RESOURCE HYDROGEOLOGIC SERVICES

232 UTE PASS WEST
DURANGO, CO 81301
TELEPHONE: (970) 247-1959
EMAIL: INFO@RESOURCEHYDROGEOLOGIC.COM

TECHNICAL MEMORANDUM

To	Tom Bird (GCC), Sarah Vance (GCC)	**Ref #**	2020-05-035-TM-2
CC		**Date**	3/19/2020
From	Landon Beck, Terry Gulliver		
Subject	Response to 2nd 2018 King Coal Mine AHR DRMS Review dated February 25, 2020		

This technical memorandum is the response to the Colorado Division of Reclamation, Mining and Safety (DRMS) comments and questions regarding the 2018 Annual Hydrology Report (AHR) for King Coal Mine presented in a letter to Tom Bird at GCC Energy, LLC, dated February 25, 2020.

The February 25th DRMS letter addressed four points generally summarized here:

1. Regulation 34 water quality standard application to Hay Gulch Ditch (imported) water monitoring
2. High pH values observed in some GCC bedrock monitoring wells
3. High sulfate values observed in some GCC Hay Gulch alluvial wells
4. Application of Regulation 34 standards to future water analysis

Points 1 and 4 above are related to each other given requested application of Regulation 34 to GCC compliance water quality monitoring. RHS recognizes the DRMS position that Regulation 34 applies to Hay Gulch Ditch, despite as DRMS noted, the water being imported from outside of what is the Hay Gulch HUC 14 Watershed. The Hay Gulch ditch is routed past the King I and II Mines through Hay Gulch generally within 150 feet of County Road 120. Specifically, the Hay Gulch Ditch Upgradient monitoring station is located upgradient of the King I and II Mines for the purpose of baseline/performance monitoring. As such, future compliance monitoring data from this location will be compared to Regulation 34, but RHS maintains that GCC not be required to interpret or explain potential sources of constituent concentrations above the Regulation 34 limits that are by definition baseline conditions of the imported water and in no way influenced by GCC mining activity. The Hay Gulch Ditch Downgradient monitoring site, located just downgradient from King II (and thus downgradient of King I), is the monitoring location that shall continue to be used to identify and assess potential effects of GCC mining on ditch water quality. Additionally, with respect to point 4, RHS will continue to utilize temporal and spatial analyses of monitoring data in future AHRs such as Figures 2 through 20 in the 2018 AHR. However, as requested by DRMS, in the future these analysis plots will delineate the respective Regulation 34 standards as applicable.

Point 2 relates to high pH values observed in bedrock groundwater wells. It should be noted that the comment in the previous RHS response dated February 13, 2020 about pH being variable at low solute concentrations was meant to apply to some ditch water samples. When salinity is low sometimes the ionic/electric interactions are "poorly poised" and the potential in a measuring electrode may drift. Although the pH of pure water at 25C is 7.0, a meter may drift between a point high or low. This does not apply, however, to aquifer water which can be relied on to have sufficient salinity for stable measurement.

In 2013 GCC commissioned a baseline water quality study of nearby Vista del Oro subdivision domestic water wells, for well owners that were interested on a voluntary basis. The data from this study is presented in **Table 1** and the corresponding sample location map is **Figure 1**. These analyses included lab-measured pH. The pH in Mesa Verde strata is typically between 8 and 9, as shown in the **Figure 2**. The GCC compliance hydrologic monitoring location map is presented as **Figure 3**. Note that 2013 study wells #8, #9, and #10 are in the immediate vicinity of the MW-4 wells and #12 is within about a ¼ mile of the MW-4 wells. Well #18 is within ½ mile of the MW-3 wells. The full study can be found at:

http://lpccds.org/UserFiles/Servers/Server_1323669/File/La%20Plata%20County's%20Community%20Development%20Services%20Department%20Migration/Planning/Oil%20and%20Gas/GCC%20Energy%20Project/Coded%20Final%20Full%20Report%20King%20II%20%20%205.8.2014%20B.pdf

This study further supports a conclusion that elevated pH in some GCC bedrock compliance monitoring wells is natural and should be considered baseline. RHS directs DRMS to review the 2019 AHR for interpretation and discussion of the bedrock recharge areas which delineate the dry King II Mine workings from the down-dip saturated Menefee formation further documenting the lack of the groundwater advection process potential from King II underground workings.

The data-fitting line shown in **Figure 2** is a quadratic, but it must be emphasized this is a fit only to the sample dataset and is not a model of the distribution of pH in the Mesa Verde as a whole. The actual distribution of pH is limited by chemical thermodynamics. One may suspect an observation of pH 10 in a sample from a new well to indicate annular cement and/or bentonite contamination. There have been such observations in previous monitoring, but these values typically decline through successive events, as seen in the alluvial Well #1 Upgradient.

Point 3 is considered satisfied per the February 25th DRMS response.

TABLES

Summary of GCC water well survey 2013 laboratory data - page 1 of 2												
Well ID	HCO3	CO3	Alk total	Chloride	EC	Lang Index	pH	SAR	SO4	TDS	TSS	Hardness
	mg/L	mg/L	mg/L	mg/L	uS/cm	See note 1	units	see note 2	mg/L	mg/L	mg/L	mg CaCO3/L
Well # 9	600	0.0	600	12.0	1920	1.180	8.11	6.93	630	905	5.44	412.0
Field data					2000		8.02					
Other data	long -108.15768 lat 37.24379 Well depth 680 feet Static level 360 feet									Well head elevation 7603 feet		
Well # 10	540	20.0	560	11.0	1830	0.670	8.81	31.1	360	1030	<2.0	30.0
Field data					1840		8.91					
Other data	Long -108.15639 lat 37.24322 Well depth 500 feet Static level 400 feet									Well head elevation 7570 feet		
Well # 12	475	10.0	485	<10.0	1060	0.220	8.45	30.8	84	595	<2.0	9.7
Field data					1140		8.53					
Other data	Long -108.15998 Lat 37.24013 Well depth 600 feet Static level 240 feet									Well head elevation 7520 feet		
Well # 8	500	0.0	500	11.0	2340	0.500	8.34	24.6	620	1440	<2.00	75.0
Field data					2300		8.36					
Other data	Long -108.15894 Lat 37.24318 Well depth 500* feet Static level 400*feet									Well head elevation 7585 feet		
Well # 18	690	20.0	710	<10	1370	0.260	8.82	68.4	17	895	22	<6.62
Field data					1390		8.83					
Other data	Long -108.16444 lat 37.23117 Well depth 540 feet Static level 300 feet									Well head elevation 7383 feet		
Well # 35	900	40.0	940	50.0	2020	0.510	8.56	45.2	138	1220	3.59	23.1
Field data					1950		8.67					
Other data	Long -108.13922 lat 37.22920 Well depth 160 feet Static level 31 feet									Well head elevation 7146 feet		
Well # 22	1250	40.0	1290	14.0	2390	0.760	8.52	49.3	<10.0	1450	916	26
Field data					2300		8.44					
Other data	Long -108.14824 Lat 37.21973 Well depth 156 feet Static level 41 feet									Well head elevation 7296 feet		
King II **	358	<10	358	NA	NA	0.680	8.19	1.47	100	360	NA	434
Other data	Long -108 08' 2.96" lat 37 14' 21.90" depth? Static level? sampled at 10 feet									Well head elevation 7182 feet		
Note 1 - Langlier Index - numbers above zero the water is not corrosive, below zero (-) are corrosive and will damage water plumbing												
Note 2 -SAR = Sodium Adsorption Ratio. The higher the number the less sutitable for plants. In general above 12 is not good for plants												
* Data from permit or from owner, not measured ** King II down gradient monitoring well *** dossolved metals NA = not analyzed												

Summary of GCC water well survey 2013 laboratory data - page 2 of 2										
			----------Cations dissolved ----------							
Well ID	Fe (total)	Mn (total)	Ca	Mg	K	Na	Methane	H2S	Temp	
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	deg C	
										Comments
Well # 9	0.504	0.211	68.8	58.3	3.69	323				High sodium, iron, manganese
Field data							0.18	<0.1	9.1	Very hard water
Well # 10	<0.05	<0.005	4.86	4.35	1.24	392				High sodium, High SAR
Field data							0.56	<0.1	9.6	
Well # 12	<0.50	<0.005	3.88	<1.00	1.22	255				High sodium, High SAR
Field data							2.97	<0.1	7.0	
Well # 8	0.105	0.021	11.8	11	2.15	490				High sodium, iron High SAR
Field data							0.35	<0.1	12.4	
Well # 18	0.248	0.005	1.35	<1.00	1.37	346				High sodium, iron, High SAR
Field data							13.34 High	<0.1	7.0	Methand is high
Well # 35	0.200	0.007	3.73	3.36	1.68	500				High sodium, iron, High SAR
Field data							0.12	> 5.0 high	12.6	H2S is high
Well # 22	80.6	0.807	5.48	2.99	2.62	578				High Na, Mn, SAR, very high iron
Field data							>30.0	>5.0	12.0	Methane is high, H2S is high
Other data	0.806***	0.007***								Iron sulfide particles very high
King II **	<0.050	0.014	69.0	63.4	NA	21.8	NA	NA	NA	Very hard water

FIGURES

Figure 1. 2013 Vista del Oro subdivision water quality sample location map.

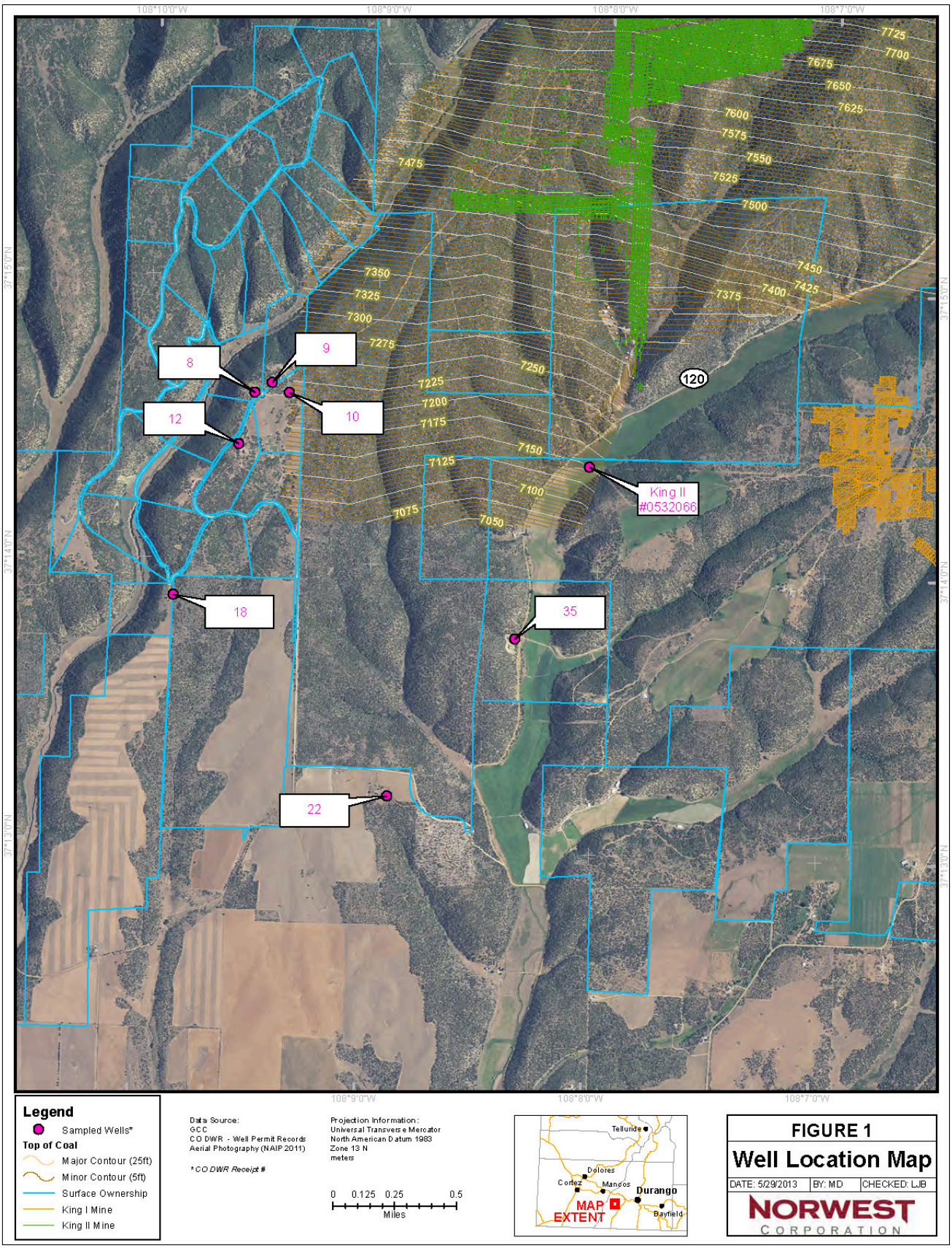

Figure 2. Vista del Oro water well lab-measured pH.

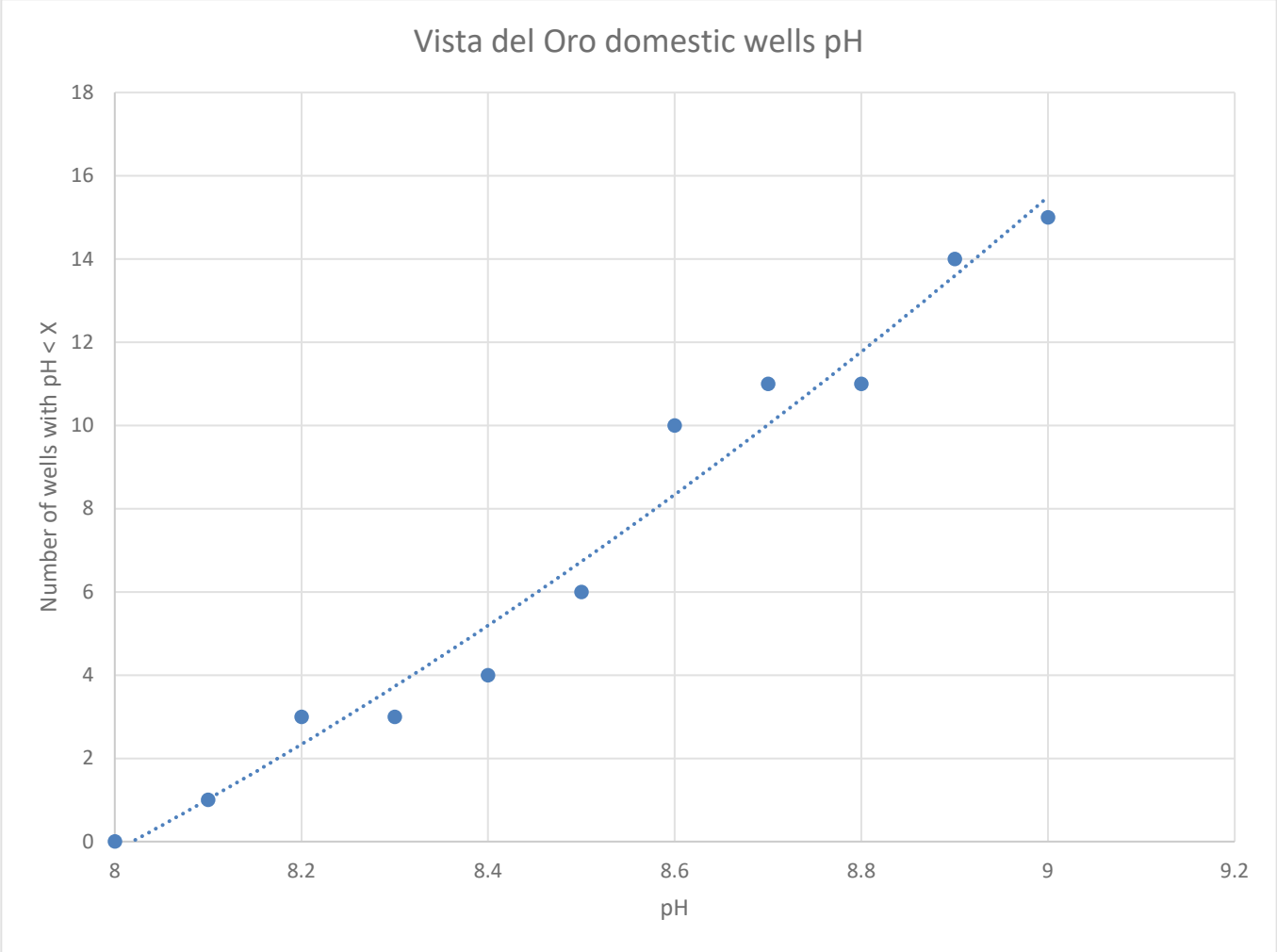

Figure 3 – GCC Hydrologic Monitoring Location Map.