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**TO: Pamela Grubaugh-Littig, Permit Supervisor
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FROM: Hugh Klein, Geologist/Hydrologist *HK*

RE: Cyprus Plateau Mining Company (CPMC), Star Point PHC, ACT/007/006, Folder #2, Carbon County, Utah

SUMMARY

The following review is based on combining the various submittals into one document as will be required upon approval. In general, the hypotheses, conjectures, and beliefs in this document do not readily reference data. Geologic discussions are not prepared by a qualified geologist which is reflected in the text. Another deficiency is the lack of references to source documents, papers or other types of communication from which information has been taken. While many of the comments found in this memorandum may seem like semantics, attention to such detail is imperative for a professional scientific and/or regulatory document. Thus, the comments made here are not believed to be trivial and are believed to be critical to supporting a central thesis and doing so as per the accepted protocol. As this memorandum constitutes a professional technical opinion, it should be taken as that. However, the views put forth here are significant to the author and reflective of his stance on the PHC and related matters.

ANALYSIS

Within this section of this memorandum, the majority of comments will be made in such a manner so as the page and paragraph will be easily found from which the comment came. Before getting into specifics, a few general comments are pertinent.

Discussions pertaining to geology are in need of serious revision. A number of terms are used repeatedly that are not part of the accepted geologic nomenclature. The term "finger fault" and "bedding structures" are not found in the American Geologic Institute's second edition of The Glossary Of Geology (Bates and Jackson, editors). In addition, "submerged tight geologic structure" or even submerged structure is not defined. Additional shortcomings in the text occur by stating a fault is displaced (see the last paragraph on page 700-65). Faults are not displaced, rather faults displace rock units. Furthermore, faults, grabens and horsts are not structural weaknesses (see paragraph 3 on page 700-70), they are structural elements. In a sense, they can be considered a manifestation of stress and the focus of energy on the rock(s). Unless a structural element is formally recognized, it should not be capitalized. For instance, referring to the "Western Boundary Fault" of the Gentry Ridge

Horst is incorrect. That fault is not formally recognized in accepted geologic literature as such, so it should be referred to as the "western boundary fault of the Gentry Ridge Horst."

Stratigraphic nomenclature in the PHC is in some cases incorrect. There are many places where the document contradicts itself. For instance, in the second paragraph of page 700-65 one finds reference to the "Spring Canyon Tongue," while in paragraph 2 of page 700-67 this same unit is referred to as the "Spring Canyon member" and then "the Spring Canyon Sandstone." The latter terminology indicating the unit is a formation which is incorrect. Needless to say, the document conflicts within itself. When discussing a geologic unit, the unit must be introduced by its accepted formal name and include the appropriate capitalization. Subsequent references to the unit must be made using the full accepted formal name, except where cumbersome. Rules pertaining to stratigraphic nomenclature protocol can be found in the North American Stratigraphic Code, and is available through the American Association of Petroleum Geologists in Tulsa, Oklahoma. While there are differences between some workers as to whether a geologic unit is a group or a formation, a tongue or a member, an author should utilize accepted sources. Once accepted nomenclature has been decided upon, that convention must be used consistently throughout a document. Two accepted and recognized workers in Utah are Lehi F. Hintze and William Lee Stokes. Hintze's Geologic History of Utah (Brigham Young University, Geology Studies, Special Publication 7, 1988) and Stokes' Geology of Utah (Utah Museum of Natural History and Utah Geological and Mineral Survey, second printing - 1988) are especially useful in providing accepted nomenclature and stratigraphic columns.

Page 700-62

Paragraph 3

The text on this page refers to "Bear Canyon spring" and "Birch spring," yet Table 728a refers to these as "Bear Canyon Spring" and "Birch Spring." The capitalization here is inconsistent and needs to be revised so as to be in agreement. When referring to a spring by itself, such as Bear Canyon Spring, the word spring needs to be capitalized. When referring to a group of springs, such as Birch and Bear Canyon springs, capitalization of the word springs is not necessary.

Page 700-63

Paragraph 1

Page 700-62 ends with a complete sentence, however, this page begins in the middle of a sentence. As such, some text and pertinent information is missing. This sentence needs to be revised. In addition, Table 728a is not self-explanatory. What is the meaning of the shaded cells? Why are the water rights tabulated at the column head but no values are given in each cell?

Page 700-64

Paragraph 1

The text states, "According to CPMC personnel the area experienced an earthquake during the fall of 1988 which appears to have temporarily increased flows in Tie Fork." Because of the

possible connection between the earthquake and flows, it would be prudent to support the statement with the following information: time of the event, magnitude and epicenter. The information should also have a source.

Paragraph one goes on to state, "long term stability in flow rates for the Tie Fork wells indicates that the wells are fed by a large recharge area which is not influenced significantly by local precipitation." While this is a reasonable assumption, it is not the only explanation. Another consideration that has not been explored is that the lag between recharge and discharge is so long that drought or other effects have yet to be seen on flow quantity.

Paragraph 2

This paragraph concludes by stating, "Because of the relative fluctuations noted at both these springs, it is believed that the recharge sources are much smaller than that projected for the Tie Fork source." Again, this is feasible, but other possibilities do exist. Another explanation may be found in the role faults play in the hydrogeology. Regardless, the text needs to reflect that there may be other explanations or to dispel other possibilities. In any case, these are all hypotheses without supporting data. Statements such as, "it is believed" are very vague and do not appear to be based on anything other than conjecture.

Page 700-65

Paragraph 7

It is interesting to note that throughout the whole stratigraphy and structure section of the PHC there is not one single reference to a source document or a piece of original research. Also of note is the fact that the structure for a highly complex geologic area is covered in one short paragraph.

Page 700-66

Paragraph 1

Reference is made to "previous efforts made by CPMC as well as by other local coal mines and government agencies." However, none of these previous efforts by CPMC or other coal mines is noted or referenced at this time within the PHC, so it is hard to see where the consistency that is discussed here comes from.

Doelling (1972) and Spieker (1931) are both widely recognized pieces of research and would be supplemented well by the Hintze and Stokes publications noted above.

Paragraph 2

The text still contains reference to the possibility of an upward vertical gradient within the Star Point Sandstone at the Co-Op Bear Canyon Mine. There is not, nor has there ever been, information presented to showing an upward vertical gradient within the Star Point Sandstone. As no such gradient is known to exist, reference to such a gradient used to support CPMC claims are invalid and inappropriate within this section of the PHC.

Paragraph 3

While the information presented here provides an indication of the stabilization that the well was going through after the nested piezometers were installed, the information hardly constitutes data for a significant time period. In addition, there is no mention as to exactly where these piezometers have been installed. It is also interesting to note that while the shallow and intermediate wells were going through some minor fluctuations, water levels at the end of this data record show the deep well experienced a 2.52 foot drop in water level which is not explained. Thus, it is of some concern that statements are made about earlier and more recent data when the difference between early and recent data is only 28 days.

Paragraph 4

"It is interesting to note the similarity in hydrogeologic conditions found within the general Wasatch Plateau coal fields." This statement is not based on any readily apparent studies and appears to be a matter of conjecture. Later in the paragraph, it is stated, "In the Gentry Ridge area hydraulic gradients generally appear to be upward immediately below the coal seam with aquifers of lower head lying at deeper units within the Spring Canyon Member of the Star Point Sandstone." Again, there is not substantiation or reference as to a study for where such hypotheses or conjecture may have been arrived at. In the latter part of this paragraph, references are made to data collected from a well. Where is the information for well 92-10-1? There are no references to any drill logs or testing from this project.

Page 700-67

Paragraph 2

It is unclear why wells discussed here did not penetrate the lower tongues of the Star Point Sandstone. Also unclear is the depth to which the wells penetrate the formations that are referenced. Whether or not they penetrate the full depth or only partially, is unclear. Although there is some indication of the depth to which these wells were drilled, it is unclear as to how thick the formations were that the well encountered. As such, it is difficult to discern the depth of these wells relative to the local strata.

Page 700-68

Paragraph 1

Reference to the depths at which the piezometers were nested, is vague in relation to its location within that stratum. It is important to know where in the unit a piezometer is located, so one can assess data in relation to the specific point(s).

Paragraph 2

Again, discussion of this well fails to adequately identify where in relation to the bottom of this rock unit that the well has been completed. Giving initial head readings in psi is not as helpful as presenting the data in feet of water.

Paragraph 3

The same concerns as to the ambiguity of well completion in relation to rock units exists here also. The last sentence discusses the well being completed in April of this year. For future considerations, the year should be specified.

Paragraph 4

Up to this point, information provided by these wells has not shed significant light on the local ground water conditions. The data presented are ambiguous and fail to really show anything at this point in the PHC.

Paragraph 6

Map 728a, which is referenced in this paragraph, has shaded some of the geology in the area. As part of a previous review, the staff had asked for this shading to be removed. Although the response to the request was that it would change the map, it is unclear why this cannot be done given the fact the shading only makes the map more difficult to read.

Paragraph 7

The statement that the majority of seeps and springs occur at either a geological interface between bedding structures or at a fault is vague. Perhaps the author means to use the word contact as opposed to geologic interface. Regardless, how can the PHC be definitive about springs issuing from a contact when no detailed field geology has been conducted? In addition, the connection between springs and faults is suspect given that Map 728a shows many springs occurring on or near an inferred fault. Given that there has been no detailed field geology conducted and the lack of certainty in relation to geologic contacts, this statement about springs and seeps does not appear to be based on any data.

Page 700-69

Paragraph 3

The discussion about small flows encountered is somewhat vague. What is a small flow? Quantification of this would be appropriate.

Paragraph 4

The last sentence states "Mine water developed is used for in-mine and surface operations purposes and no mine discharge has occurred since July 1987." If the water from the mine is being used for surface operations then it would seem as though the water has been discharged from the mine. Semantics aside, the State Engineer's February 17, 1993, letter to Ben Grimes discussing water rights may bring up other issues. The letter states, "if any discharge water is placed to a beneficial use, a water right is required." Utilization of the mine water for surface operations would seem to be a beneficial use. As such, this issue warrants further investigation by both the permit supervisor and staff attorneys.

Paragraph 5

The discussion of significant inflows which drop off rapidly is vague. What are significant inflows and how rapidly do they drop off? Quantification of this is necessary.

Page 700-70

Paragraph 1

What is the significance of the 134 gpm annual yield? Why is the contributing area of the aquifer calculated in order to produce a specific flow? Why isn't the area that the PHC believes is recharging the aquifer calculated first in order to ascertain what yield is derived from that?

Paragraph 2

It may be true that there is less than five gpm taken from the surface streams, but it does mean that there is a net loss occurring (this amounts to 8.07 acre-feet per year). Furthermore, this paragraph is somewhat vague and doesn't conclude anything significant because the PHC is not definitively showing where the remainder of the water would have gone.

Paragraph 4

If there are efforts to try to measure the flow more accurately through the portable flumes noted here, then how precise are past measurements?

Paragraph 6

The text discusses flows that are "estimated" and "appear to be approximately." As such, how precise was the monitoring in this area? Since the flow discussed in this paragraph is sustained, how come it is not being monitored more accurately?

Paragraph 7

There is mention that "the wet areas noted are small and appear to be indicative of conditions which would be expected in a submerged tight geologic structure." What is a submerged tight geologic structure? This needs to be clarified. Next, one reads, "This submerged condition is consistent with what was expected based upon a review of both historic and current ground water level data." What does this mean? What submerged condition? Is the PHC referring to the fact that the area is wet and that is expected with the type of geology there? Clarification is needed here.

Page 700-71

Table 728c

Well 86-18-2 dropped 62 feet in three years. It is not stated exactly where the completion was or how deep the well penetrated.

Well 86-26-6 dropped 35 feet in five years. Supposedly, most of that is since 1986, but there are no data referenced to support that. Again, there is no information presented that will aid in ascertaining how deep the well penetrated into the lower unit or where it was completed.

Well 86-35-1,2,3 has only one water level taken and that is for 86-35-1. This measurement was taken in March of 1992 and there is nothing to compare this against. As such, it really does not provide significant information over time.

Well 86-01-TD: over five years this well has shown absolutely 0.0 change. It is difficult to believe that this well has not changed one tenth of a foot over six years. Again, there is no information showing where this well was completed and how deep it penetrated.

Well 86-02-HD has dropped 10.5 feet in approximately four and one half years. Most of this is claimed to have occurred in late 1987. The bottom elevation of the well is given, but again, the PHC doesn't state where this is in relation to the unit it is in (i.e., is it at the bottom or in the middle of this unit).

Well 86-03-WD has lost 17 feet of water in elevation in just under five and one half years. The information here does not show where in the formation the well was completed.

Well 92-01-WD does not show where the piezometers are within the formation itself and there is only one water level reading, so it is unclear what is happening over time here.

Well 92-02-WD does not indicate exactly where in the Spring Canyon it is completed and there is only one water level. There is no idea of knowing what is happening over time to the water level in this well. This is also true of Wells 92-03-WD and 92-04-WD. Again it does not state where within the unit a well completed.

The graben crossing well is referenced for the reading as being in the late 1980's. What kind of monitoring was done that the level is known, but not the date? Such data are questionable.

Page 700-72

Paragraph 1

"According to data provided, it appears that the overall water table has been relatively consistent over time with the exceptions of a few wells." This statement is not true, and is not based on facts. Out of six wells with eight monitoring points, there is only one date of monitoring for each point. Then, there is a well, which in six years had absolutely 0.0 amount of change. This information may be questionable. Finally, the remaining four wells have been monitored more than once and had significant water level changes. The minimum change in head was 10.5 feet and the maximum was 62 feet. Therefore, the statement that the overall water table has been relatively consistent over time is not substantiated.

Paragraph 2

This paragraph discusses the fact that Table 728d actually shows where the water is in relation to the coal seam (in a relative way). While some of the conclusions that are drawn are reasonable, it is also reasonable that one does not know for sure where the water is. This stems from the fact that these holes were not allowed to stabilize. Additionally, it is not specified as to how many different units were penetrated during the drilling operation. In terms of this latter concern, water could have been going into or coming out of another formation during the operation. The point is that the data are really inconclusive.

Paragraph 4

"The three wells located east of the current mining operations 86-01-TD, 86-02-HD, and 86-03-WD form a triangular pattern capable of allowing a prediction of ground water flow direction." This is somewhat true. Three points allow one to define a plane and make some predictions about groundwater flow direction. However, it is best when the points form an equilateral triangle, which is not the case here. In addition, 86-01-TD lies to the east northeast of 86-02-HD and 86-03-HD; east of three inferred faults. Trying to make statements or predictions of how ground water flows across a fault seems very tenuous and uncertain.

Page 700-74

Paragraph 1

On what basis can the PHC state, "Water level data...show a remarkably consistent ground water gradient."? Well 92-03-WD shows remarkably consistent ground water gradient because there is only one monitoring date shown. Well 86-26-6 has dropped 35 feet since 1986 and the last monitoring date shown is 1991. Well 92-03-WD was not even drilled until last year. These wells are not completed in the same formation. Given this information, it hardly seems adequate data are presented to make such a statement. If there are additional data from previous dates, this needs to be added or referenced.

It is confusing as to where the information or conclusion was derived that the western boundary fault of the Bear Canyon Graben is a recharging fault. There is absolutely no reference in this part of the text to any data. In hopes of finding information to support this idea, Map 722.100c was reviewed. After a cursory review of the map, it would not appear as though there is inadequate information to support the recharging hypothesis. In an eastward traverse from Well 92-02-WD to 92-04-WD and then to 92-01-WD, the information shows the piezometric surface dropping down towards 92-04-WD and then rising up to 92-01-WD. It is very difficult to understand how either well 92-02-WD or 92-04-WD could be placed between the 8350 and 8400 foot piezometric contour. Table 728c shows these wells to have water levels of 8343 and 8232 feet, respectively. The ground water contouring has been extremely generous where the contours take an obvious bend to the north across an inferred and a known fault. No water level data are shown for any of these bends, so they appear to be drawn to fit the conclusion without any supporting data.

Paragraph 2

"It was felt at the time of construction that water within this well was at an elevation of approximately 8330 feet." What is this based on? Is this quantified through some monitoring method?

Paragraph 3

In this paragraph, it is discussed that the PHC has combined data and concepts to lead to conclusions. The data used are not highly significant and the concepts are not very clear. Text indicates that ground water is moving southward and is fault controlled. However, the dip of the rock is also south southeast so that would be the normal way for water to flow. What is the basis for making statements about discharging and recharging faults? There are no real data to support this. Another conclusion is made based on "theoretical permeabilities of the geologic structures present in the area are small," yet no theoretical permeabilities are presented.

Page 700-75

Paragraph 1

With information that has been presented at this time, the overall gradient at Co-Op between the three tongues of the Star Point Sandstone is downward. Discussion related to this has been of ongoing contention, but there is no information which indicates an overall upward vertical gradient.

Paragraph 2

The fact that the text indicates that there is both upward and downward vertical gradients potentially existing on the Co-Op permit area, and that this strengthens the PHC's conclusion for the Gentry Ridge and Castle Valley Ridge coal lease tracts is not true. Given the above discussion about the gradient at Co-Op, this does not strengthen the Star Point PHC and needs to be removed. Once again, vertical gradients at Co-Op at this time have been shown to be downward.

Table 728e

Data used to come up with this table are somewhat sparse and there is no discussion about the methodology used to perform the slug test.

Page 700-76

Paragraph 2

Through reviewing and analyzing all data available, the PHC points to a possible water source in a very general way. However, the idea comes from a belief and does not reference any studies. It would be helpful to reference other information or studies that might help the reader in reaching the same conclusion.

Paragraph 4

Text states, "The stream appears to be loosing water." Rather, this should be "losing water." This mistake occurs repeatedly in the PHC and needs to be corrected.

Paragraph 6

There is discussion about recharge from local precipitation, surface water streams and regional fault flow. It is important to note that this water is migrating vertically through younger strata that are above the Star Point Sandstone and Blackhawk Formation, but also that these perched aquifers that mines are intersecting may be temporary. If these perched aquifers or zones are temporary, then they may be slowly recharging the Star Point Sandstone depending on the permeability of the unit(s) below the perched zone(s). Individually, this may be very slow and of small amounts, but integrated over the whole mine area this may be significant.

Page 700-79

Deuterium analysis presented has failed to show anything significant other than the fact the water tested is meteoric and as the text indicates, no comparisons can be made to Carbon 14 dates.

Page 700-80

Paragraph 3

Of notable importance is that throughout this paragraph and the three subsequent paragraphs discussing tritium analysis there is no reference provided. References should be added.

Paragraph 7

The age of this Carbon 14 water sample is not highly significant in terms of the overall ground water regime because it is only one sample, and as the text states, "no comparisons can be made as to the overall age of other waters sampled."

Paragraph 8

It is interesting to note that the water quality discussion does not get into any real detailed analysis of the parameters found on the DOGM list. The discussions for anion-cations and the water quality use only one sampling date and are for "A recent set of data." Mention is made of "historic data," but none are presented. There is no tracking of these parameters over any significant time period or correlation to baseline data.

Page 700-81

Paragraph 5

The PHC indicates "it is believed" that spring data can be correlated with deep waters. However, this is interesting to note, especially given the admission by the PHC that the area is highly

faulted and fractured. So, how can the PHC be definitive that the water coming out of the spring is from the deeper source and where that deeper source is? Such a conclusion or connection may not be made so easily in light of the presence of many perched aquifers.

Page 700-82

Paragraph 2

Again, it is not certain that spring data can serve as the groundwater baseline, given the uncertainty about sources. Faulting and fracturing of the rocks in this area is such an integral part of the geology that it can not be overlooked.

Page 700-82c

Paragraph 4

"Spring 753 shows a marked increase in flow during the 1981 to 1987 period. This increase reflects the wetter climatic conditions experienced locally between 1982 and 1985." If there is a connection between the wetter climate (1982 to 1985) and the spring flow, how did this manifest itself prior to the wet years (i.e., 1981)?

Page 700-82e

Paragraph 1

A stream survey conducted on July 2, 1986 is discussed here, but there is no reference to the data for this survey.

Paragraph 3

Text indicates that aquifer characteristics are going to change in certain subsidence zones due to fracturing, yet previously the proposal was to use springs to correlate with deep waters. If aquifer characteristics are going to change due to fracturing, then how can there be any certainty about spring sources?

Paragraph 4

The PHC acknowledges that "There has undoubtedly been some impact (although perhaps small) to the regional aquifer system due to mining as perched systems in the channel sandstones of the Blackhawk Formation have been intercepted." Given this, the possibility of continued impact is likely and warrants serious consideration.

Page 700-82g

Paragraph 3

There is indication that the PHC believes mining in Castle Valley Ridge and Gentry Ridge leases will have little or no impact on Birch or Bear Canyon Springs because other mines are closer. This is not necessarily true. Cumulatively many mines may/are affecting the water in the area. The basis for this is due to: 1) uncertainties in geology (the highly faulted and fractured nature of the area); and 2) does anyone know the difference in effects on the ground water system caused by room and pillar mining versus longwall mining? Even given the difference in distance, can the PHC be definitive about the difference in the impact(s)?

Paragraph 4

If CPMC encounters higher flows than U.S. Fuel (which encountered 800 to 900 gallons per minute), how is this going to affect the Tie Fork wells or Bear Canyon Spring? As this possibility exists, it requires an explanation.

Page 700-82k

Paragraph 1

True, "The complexity and additional length" of the flow path from CPMC to Birch and Bear Spring reduces the potential for impact, but it does not eliminate it.

Paragraph 3

"The stability of flows within the Tie Fork water supply indicates that the recharge source consists of a large drainage area and that it is not readily influenced by surface sources." True, this well is probably not readily influenced by surface sources, but how can one be certain about a large drainage area? What of a complex hydraulic pathway that is extremely long?

Paragraph 4

Will the Tie Fork wells and/or Bear Canyon Spring not be subject to a quantity impact even if flows like those at U.S. Fuel are encountered by CPMC?

Page 700-82k-2

Paragraph 3

The statement about the water passing through the coal seam being carbon filtered, is not realistic. Perhaps the point being made is about filtering and dilution as water migrates through rock, but this really depends on the rock. When passing water through a coal seam, the quality is more apt to decrease as the water encounters mudstones, siltstones and shales. Additionally, water passing through a coal seam can be subject to an increased concentration of pyrite and sulfate. If the

intention here is to show a particular contaminant bonds or reacts with some constituents found in those beds, that should be made apparent.

Page 700-82m

Paragraph 7

At this time, baseline data for ground water has not been met. This opinion is based on the fact Table 728c and Map 728a do not present conclusive data. Many of the points provide information for only one monitoring event which does not indicate any type of consistency and thus, is not statistically representative. Moreover, the PHC has not shown springs to be statistically representative of the formations from which they flow. The highly faulted and fractured nature of this area can not be discounted, so how can the PHC be certain about a spring's deep source? In addition, where are the water quality data for the wells mentioned in this paragraph?

Page 700-82n

Paragraph 2

How are conclusions about an "approximated" water level confirmed by one well? Where are the data from this well and which map is it shown on?

Final general comments

After reading the PHC, many questions are still left unanswered. For instance, why were none of the wells drilled into the lower tongues of the Star Point Sandstone? If the PHC is certain about the water table between wells, why wasn't a cross-section provided for clear illustration? Why weren't drillhole logs presented and why isn't it clear as to exactly where in a formation a well is completed? It is also difficult to understand how water levels are correlated between drillholes completed in different formations without any discussion of that. The PHC has omitted any discussion of possible impacts the refuse pile may or may not have on ground water. Finally, the PHC does not contain a serious mitigation plan.

RECOMMENDATION

The PHC must be revised so as to resolve the numerous questions above. Geologic discussions made at the beginning of this memorandum will require changes throughout the document and were too numerous to list.