after which the water level rose approximately 5 ft. Well SM1-1 also showed a similar trend during the same period, although the magnitude of change in level was less than SM1-2. It is believed to be pure coincidence that the small decline in water levels in these two wells began near the time the mine was idled (1989). Small variations in water level from one reading to the next are probably due to changes in available moisture to the aquifer in the form of precipitation.

Quitchupah Creek Alluvial Aquifer. Figure 3 shows water level elevations for six monitoring wells completed in the Quitchupah Creek alluvial aquifer. As with the Christiansen Wash alluvial aquifer, there has been little sustained change in water level over the period of record. There appears to be no difference in water level trends before and after idling of the mine (1989). Small variations in water level from one reading to the next are probably due to changes in available moisture to the aquifer in the form of precipitation.

Bluegate Shale Aquifer. Figure 4 shows water level elevations for eight monitoring wells completed in the Bluegate shale aquifer. This aquifer is the shallowest bedrock unit over much of the Emery Mine area. Generally speaking, there has been little change in water level in this aquifer over the period of record with a few notable exceptions. It appears that wells "I-BG" and "R2-BG" showed a gradual decline in water level beginning in approximately November 1984 and continuing until approximately November 1988 for well "R2-BG" and until approximately November 1992 for well "I-BG". Because the onset of this gradual decline is prior to idling of the mine in 1989, it is not attributable to this change in mining status. Additionally, there are some "spikes" in water level in some of these wells ("H-BG", "I-BG", and "R2-BG"), which are attributed to measurement or recording errors in the water level readings.

Upper Ferron Sandstone Aquifer. Figure 5 shows the water level elevations for twelve monitoring wells completed in the Upper Ferron sandstone aquifer. This aquifer immediately overlies the mined IJ seam at Emery Mine. Generally speaking, there is a fairly steep drawdown cone in the Upper Ferron aquifer, which is centered near well R2, TP, T1 and T2. These wells have shown the most change in water level since mining began. Other wells such as H, Muddy 1, Muddy 2, Lewis and USGS 1-2 have shown far less drawdown during and after active mining because of their distance from center of the drawdown cone. The only well that shows a change in trend approximately coincident with idling of the mine is well T2, which shows an approximate 40 foot rebound in water level in the 1990-91 time frame. Besides this well, there does not appear to be a general change in trend after idling of the mine.

Middle Ferron Sandstone Aquifer. Figure 6 shows the water level elevations for four monitoring wells completed in the Middle Ferron sandstone. This aquifer immediately underlies the mined IJ seam. Two of the Middle Ferron wells showed dramatic declines in water level within the period of record. Well H(M) showed about a 250 foot drop in water level in 1987 and well R2(M) showed about a 500 foot drop in water level 1989. Although neither of these wells is located near active mining, such drastic declines in water level can only be attributed to mining, but it is unlikely due to idling of the mine because, if anything idling of the mine would tend mute drastic declines because new areas of the mine are not being opened. Wells AA(M) and I(M) show less water level decline during mining than R2(M) and H(M), and little if any change during idling of the mine.

Lower Ferron Sandstone Aquifer. Figure 7 shows the water level elevations for six monitoring wells completed in the Lower Ferron sandstone. Generally speaking, this aquifer showed little change in level during the period of record, with the exception of R1-L, which is located some distance from the mine. This response is not well understood when related to mining (mining is nearly 200 feet above the top of the Lower Ferron), although its proximity to well R2(M) – Middle Ferron sandstone well – suggests it may be in communication with this well. There is no apparent relationship between idling of the mine and the Lower Ferron water levels.

Aquifer Well Quality

All available well water quality data were reviewed and analyzed in terms of mean values of selected parameters measured prior to mine idling and after mine idling to determine if significant changes had occurred. These data are presented in Table 1. Generally speaking, more data was available for analysis for samples collected after mine idling than before, so there will be some bias in the analysis. The following parameters were compared: pH, specific conductance, total dissolved solids (TDS), alkalinity, iron, manganese, and sulfate. Wells are grouped by aquifer in which the wells were completed. No water quality data was available for the Middle Ferron aquifer. It should be noted that although TDS and specific conductance are usually well correlated to each other, the mean values shown in Table 1 may not show similar trends. This is because more post-mine-idling TDS data were available than post-mine-idling conductance data.

For the Upper Ferron aquifer, four wells were sampled with data spanning both the pre- and post-idling of the mine. Of the parameters analyzed, iron, manganese, sulfate, TDS, and pH showed changes coincident with (but not necessarily caused by) mine idling. There was a decrease in iron after idling in the following wells: Bryant, TP, and USGS 1-2. There was also a decrease in manganese in the Bryant well and increase in manganese and decrease in pH in the Lewis well. Sulfate and total dissolved solids increased in well USGS1-2.

For the Lower Ferron aquifer, one well (ZZ) had quality data spanning both the pre- and post-idling of the mine. This well showed a decrease in iron and sulfate after mine idling.

For the Bluegate shale aquifer, one well (T1) had quality data spanning both the pre- and post-idling of the mine. This well showed a decrease in iron and specific conductance after mine idling.

For the Christiansen Wash alluvial aquifer, four wells had quality data available for analysis. The only parameter that showed no significant change before and after mine idling is sulfate. All four wells showed a decrease in specific conductance and all but one well (SM1-3) showed a decrease in iron. Well SM1-3 showed a decrease in pH and an increase in manganese after mine idling. Well SM1-2 showed a decrease in TDS and manganese after mine idling.

For the Quitchupah Creek alluvial aquifer, six wells had quality data available for analysis. All six parameters showed some change when comparing pre- to post-mine idling. All six wells showed increases in manganese pre- to post-mine idling. Other parameters are discussed on a well by well basis. Well RDA1 showed a decrease in iron. Well RDA2 showed a decrease in pH. Well RDA3 showed an increase in TDS, alkalinity and sulfate. Well RDA4 showed a decrease in specific conductance. Well RDA5 showed a decrease in pH, specific conductance, TDS and sulfate, and an increase in iron. Well RDA6 showed an increase in every parameter except specific conductance and pH, both of which decreased slightly.

There is one well, EMRIA2, that taps all three Ferron sandstones and the Bluegate shale. This well showed an increase in TDS, iron and manganese and a slight decrease in alkalinity.

Mine Discharge Quantity and Quality

Mine pumpage quantity data are only available for 1989 to the present, so no pre- and post-mine idling comparison of pumpage volumes can be made. However, Table 2 shows average yearly pumpage rates for the Emery Mine. The most accurate data are for 1996 to the present when flow recorder data were available for analysis. Prior to 1996 only pump running time data were available and an instantaneous pump discharge value had to be assumed to be constant over a several year period. These data demonstrate that the mine was continuously pumped during the 12+ years of idle status so as not allow flooding of portions of the mine, which might have altered the hydrologic balance after the mine was idled.

As far as mine discharge quality is concerned, there is sufficient data to make a comparison between pre-mine idling and post-idling for Pond 1 (outfall 001), but not for Pond 6 (outfall 003). Both ponds receive mine water discharge from Emery mine. These data are shown in Table 3. The data for Pond 1 show virtually no change in mine water discharge quality as a result of idling of the mine. The post-idling quality from Pond 6 is very similar to that of Pond 1, so one could infer that pre-idling quality was similar as well.

Summary and Conclusions

Because the mine was continuously pumped, alterations to the local hydrologic regime resulting from idling of the Emery mine for several years are expected to be minimal. This is what the data presented herein demonstrate. Although there were apparent changes in some chemical parameters in the monitoring wells, these are more likely attributed to a lack of available data collected prior to idling of the mine (thereby skewing the data set) combined with the effect of drilling on early sample quality stabilization.

Table 1 - Comparison of Well Water Quality Data

Aquifer	Well ID	Parameter pH	Specific Conductance (umhos./cm)	TDS	Alkalinity	Iron	Manganese	Sulfate
Upper Ferron	Bryant well (pre idling)	8.92	2127	1420	184	5.61	6.00	778
	Bryant well (post idling)	9.05	1856	1077	277	0.10	0.10	515
	Lewis well (pre idling)	8.34	1329	906	303	0.02	0.01	373
	Lewis well (post idling)	7.60	1180	912	306	0.09	1.73	373
	Well TP (pre idling)	10.27	1719	902	512	10.35	0.07	231
	Well TP (post idling)	9.30	1786	1008	491	0.00	0.01	250
	Well USGS 1-2 (pre idling)	7.65	1423	943	415	2.38	0.31	389
	Well USGS 1-2 (post idling)	7.86	2797	3351	496	0.06	0.25	1704
Lower Ferron	Well ZZ (pre idling)	8.34	1263	743	460	0.25	0.01	134
	Well ZZ (post idling)	8.50	1167	713	577	0.00	0.05	33
Bluegate Shale	Well T1 (pre idling)	7.82	18967	19583	392	2.13	0.38	13633
	Well T1 (post idling)	7.43	6923	14327	443	0.04	0.27	10915

Note: all perimeters except pH and conductuance are in mg/L

Table 1 - Comparison of Well Water Quality Data

Aquifer	Well ID	Parameter pH	Specific Conductance (umhos./cm)	TDS	Alkalinity	Iron	Manganese	Sulfate
Christiansen Wash Alluvium	Well SM1-1 (pre idling)	7.58	17721	23892	837	3.44	1.08	15407
	Well SM1-1 (post idling)	7.14	8079	29843	1067	0.05	1.88	19581
	Well SM1-2 (pre idling)	7.82	14261	9118	483	9.14	1.50	5489
	Well SM1-2 (post idling)	7.80	4303	1843	633	0.22	0.24	1356
	Well SM1-3 (pre idling)	7.93	37133	55536	526	3.04	1.18	36781
	Well SM1-3 (post idling)	6.47	8783	53424	659	3.77	3.37	35106
	Well SM1-4 (pre idling)	7.75	3899	3085	430	6.52	0.15	1815
	Well SM1-4 (post idling)	7.54	3275	3036	417	0.04	0.13	1728
Quitchupah Creek Alluvium	Well RDA1 (pre idling)	7.26	4779	4000	476	0.10	0.06	2322
	Well RDA1 (post idling)	7.47	4240	3449	549	0.04	0.55	1897
	Well RDA2 (pre idling)	8.21	4846	3997	633	0.01	0.03	2376
	Well RDA2 (post idling)	6.29	4025	4089	564	0.04	0.27	2348
	Well RDA3 (pre idling)	7.39	4849	4192	567	0.03	0.07	2524
	Well RDA3 (post idling)	7.11	5935	15037	913	0.04	0.45	14707

Note: all perimeters except pH and conductuance are in mg/L

Table 1 - Comparison of Well Water Quality Data

Aquifer	Well ID	Parameter pH	Specific Conductance (umhos./cm)	TDS	Alkalinity	Iron	Manganese	Sulfate
	Well RDA4 (pre idling)	7.49	8383	7288	505	0.03	0.03	4701
	Well RDA4 (post idling)	7.24	6488	5751	705	0.04	0.37	3311
	Well RDA5 (pre idling)	7.71	30191	30344	632	0.00	0.13	17651
	Well RDA5 (post idling)	6.28	6878	14686	459	0.04	0.49	9659
	Well RDA6 (pre idling)	7.89	12166	11199	427	0.00	0.01	7534
	Well RDA6 (post idling)	7.17	8885	29516	785	0.04	0.17	17867
Multi Aquifer	Well EMRIA2 (pre idling)	6.89	5406	5688	407	34.86	3.03	4255
	Well EMRIA2 (post idling)	6.29	6261	8908	292	119.42	8.49	5701

Note: all perimeters except pH and conductuance are in mg/L

Table 2 - Emery Mine Discharge Volume Data

Year	Pumpage (gpm)
1989	547
1990	446
1991	513
1992	411
1993	663
1994	530
1995	663
1996	450
1997	532
1998	489
1999	462
2000	462
2001	404
2002	328

Table 3 - Mine Discharge Quality (Settling Pond Effluent)

	pH	Specific Conductance (umhos/cm)	TDS	Alkalinity	Iron	Manganese	Sulfate
Pond 1 (pre idling)	8.04	4172	3091	349	0.21	0.06	1791
Pond 1 (post idling)	8.07	4779	3964	411	0.43	0.04	2089
Pond 6 (pre idling)	none	none	none	none	none	none	none
Pond 6 (post idling)	8.18	3206	2281	371	0.27	0.02	1064

Note: all parameters are expressed in mg/L except pH and specific conductance

EMERY DEEP - MONITORING WELL LOCATIONS & ELEVATIONS

WELL	AQUIFER	NORTHING	EASTING	TOP OF PIPE	GROUND ELEV
RDA1	QAL	193948	2064708	5958.5	5957.8
RDA2	QAL	193573	2064773	5955.7	5954.5
RDA3	QAL	193438	2065795	5946.5	5945.4
RDA4	QAL	193049	2066002	5944.0	5943.1
RDA5	QAL	192671	2065983	5942.4	5941.2
RDA6	QAL	192178	2065515	5942.0	5940.4
CSPRG	U	199650	2079980	6050.0	6050.0
SM1-1	CAL	199675	2077237	6071.6	6070.3
SM1-2	CAL	197589	2076031	6051.8	6048.2
SM1-3	CAL	197903	2073514	6056.5	6056.0
SM1-4	CAL	192536	2070876	5941.6	5939.2
AA	BG	189698	2064358	5969.7	5967.0
AA	L	189698	2064358	5968.6	5967.1
AA	M	189698	2064358	5969.2	5967.3
AA	U	189698	2064358	5969.8	5967.5
BRYANT	U	190961	2061578	6024.5	6020.8
EMRIA1	UML	203515	2082872	6155.7	6154.1
EMRIA2	BGUML	199388	2078782	6083.4	6082.3
EMRIA3	BGU	199714	2075510	6091.8	6090.5
FC343WW	BGU	196510	2072537	6087.3	6086.1
FC346WW	UML	202152	2078871	6123.2	6121.7
FC363WW	UML	196401	2074157	6041.9	6039.9
H	BG	203897	2066432	6231.6	6228.8
H	L	203897	2066432	6230.4	6229.1
H	M	203897	2066432	6230.4	6228.8
H	U	203897	2066432	6230.4	6228.7
I	BG	200024	2070563	6109.6	6107.3
I	L	200024	2070563	6108.7	6107.3
I	M	200024	2070563	6108.9	6107.2
I	U	200024	2070563	6108.9	6107.2
I2	U	199850	2070900	6105.0	6102.0
KEMMER	L	208863	2065391	6286.7	6284.7
LEWIS	U	195092	2060334	6020.4	6018.5
MUDDY1	U	193463	2071408	6068.2	6066.5
MUDDY2	U	195194	2072941	6046.8	6045.8
MUDDY3	BGU	196522	2073730	6049.7	6049.0
MUDDY4	BGU	197871	2075844	6053.4	6052.3
R1	L	198381	2062436	6034.2	6031.8
R2	BG	198327	2062407	6031.7	6029.7
R2	M	198327	2062407	6031.1	6029.5
R2	U	198327	2062407	6031.7	6029.9
TP	U	196132	2066058	6002.7	6001.9
T1	BG	196158	2066014	6003.2	6000.9
T1	U	196161	2066014	6003.2	6002.8
T2	BG	196167	2066020	6003.0	6002.1
T2	U	196032	2066167	5997.7	5997.4
USGS1-1	L	196704	2073798	6046.5	6045.6
USGS2-1	U	196717	2073793	6046.3	6045.7
USGS3-1	BG	196718	2073774	6046.9	6046.0
USGS4-1	BG	196709	2073753	6047.5	6046.7
WW1	L	191569	2068914	5920.0	5918.5
ZZ	L	193365	2071454	6068.7	6065.7

Table 4 - Well Locations

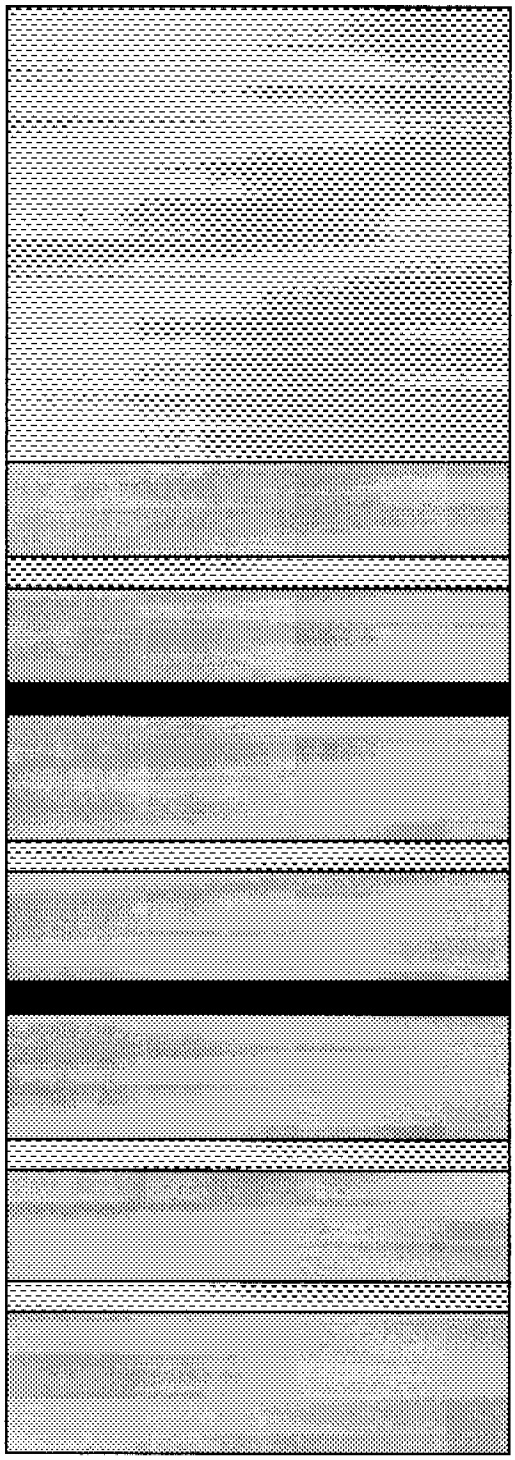

Figure 1. Generalized Emery Mine Geology