COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

1313 Sherman Street, Room 215
Denver, CO 80203

MEMORANDUM

Date: April 14, 2015

From: Tom Kaldenbach, DRMS Tom Kaldenbach

To: Peter Hays, DRMS

Re: Henderson Operations (Mine and Mill), Permit M-1977-342
Review of Numeric Protection Limits (NPLs) proposed by Climax Molybdenum for indicator parameters at the Henderson Operations in the following three submittals:

-- 5-Quarter Water Quality Data and Baseline Parameters Report (May 29, 2014)
-- Mill Groundwater Quality Assessment for MLGW-7 Low pH (March 20, 2014)
-- Groundwater Management Plan, TR-16 (April 2012)

I have reviewed the above-referenced submittals (the "submittals") which, collectively, propose establishing numeric protection limits (NPLs) for indicator parameters at the Henderson Operations. As explained in item 6, below, DRMS preliminarily accepts the proposed NPLs as adequate.

1. **Governing Rules.** Hard Rock/Metal Mining Rule 3.1.7(2)(c)(i) requires use of the following regulations as a guide in establishing permit conditions regarding ground water quality: "Colorado Water Quality Control Commission Rule 41, the Colorado Basic Standards for Ground Water" (CBSG).

2. **DRMS Implementation of CBSG.** The Colorado Water Quality Control Commission recommends that agencies who implement the CBSG use for guidance the ground water use classifications and standards of the CBSG when implementing ground water protection responsibilities, on a case-by-case basis, consistent with applicable law (CBSG 41.7H). Accordingly, as summarized in this Memorandum, DRMS has:

   a. Identified "specified areas" for the Henderson Operations (*see* CBSG 41.3.12) ,
   b. Informally adopted use classification(s) for ground water in each specified area (*see* CBSG 41.4), and
   c. Identified the standards that are applicable to ground water in each specified area, based on the informally adopted use classification(s) for each specified area (*see* CBSG 41.5).

3. **Rule Interpretations used in this Memorandum.** Key interpretations of the CBSG and the Hard Rock/Metal Rules that are used in this memorandum are summarized below (these interpretations may not apply to other sites where conditions are different from those at the Henderson operation).

   a. The Interim Narrative Standard (CBSG 41.C.6) is the section of the CBSG that applies in a specified area where **t**he Colorado Water Quality Control Commission has not assigned site-specific standards.

   b. Hard Rock/Metal Mining Rule 3.1.7(1)(d) explains that the Interim Narrative Standard of the CBSG supersedes any NPLs established following Hard Rock/Metal Mining Rule 3.1.7; therefore, DRMS can recognize an NPL value only if it is as restrictive as the values specified in the Interim Narrative Standard.

   c. Section 41.C.6.b.i. of the Interim Narrative Standard requires that ground-water quality be maintained for each parameter at the *least restrictive* of:
      - existing ambient quality as of January 31, 1994, or
      - that quality which meets the *most stringent* criteria set forth in Tables 1 through 4 of the CBSG.

   d. The words "most stringent criteria" in Section 41.C.6.b.i. of the Interim Narrative Standard and "the most stringent levels" in Section 41.C.6.b.iii of that Standard are interpreted to mean: if more than one use classification applies to a specified area, then the table value for a parameter must be selected from whichever table in Tables 1 through 4 contains the most stringent value for the use classifications that apply to the specified area.

   e. Based on the words "each parameter" in the Interim Narrative Standard, either the ambient quality or a CBSG table-value standard can be applied to ground water quality on a parameter-by-parameter basis.

   f. "Ambient groundwater quality" is the quality at the Henderson Operation as of January 31, 1994 (Hard Rock/Metal Mining Rule 1.1(5)).

   g. DRMS may use some discretion when considering accepting post-January 31, 1994 data as representing ambient water quality, based on CBSG Section 41.C.6.b.iii, which says:
      - In applying this interim narrative standard, the Commission intends that agencies with authority to implement this standard will exercise their best professional judgment as to what constitutes adequate information to determine or estimate existing ambient quality, taking into account the location, sampling date, and quality of all available data. Data generated subsequent to January 31, 1994, shall be presumed to be representative of existing quality as of January 31, 1994, if the available information indicates that there have been no new or increased sources of ground water contamination initiated in the area in question subsequent to that date. If available information is not adequate to otherwise determine or estimate existing ambient quality as of January 31, 1994, such ground water quality for each parameter shall be assumed to be no worse that the most stringent levels provided for in

Tables 1 through 4 of "The Basic Standards for Ground Water," unless the Commission has adopted alternative numerical standards for a given specified area.

h. A specified area has a three-dimensional geometry as indicated in CBSG 41.4.B.

4. **DRMS Designation of Specified Areas for the Henderson operation.** A "specified area" is an area where ground water is classified (CBSG, 41.3.12). DRMS recognizes four "specified areas" in the vicinity of the Henderson Operations, as described in Table A, below.

Table A – Specified areas of the Henderson operation

Specified Area	Extent
Mill Site Specified Area	All confined and unconfined ground water within the saturated zone in the area illustrated on attached Figure 1.
Aspen Canyon Ranch Specified Area	All confined and unconfined ground water within the saturated zone in the area illustrated on attached Figure 1.
Mine Site Specified Area	All confined and unconfined ground water that can reasonably be expected to be tributary to the West Fork of Clear Creek and is located within 2 miles downstream from the affected area of the Henderson Operations.
Crystalline Rock Specified Area	All confined and unconfined ground water within the saturated zone in crystalline rock in all areas that are within 2 miles downgradient from the affected area of the Henderson Operations, but are outside the three aforementioned specified areas. (The 2-mile downgradient distance is based on the discussion of specified area in section 41.12 of the CBSG.)

5. **DRMS Informal Use Classifications in Specified Areas.** DRMS informally classifies the uses of ground water in the Henderson Specified Areas as shown in Table B, below, subject to the possible addition of the use classification "Surface Water Quality Protection" that may result from further DRMS review as discussed in item 7 below.

Table B – DRMS informal use classifications of ground water in Specified Areas (subject to revision, pending outcome of additional review discussed in item 7, below)

Specified area	DRMS informal use classification of ground water (see CBSG section 41.4)	DRMS rationale for the informal classification
Mill Site Specified Area (see location on attached Figure 1)	Agricultural Use Quality	Topography and climate indicate the only probable future uses of ground water are agricultural or rangeland
Aspen Canyon Ranch Specified Area (see location on attached Figure 1)	Domestic Use Quality	Existing ground water use in ACR well
Mine Site Specified Area	Agricultural Use Quality	Topography and climate indicate the only probable future uses of ground water are agricultural or rangeland.
Crystalline Rock Specified Area	To be determined	

6. **NPLs applicable to the Henderson Operation.** The operator's submittals for TR-16 (April 2012) and the "5-Quarter Water Quality Data and Baseline Parameters Report" (May 28, 2014) propose NPLs as shown in Table C, below. The submittals propose NPLs only for the short list of analytes that were approved as indicator parameters in TR-16. The values in Tables 1 through 4 of the CBSG that apply to the informal use classification of ground water in a specified area are applicable to all ground water parameters for which NPLs are not established in the specified area.

   The Operator has proposed in their submittals ground water standards that are based on ambient quality for pH in the Mill Site, Aspen Canyon Ranch, and Mine Site specified areas, and for manganese in the Mill Site Specified Area. The proposed standard for manganese in the Mine Site Specified Area is based on the Table 3 value in the CBSG; a standard for manganese and iron has not been proposed for the Aspen Canyon Ranch Specified Area, pending further investigation by the operator.

   The submittals contain statistical analyses of long-term manganese and pH trends in the Mill Site Specified Area in support of the operator's proposal that the observed pH and manganese data represent ambient quality as of January 31, 1994. The Division considers the statistical analyses in the submittals probably constitute adequate information to determine or estimate existing ambient

quality, taking into account the locations, sampling dates and quality of all available data —although the Mill Site sampling locations may be within the ground water flow path of ground water seeping from the Tailings Storage Facility.

The proposed NPLs for the indicator parameters, as shown in Table C, are reasonable; therefore, DRMS preliminarily accepts the proposed values for the indicator parameters as NPLs, subject to the following two future additional reviews:

a) Review the possible need and the feasibility of installing and sampling a well in the Williams Fork alluvium at a location that is upgradient from all possible ground water that seeps from the Tailings Storage Facility. The purpose of such an upgradient location would be to confirm the manganese concentration of 0.79 mg/l and the pH lower limit of 5.9 are appropriate ambient values in the Mill Site Specified Area.

b) Review the need for adding the use classification "Surface Water Quality Protection" and associated standards, as discussed in item 7 below.

Table C – NPLs for the Henderson Operations, proposed by the operator and accepted in this memorandum by DRMS

Specified Area	Groundwater Point(s) of Compliance	Analyte	Basis for Proposed NPL	Proposed NPL (mg/l, except pH)
Mill Site Specified Area (see location on attached map)	MLGW-7, MLGW-15, and MLGW-17	Iron, dissolved	Table 3, CBSG	5
		Manganese, dissolved	Ambient	0.79
		Selenium, dissolved	Table 3, CBSG	0.02
		Zinc, dissolved	Table 3, CBSG	2.0
		Conductivity, umhos/cm	N/A	N/A (report)
		pH, s.u.	Ambient	5.9 – 8.5
		Sulfate		N/A (report)
Aspen Canyon Ranch Specified Area (see location on attached map)	MLGW-ACR	Iron, dissolved	Awaiting operator's investigation	Awaiting operator's investigation
		Manganese, dissolved	Awaiting operator's investigation	Awaiting operator's investigation
		Selenium, dissolved	Table 1, CBSG	0.05
		Zinc, dissolved	Table 2, CBSG	5
		pH, s.u.	Ambient	5.9 – 8.5
		Sulfate	Table 2, CBSG	250
Mine Site Specified Area	MNGW-1	Iron, dissolved	Table 3, CBSG	5
		Manganese, dissolved	Ambient	0.79
		Selenium, dissolved	Table 3, CBSG	0.02
		Conductivity, umhos/cm	N/A	N/A (report)
		Zinc, dissolved	Table 3, CBSG	2.0
		pH, s.u.	Ambient	5.9 – 8.5
Crystalline Rock Specified Area	To be determined			

7. **Additional review needed for considering applying use classification of "Surface Water Quality Protection" to Mill Site and Mine Site Specified Areas.** There may be potential for the Henderson Operations to discharge contaminated water into surface waters via the four pathways described below, especially after water pumps are turned off when operations end:

   a. **Tailings Impoundment Seep Water migrating to Mill Site Specified Area.** Tailings-impoundment seep water migrates from the Tailings Storage Facility to the Williams Fork River through the glacial and alluvial deposits that lie between the Facility and the River.

b. **Underground Mine Water migrating to Mill Site Specified Area.** Underground mine water migrates from the underground mine workings to the upper Williams Fork River Watershed through fractures in the crystalline rocks that lie between the workings and the river. This migration of mine water would occur only if the underground mine workings flood to an elevation higher than the Williams Fork River. (The crystalline rocks are permeable as indicated in Section 2.3 of TR-06 submittal from Climax Molybdenum, dated August 28, 1996, which refers to the storage capacity of the rocks.)

c. **Underground Mine Water migrating to Mine Site Specified Area.** Underground mine water migrates from the mine workings to the West Fork of Clear Creek through fractures in the crystalline rocks that lie between the workings and the creek. This scenario would occur only if the underground mine workings flood to an elevation higher than the creek.

d. **Leachate from Mine Site Bench migrating to Mine Site Specified Area.** Rain or snowmelt infiltrates the waste rock in the bench on the mine site, creates a leachate, and then migrates to the West Fork of Clear Creek.

Section 41.5.B.3.c of the CBSG defines "Surface Water Quality Protection" as "The standards necessary to prevent the exceedance of surface waters standards."

Section 41.4.B.3 of the CBSG says:

"Ground water within a specified area shall be classified "Surface Water Quality Protection" when: A proposed or existing activity does or will impact ground waters such that water quality standards of classified surface water bodies within the specified area will be exceeded."

The Williams Fork River and the West Fork of Clear Creek are surface water bodies that have been classified by the Colorado Water Quality Control Commission. The issue of applying Surface Water Quality Protection to the Williams Fork River was noted by DRMS (then, DMG) in a memo from Allen Sorenson of DMG/DRMS to the file of permit M-1977-342, dated August 20, 1996. The last sentence of the memo says:

"It is DMG's position that if potentially affected ground water is tributary to a surface water body, that ground water should meet surface water standards that have been established by the Water Quality Control Commission."