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TECHNICAL MEMORANDUM

To	Tom Bird (GCC), Sarah Vance (GCC)	**Ref #**	2018-05-035-TM-1
CC		**Date**	2/13/2020
From	Landon Beck		
Subject	Response to 2018 King Coal Mine AHR DRMS Review dated January 2, 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 January 2, 2020.

The water quality criteria cited in the AHR are from EPA National Primary (enforceable) and Secondary (non-enforceable) Drinking Water Regulations, which set maximum contaminant levels (MCL's) for each listed constituent.

The Colorado Department of Public Health and Environment (CDPHE) Regulation 34 criteria quoted in the letter apply specifically to surface water. The only surface water in the area of concern is the Hay Gulch Ditch, which imports water from the Animas River to Hay Gulch for irrigation and mine use, with surplus emptying into the Mormon Reservoir. The ditch water used by the mine is totally consumed (under a valid water right) and does not reach or impact any natural water body.

Surface water quality classifications and standards (currently effective):

> Regulation 34: Classifications and Numeric Standards for San Juan River and Dolores River Basins (amended 1/14/2019, effective 6/30/2019).

It is claimed below that 1, all water quality data in the AHR reflect a natural baseline, and 2, that the mine has no possible mechanism to impact the baseline water quality as represented. Specific exceedances mentioned in the DRMS review letter are discussed in section 3.

1 BASELINE WATER QUALITY

Bedrock formations dipping across the mining lease consist of fine sandstones and shales with coal, which contain iron sulfides, which in turn concentrated trace metals in the reducing depositional environment. Weathering oxidation of these strata in contact with alluvial groundwater generates some concentrations of those trace metals, some of which (such as manganese) and sulfate tend to persist in the alluvial groundwater. The alluvial sediments are themselves derived from the same bedrock strata, and so should be expected to add to the

groundwater concentrations. Manganese levels exceed secondary "nuisance" criteria in some places, meaning they would stain laundry; sulfate in alluvial water is commonly high enough to be emetic to both humans and stock. There was some perceived potential for those constituents to have been released from King I mine waste, but they have been identified in monitoring data in wells upgradient of mining activity at similar levels to those near the King I waste site.
There are no alluvial groundwater wells known to be currently supplying domestic water because the landowners recognize these native properties.

In short, groundwater in the area may be pristine but is not altogether suitable for human consumption, and surface water is ephemeral (runoff from big storms), or imported (by ditch and pipeline) from outside Hay Gulch.

2 MINING IMPACTS

The mine has been dry and has no discharge, and hence no potential for impacting natural water quality. There is some potential for minor settling (pillars are left and there is no significant subsidence) to cause roof cracks which could drip-drain lenses of water from the overlying, low permeability Cliff House Formation, but this water would evaporate in mine ventilation. A mine water balance prepared on behalf of GCC Energy and presented in a report in 2014 by CDS Environmental Services LLC showed ventilation moisture accounted for all water applied for dust control. This report 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/GCC%20Class%20II%20%202012-0089%207-31-15%20%20E.1%20Water%20Balance%20Study%207.20.pdf

3 SPECIFIC "EXCEEDANCES"

Table 2 and the discussion thereafter mention manganese and TDS in the Hay Gulch ditch. As this water is imported from the Animas River, and is not impacted by the mine, the Regulation 34 criteria are not applicable.

Table 4 identifies pH and sulfate as potentially concerning in groundwater, with respect to CDPHE Regulation 41 criteria. As the letter notes, high sulfate is ubiquitous (due to weathering of pyrite-bearing coal and shale) and "not likely caused by mining activity." This should apply to alluvial as well as bedrock groundwater.

The following two plots, made during assessment of the monitoring data but not included in the AHR, show some relations between pH and total solutes (represented by SC). It can be seen the Animas River water in the Hay Ditch has widely variable pH and low SC, and the low SC may actually lend some of the pH variability through sensitivity which comes in dilute water with lack of buffering. Alluvial wells (1UpGrad = Well #1 Upgradient, Wiltse, MW-7-EAA) and Seep-1 generally have pH less than 8, though the Mormon Reservoir (MorRes) ranges between 8 and 9. Several bedrock wells, particularly in the deeper and less permeable Menefee floor designated Menefee Interburden (MW-4-MI, MW-5-MI, MW-6-MI) , have elevated pH, which might be due to hydrolysis of shale clays. Such hydrolysis is common, and may be represented as sodic clay + H^+ + H_2O yielding aluminosilicate + silicic acid + Na^+. The effect of such hydrolysis on pH is limited by the availability of H^+ in the first place.

Clearly each of these monitoring wells shows a discrete pattern, reflecting local rock-water interaction rather than some homogeneous entity (or entities). These figures do not show any sort of flow path evolution. If one compares pH and SC at coal wells MW-1-A (upgradient of the mine) and MW-3-A (downgradient, the differences would be better explained as lower TDS in MW-1-A due to shorter infiltration path, and longer path to MW-3-A dissolving more solutes and hydrolyzing more clay, than through some impact by the dry intervening mine.

FIGURES

Figure 1. pH vs SC (surrogate for total dissolved solids) in some surface waters and alluvial wells

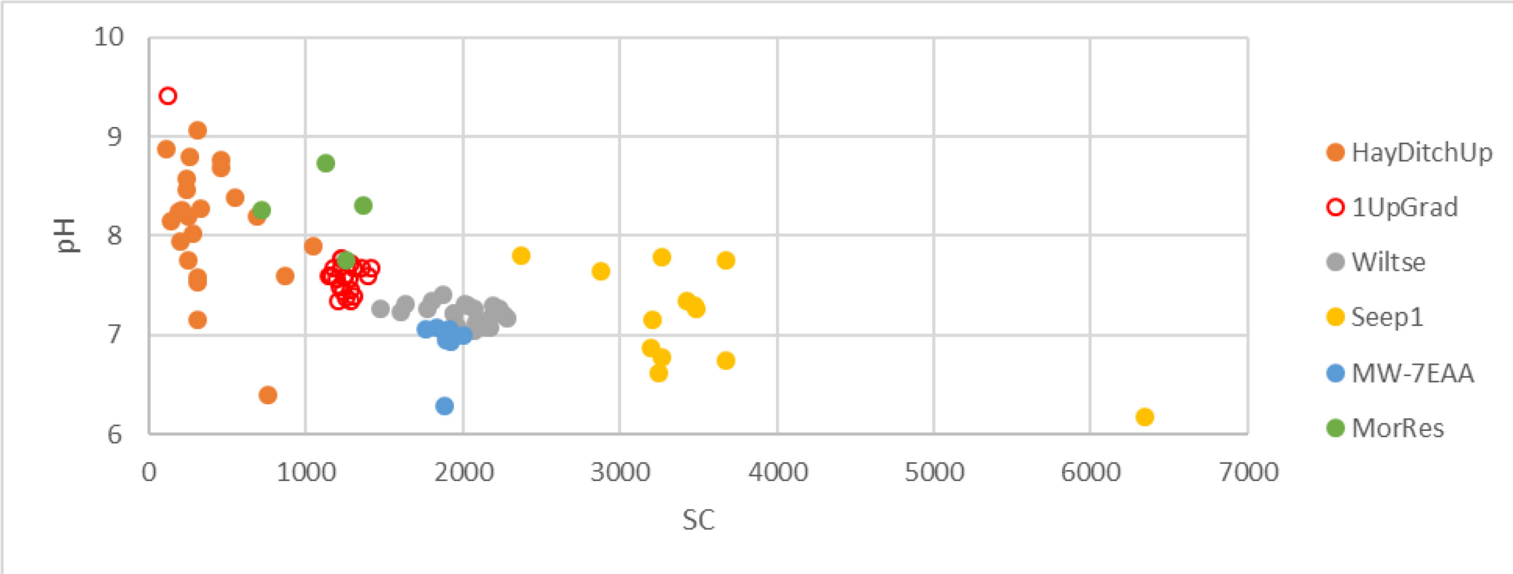

Figure 2. pH vs SC (surrogate for total dissolved solids) in bedrock wells

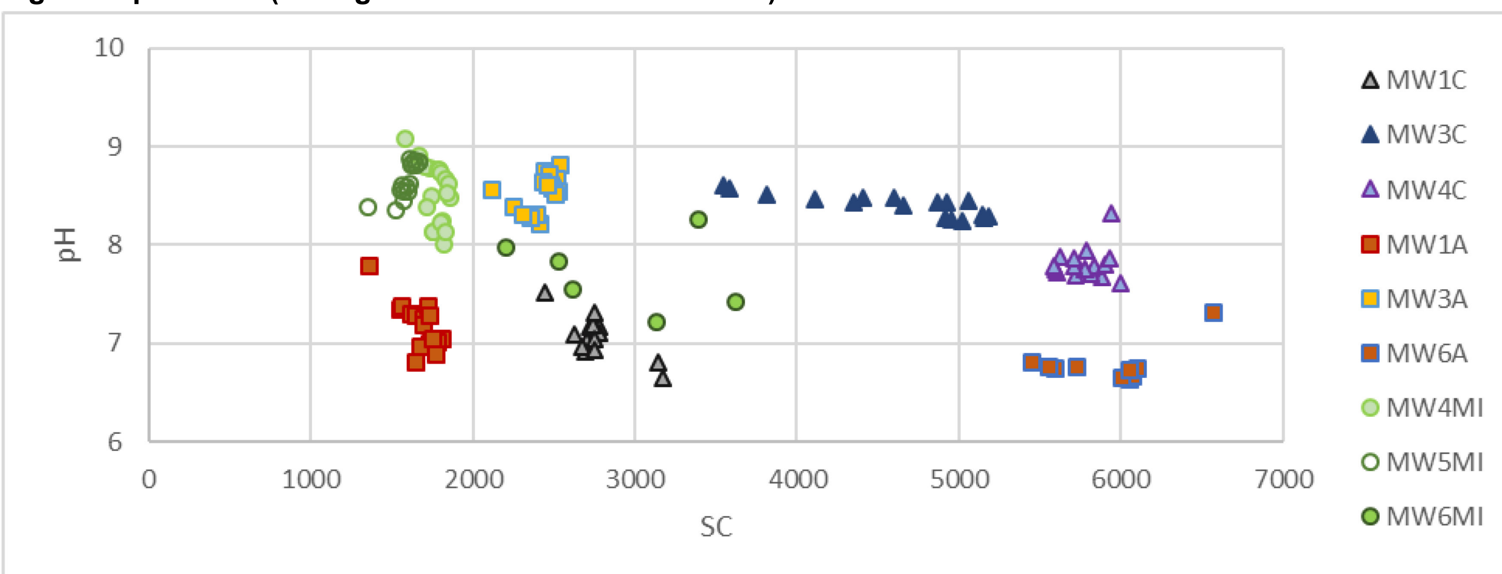

Figure 3 – GCC Hydrologic Monitoring Location Map