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March 23, 1993

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RECEIVED
MAR 24 1993
DIVISION OF
OIL GAS & MINING

Re: Protest to Application for
Federal Coal Lease UTU-64263

Dear Sir or Madam:

This firm represents Huntington-Cleveland Irrigation Company ("Huntington-Cleveland") and submits this protest to Cyprus-Plateau Mining Corporation's Application to add Federal Coal Lease UTU-64263 to its Coal Mining and Reclamation Permit Number ACT/0077006. This protest is filed pursuant to the Utah Coal Mining and Reclamation Act, Utah Code Ann. § 40-10-1, et seq. and Regulations adopted thereunder, R645, Utah Administrative Code. This protest is timely filed in that the final publication date of the Notice of Completion is March 25, 1993.

Protestant Huntington-Cleveland is a non-profit mutual water company which holds substantial surface and underground water rights in the Huntington Creek drainage, Emery County, Utah. Huntington-Cleveland provides irrigation, domestic, municipal, stock-watering, and industrial water to its shareholders and is the principal purveyor of water in the north Emery County area. As such, Huntington-Cleveland is an interested party under R645-300-122.200 and R645-300-121.310.

The protest of Huntington-Cleveland is based on expected adverse impacts that mine activity and mine dewatering in the area encompassed by Lease UTU 64263 on hydrology and water sources of Huntington-Cleveland in that vicinity.

Huntington-Cleveland commissioned a review and analysis of the probable hydrologic consequences submitted by applicant pursuant to R645-301-700 in support of its application. This review and analysis by EarthFax Engineering, Inc. demonstrates both deficiencies in the probable hydrologic consequences and the greater extent of impact that mine-dewatering practices of the Applicant will have on water sources in the Huntington Creek Drainage including those of Huntington-Cleveland. That review and analysis is submitted herewith and incorporated by this reference.

It is important to note that the mine dewatering practices of the applicant will, if the permit is granted, pump water out of an area of the mine in the Huntington Creek drainage into other areas of its mine which is in the Price River drainage. Thus, moving water from one drainage to another, and away from the points of diversion (springs and wells) of Huntington-Cleveland.

This permit, if granted, would violate R645-300-133.400 in that material damage to the hydrologic balance outside the permit area will occur. Also, adverse impacts to water quality may occur to water that remains in that drainage. Without mitigation, the issuance of the permit would violate R645-301-700, et seq.

Huntington-Cleveland further requests an informal conference.

Thank you for your attention to this matter.

Yours truly,

J. Craig Smith

Enclosure
cc: Huntington-Cleveland Irrigation Company

PS>C:\FILES\HUNTINGT\DOGM.LTR

March 11, 1993

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Re: Review of Cyprus-Plateau PHC Document

Dear Mr. Smith:

This letter transmits a report of the review of the Probable Hydrologic Consequences Determination (PHC) of the Cyprus-Plateau Mining Corporation's Star Point Mine. During our review particular attention was paid to the impacts which mining activities described in the PHC may have on the water rights of the Huntington-Cleveland Irrigation Company.

Our review has identified the following points:

- Estimates of mine inflows in the Gentry Ridge section of the mine, range from 62 gpm to approximately 1100 gpm. The lower end of the range is from non-fracture related inflows, while the upper end of the range is from anticipated inflows if the fractures associated with the eastern margin of the Pleasant Valley Graben are intersected.

- Significant inflows to the mine could be encountered from the fractures of the eastern margin of the Pleasant Valley Graben. The anticipated inflow rate from these fractures may be as high as 800 to 900 gpm. If these flows are encountered, the downgradient Tie Fork wells and other fracture-related water sources may be significantly affected.

- Dewatering from the mine is expected to result in drawdown that will be measurable a maximum of 20,000 feet to the south of the mine and 25,000 feet to the east and west of the mine. This is a theoretical extent and may be affected by topography and the continuity of the aquifer.

- Maximum drawdown at the Tie Fork wells, resulting from the anticipated mine dewatering, is estimated to be 25 feet. Such a head reduction would likely result in discontinuance of artesian flow from the wells.

- The dewatering of the mine will reduce the gradient of the water table south of the mine and is estimated to reduce the non-fracture related flow of groundwater downgradient of the mine by a rate of 0.0009 gpm per foot of aquifer width. Within the area of drawdown, a typical spring might anticipate 0.19 gpm reduction in flow and the stream flows might be reduced by 4.75 gpm per mile of stream.

- o The estimated total cumulative impact of mine dewatering to all springs, streams, and wells, within the maximum drawdown area, is approximately 133 gpm. The total potential impact to HCIC water rights is an estimated flow reduction of about 85 gpm.

- o The potential exists for long-term downgradient water quality impacts. The time frame for movement of a contaminant plume could be rapid if it entered the fractures of the graben-bounding fault systems on either side of the Gentry Ridge mining area or extremely slow as interstitial migration. Migration of toxic or carcinogenic constituents, used and spilled within the mine, could have a significant effect on a culinary water source. Based on the analysis in the PHC, the concentrations of some contaminants could be high enough to cause health concerns.

- o The proposed 62 gpm (300 shares) compensation water may be inadequate considering the estimated potential impact is greater than the proposed compensation water flows.

Based on the above findings, the following recommendations are offered to ensure that the water sources for HCIC are protected:

1) The full effects of dewatering and other diversion during and after mining are difficult to project. Based on the anticipated theoretical impacts, it would be prudent for HCIC to require CPMC to consider options for protection of the Tie Fork wells. It is recommended that an agreement be developed with CPMC specifically addressing potential impacts to the Tie Fork wells.

   One simple option would be to ensure that regular and accurate flow measurements are collected at the Tie Fork wells. These measurements could be the basis for any compensation based on actual impacts to the average (or an agreed-upon minimum) flow. The compensation could be in the form of water rights, replacement wells, pump installation and operation costs, etc.

   As indicated in Exhibit 728a of the PHC, combined flow at the wells has averaged about 85 gpm between 1983 and 1992, excluding erratic flows inferred to be related to earthquake activity in 1988. According to the graphs contained in Exhibit 728a, flow at the wells during that period has been consistently greater than 82.5 gpm. This flow rate could be used as a baseline against which future flows are compared.

2) It is recommended that a water-quality monitoring program be developed for the downgradient culinary water sources. This monitoring program should be developed

based on the results of an inventory of all chemical compounds used underground at the mine.

We hope that this review summary meets your needs and the needs of your clients. If you should have any questions, please call.

Sincerely,

Thomas J. Suchoski
Hydrologist

and

John D. Garr
Geologist

Enclosure: PHC Review Report

REVIEW OF CYPRUS-PLATEAU STAR POINT MINE
PROBABLE HYDROLOGIC CONSEQUENCES DETERMINATION

HUNTINGTON-CLEVELAND IRRIGATION COMPANY
Huntington, Utah

Prepared By:

EARTHFAX ENGINEERING, INC.
Midvale, Utah

March 11, 1993

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CHAPTER 1

INTRODUCTION

This report presents a review of the Probable Hydrologic Consequences Determination (PHC) of the Cyprus-Plateau Mining Corporation (CPMC) Star Point Mine. CPMC is proposing the expansion of the Star Point Mine to allow mining under Gentry Ridge on the Wasatch Plateau. During the review, particular attention was paid to the impacts which the proposed mining activities described in the PHC may have on the water rights of the Huntington-Cleveland Irrigation Company. The review consists of the following elements:

- o Review of PHC Text
- o Water Rights Inventory
- o Evaluation of Dewatering Impacts
- o Conclusions and Recommendations

The review is divided into five chapters, including this introduction. Chapter 2 is a point-by-point review of the PHC document as submitted by CPMC to the Utah Division of Oil, Gas, and Mining (UDOGM). Chapter 3 is a comparison of the water rights information currently on file with the Utah Division of Water Rights (UDWR) and the water rights information identified by CPMC in the PHC document. Chapter 4 is an evaluation of the dewatering impacts of the mining operation, based on our best estimate of hydrogeologic conditions and parameters. This is followed by a conclusions and recommendations section in Chapter 5. References and calculations are included as appendices.

CHAPTER 2

REVIEW OF PHC TEXT

The PHC document herein reviewed contains text revisions dated September 8, 1992 and redline/strikeout revisions dated January 15, 1993. The text of the PHC was reviewed for technical adequacy, thoroughness, and consistency. While the document contains some misspellings, unconventional or misused jargon, and improper geologic names, this review is limited to the technical aspects of the document.

This review is organized according to page number. The content under review (quotes, paraphrases, or concept summaries) is in italics; the review comments immediately follow, and are not italicized.

Page Number

700-62 *Paragraph 3, last two sentences: "According to information provided by the water suppliers involved and the Utah Division of Water Rights database computer, there are three water sources used for culinary water supply which may potentially by (sic) impacted by mining. These water sources include two wells located in Tie Fork Canyon and two springs identified as Birch and Bear Canyon springs."*

In fact, according to the PHC, there are five potentially impacted culinary water sources (three wells in Tie Fork Canyon and the two indicated springs). These water sources should be consistently documented or explain why they are not addressed.

Subsequently, on page 700-82l, Paragraph 3, it is stated that "the majority of impact to the surrounding environment will potentially be a reduction in, not elimination of the water supplies currently identified as Tie Fork wells, Birch Spring, and Bear Canyon Spring." Page 700-82o-2, Paragraph 1, first sentence, removes Birch Spring and Bear Canyon Spring from the list of water sources "to be potentially impacted by mining in the Gentry Ridge or Castle Valley Ridge areas", leaving the Tie Fork Wells as the only potentially affected culinary source. On page 700-82p, Paragraph 1, first sentence, all three water *sources are again discussed, but the text has been redlined to discount Birch Spring and Bear Canyon Spring as potentially affected sources.*

References to the water sources which may be affected by mining in the Gentry Ridge and Castle Valley Ridge areas should be consistent throughout the document.

700-63 *Paragraph 1, first line: "combined flow right)."*

The final sentence on the previous page is complete; this appears to be a sentence fragment.

Table 728a, CVSSD Water Rights and Sources

It is unclear what the table is showing. It would be helpful if the meaning of the shaded/unshaded boxes was explained.

700-70 *Paragraph 1: The area of aquifer required to produce an annual yield of 134 gpm from "channel sandstones" is discussed.*

The significance of the 134 gpm value is not discussed or referenced in the PHC. Further, because flow from such sandstones typically diminishes over time (as discussed in the previous paragraph), it is unclear why there is discussion of "an annual yield".

Paragraph 2: ". . . it is estimated that over 95 percent of traditional water made within the mine is derived from storage of the channel sandstones in the Blackhawk Formation, and actual total impact to surface receiving streams is probably less than five gpm".

These values are not supported by references, measurements or calculations. For example, page 700-69, paragraph 3 presents several additional sources of potential mine inflow, none of which are quantified. Given the importance of the estimate (i.e., off-site impacts of mining operations) appropriate backup information is critical. Also, the meaning of the phrase "traditional water" is unclear.

These inflow and total impact values apparently represent channel sandstones only. The impacts from other sources are not addressed. Page 700-82g, paragraph 4 indicates the "significant" possibility of fracture-interception inflows on the order of 800 to 900 gpm. However, this significant inflow is

dealt with only from the standpoint of in-mine impacts. The potential downgradient impacts to water sources are not addressed.

700-72 *Paragraph 1, first sentence, in a discussion of water level data on Table 728c: "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 assertion is not supported by data presented in Table 728c. Of the 11 wells listed on the table, six have only one water level measurement reported; the remaining five wells have only two measurements reported. Of these five, the water level in only one well (86-01-TD) was "consistent over time", with groundwater elevations of 8350.0 feet measured in both 1986 and 1992. In the remaining four wells (i.e., 80 percent of the wells with more than one water-level measurement), water-level declines were measured. These declines ranged from 10.5 feet to 62 feet, over periods ranging from three to six years. Thus, it is not appropriate to conclude that water levels in the area have been consistent through time.

700-75 *Paragraph 3 and Table 728e: Table 728e is a list of the hydraulic conductivities (K) calculated from the results of four aquifer tests of CPMC in-mine wells and three tests conducted in the Co-Op Mining Company Bear Canyon Mine. Exhibit 728c of the PHC contains supporting time/drawdown plots for CPMC slug tests conducted in wells 92-01C-WD and 92-02-WD.*

Time/drawdown plots and supporting data are presented in the exhibit for only two of the four CPMC wells tested; data for wells completed in the Blackhawk Formation (92-01A-WD and 92-01B-WD) are not included in Exhibit 728c. Because the Wattis coal seam is within the lower Blackhawk Formation, data should be included to support conclusions regarding the hydraulic characteristics of the lower Blackhawk. In view of the statement that "calculated permeabilities within the Blackhawk Formation are two to nine orders of magnitude lower than those found within the Star Point Sandstone" it is important that all plots and supporting data be presented.

Additionally, there appear to be several problems associated with the slug test analyses. First, the K value (inaccurately identified as "permeability" in the text as opposed to "hydraulic conductivity") reported for well 92-02-WD in Table 728e does not correlate with the transmissivity (T) value for 92-02-WD listed in the output file in Exhibit 728c. The T value in the output file is reported as 8.1109^{-3} ft^2/min. Transmissivity is converted to hydraulic conductivity by dividing the T value by the aquifer saturated thickness. The output file in

Exhibit 728c lists the aquifer saturated thickness as 194.8 feet. Therefore, the transmissivity (8.1109^{-3} ft^2/min) divided by saturated thickness (194.8 feet) equals a hydraulic conductivity of 4.16^{-5} ft/min (0.06 ft/day). The hydraulic conductivity value presented in Table 728e for well 92-02-WD is 3.07^{-4} ft/min (0.44 ft/day).

Second, it appears that the plot for well 92-02-WD contained in Exhibit 728c represents a hand-fit unconfined Bouwer and Rice analysis plot of the slug test data, while the output file generated by the estimation procedure in AQTESOLV includes the constants for an unconfined Bouwer and Rice analysis and the title and residuals from a confined Cooper, et al. analysis. Therefore, the results of the analysis generated for this well are questionable. Based on the initial input data provided where the saturated thickness and the static height of water in the well are the same, the aquifer appears to be unconfined. Well logs and drilling records would be required to clarify the aquifer condition and these are not provided in the PHC. Therefore, it is difficult to evaluate the validity of the analysis.

Third, according to the well completion diagrams in Exhibit 728b, wells 92-02-WD and 92-01C-WD were constructed with 2-inch diameter PVC pipe. Slug test analysis with AQTESOLV requires the input of casing and well radius in feet. The radius of 2-inch diameter PVC (in feet) is 0.0834. The value used by CPMC in the analyses of both wells was 0.17 feet, which roughly corresponds to the casing diameter. The radius or diameter of the well borehole is not shown in the completion diagrams. However, the diameter is indicated in the aquifer evaluation calculation sheet of Exhibit 728c. The well borehole diameter for both wells was also used instead of the well borehole radius. Such input errors in the AQTESOLV program would decrease the CPMC calculated hydraulic conductivity values, resulting in a more conservative estimate of hydraulic conductivity.

Re-analyses of the slug test data using the AQTESOLV program with the correct inputs for well construction, the time-drawdown data provided in the PHC, and the Bouwer and Rice method are presented in Appendix A of this review. Based on these re-analyses, the hydraulic conductivity values for the Spring Canyon slug tests are 7.62×10^{-4} ft/min (1.10 ft/day) and 8.54×10^{-5} ft/min (0.12 ft/day) for 92-01C-WD and 92-02-WD, respectively. These new values are lower than the reported values by a factor of approximately 3.5. As indicated previously, data were not provided for the remaining wells, thus not permitting re-analysis.

700-80 *Paragraphs 3 through 6: Discussions of tritium dating theory and results of tritium analyses.*

As in other sections of the document where information derived from other sources is presented (e.g., regional geology, stratigraphy and structure), no references are cited. Thus, the validity of the conclusions is difficult to assess.

700-82f *Paragraph 1, last sentence: "The historic removal of waters discharging from the mine probably reflects less than a five gpm impact to surface streams which receive recharge from ground water systems of the mine plan area."*

This sentence appears to refer back to page 700-70, paragraph 2. However, the 5 gpm value is not supported in either section by references, measurements or calculations. If the estimate has a basis, it should be stated. Again, with a major purpose of a PHC being to estimate hydrologic impacts in adjacent areas, this and other impact estimates should be supported by backup information.

Paragraph 2, line 11: "Some of the water may also be derived from a decrease in natural discharge from the aquifer."

The meaning of this sentence is not clear. Perhaps the words "decrease in natural discharge" should be replaced with "discharge of stored water".

Paragraph 3, first sentence: "It is believed that the more significant impact to the hydrologic system will occur as inflows are encountered at intercepted faults of the north-south extensional system."

"North-south extension" would be expected to produce volume-compensating normal faults oriented east-west (no such faults are depicted on the hydrogeologic map, Plate 728a). It is presumed that the faults or fractures referenced here are normal faults and joints, oriented north-south, which were produced by east-west extension.

Paragraph 3, third sentence: "The interception of significant quantities of ground water from faults within the mine beneath Gentry Ridge in the future may temporarily reduce recharge to springs and/or wells located within Tie Fork Canyon."

The Tie Fork wells are depicted on Plate 728a as being located in the vicinity of the eastern margin fault of the Pleasant Valley graben. Extrapolation of groundwater elevations, measured in the Gentry Ridge wells (listed on Table 728d), to the extreme southern portion of the permit area on Gentry Ridge

show that mining will be conducted approximately 275 feet below the regional water table. Because flow at the Tie Fork wells is inferred to be through faults and joints associated with the eastern margin of the Pleasant Valley graben, if connected faults and/or joints are intercepted by the mine (the possibility of fault-interception inflows on the order of 800 to 900 gpm is noted in Paragraph 4 of page 700-82g) flows at the Tie Fork wells may be significantly affected. Although the effects of such mine-intercepted flow are difficult to predict, no means of monitoring or mitigation are proposed. Monitoring methods and potential mitigation measures are discussed in the Recommendations section of this report.

700-82g *Paragraph 5: In a discussion of total water volume and sustained inflow to the mine beneath Gentry Ridge as the local water table is intercepted, it is estimated that a total of 2,565 acre-feet of water could be dewatered.*

Two factors which may increase the quantity of water available for inflow to the mine were not considered in the analysis. First, the analysis ignores recharge. As recharge occurs, more water is added to the dewatered "void", thus increasing discharge. Second, the analysis ignores the potential influence of groundwater flow along faults and fractures (an influence which was identified on page 700-82f, paragraph 3 as being significant). The effect of the fractures would be to greatly increase the lateral extent of the area of inflow, and increase the quantity of inflow to the mine.

Another factor in the analysis, however, may indicate that the potential inflows to the mine would be less than the estimated 2,565 acre-feet. This factor involves the time during which inflow to the mine will occur. The estimates for inflow to the mine ranged from 135 gpm to 400 gpm for flow through unfractured bedrock. These values are based on a hydraulic conductivity value of 10 gpd/ft^2 (1.34 ft/day). This value is slightly lower than the average value for hydraulic conductivity values from the CPMC well analyses and within the anticipated range of values for the materials anticipated. No time period is provided during which inflow to the mine will occur. At the lower estimate of 135 gpm, 2,565 acre-feet of water would flow into the mine in approximately 12 years (see Appendix B of this review). At the upper estimate of 400 gpm, the inflow would occur over 4 years. At the maximum combined rate for fracture and non-fracture inflow of 1,000 to 1,100 gpm, 2,565 acre-feet would flow into the mine in approximately 1.5 years.

If the average value for the re-analyzed well data (0.61 ft/day) is assumed to be representative of actual conditions in the area, estimated inflow to the mine is from 62 gpm to 185 gpm for bedrock inflow (see Appendix B of this review).

At the rate of 62 gpm, the time required for 2,565 acre-feet of water to flow into the mine would be about 26 years. At the higher rate of 185 gpm, the water would flow into the mine in about 8.5 years.

According to CPMC, mining beneath Gentry Ridge may be completed in mid-1996. Based on the estimated inflow rates, only a limited amount of water may flow into the mine within this time frame. If flows through fractures are not significant and non-fractured bedrock flows are within the estimated range (62 to 400 gpm), the volume of mine inflow which must be diverted from the mine during operations may be less than 2,565 acre-feet during the 3.5 year period of mining.

700-82i *Paragraph 6: The interbasin transfer of as much as 1,100 gpm inflow from fractures intercepted in the portion of the mine beneath Gentry Ridge is discussed, and references are made to measures intended to mitigate the impacts of such a transfer.*

The occurrence of fracture-related inflows is possible and may significantly affect downgradient water sources. The plans provided in the PHC address possible measures for avoidance of these potential inflows to the mine and associated interbasin water transfer, but no specific plans are proposed to mitigate decreased groundwater quantity or quality at the Tie Fork wells or other fracture-related water sources downgradient from the mine. Because potential impacts to these water sources have been identified and the impact could be the complete elimination of a downgradient water source, impact-mitigation measures should be discussed in appropriate sections of the PHC.

700-82k *Paragraph 3: The seasonal stability of flows at the Tie Fork wells is attributed to a large recharge area; it is stated that the Tie Fork wells are "not readily influenced by surface sources". This stability is contrasted with flows at Birch and Bear Canyon Springs, which according to the PHC "are influenced by drought, show seasonal variation and are probably influenced by heavy localized precipitation events."*

While it may be true that flow at the Tie Fork wells is seasonally stable, tritium analyses presented in Table 728g indicate that water collected at Birch Spring (0.98 tritium units) is older than that collected from Tie Fork Well 86-35-2, which was analyzed at 9.32 tritium units. Although all of the sampled waters are probably blends of pre- and post-bomb sources, based on the tritium data alone, the Tie Fork water is generally "younger" than the seasonally variable

(and thereby presumably younger) Birch Spring water. No explanation for this apparent inconsistency is given in the PHC.

700-82k-1 *Paragraph 4: In a discussion of contaminant dispersion, it is stated that an increase of 1,000 mg/l of any contaminant in the mine water would result in a 38 mg/l increase at the Tie Fork Wells, assuming that only the Spring Canyon Tongue of the Star Point Sandstone was affected.*

Paragraph 5: Assuming that the entire 550-foot-thick Star Point Sandstone was affected, dispersion and dilution would result in a contaminant increase of 14 mg/l at the Tie Fork Wells.

Paragraph 6: It is concluded that "potential contamination to downstream sources will be insignificant regardless of whether the Spring Canyon sandstone is fully confined or intermingles with other Star Point formations. The potential effects on small aquifers below the Spring Canyon sandstone unit will be negligible and undetectable. Potential increases on the order of magnitude of those determined above may be undetectable as a result of accuracy limitations of either the sampling equipment or the laboratory method used."

It is agreed that for most common mining-related contaminants (sulfates, nitrates, etc.), distributed according to non-fracture related flow, increases on the order of those determined by the dispersion analyses would be difficult to discern from natural variations. However, such is not true of "any contaminant", as stated. For example, an increase of 14 to 38 mg/l of a toxic or carcinogenic constituent could be profoundly significant to a culinary water source. The constituents likely to be contained in mining-impacted waters should be included in the discussion. Regarding laboratory detection limits, volatile organic compound analyses are routinely performed with 1 ug/l levels of detection.

No estimate is provided to determine the time it would take for water to travel, along a fractured or unfractured flow path, to the nearest water source. Preliminary estimates of flows through unfractured bedrock were prepared for this review using the average linear velocity equation (Freeze and Cherry, 1979). These calculations are provided in Appendix C of this review. Based on the hydraulic conductivity values from the slug tests, the groundwater gradient presented in the PHC, and an estimate of the porosity of the Spring Canyon Member from the PHC, the estimates of travel time (through unfractured material) from the mine to the Tie Fork wells range from approximately 190 years (based on the pre-mining gradient) and 200 years (based on the dewatered gradient). Thus, if contaminants are released from the

mine and are transported by non-fracture related flow paths, it may take many years for such contaminants to be discharged from the groundwater system.

Contaminants released from the mine which entered a fracture-related flow path, would be diminished only by dilution of the fracture flow. Additionally, the time for contaminant travel would be the significantly shorter than that presented above. Thus, contaminant transport through fractures would be expected to occur rapidly and with less reduction in concentration.

700-82k-2 *Paragraph 2: The filtering of groundwater through coal seams and mudstone units below the Wattis seam is proposed as a natural means of remediating mine-contaminated groundwater. The coal seams are compared to "carbon filters".*

Activated carbon is an effective adsorbent filter medium because it has an extremely large surface area-to-weight ratio. Commercially produced activated carbon has from 1,000 to 1,400 square meters of surface area per gram (Noonan and Curtis, 1990). Although coal is sometimes used as a raw material in the production of activated carbon, it is the dehydration, carbonization, and activation processes that create the high internal porosity by which activated carbon is distinguished.

Far from being a "carbon filter", unprocessed in situ coal is a poor adsorbent, and any benefit to groundwater quality from adsorption would probably be far outweighed by other impacts from the coal itself (e.g., pH changes as well as increases in total dissolved solids, calcium-, magnesium-, and sulfate-salts). Similarly, due to their evaporite-mineral content, the adjacent mudstones would not be expected to improve groundwater quality.

700-82p *Paragraph 1: "A review of historic data for all three ground water sources identified herein has shown that flows originating from either the Tie Fork Wells, Birch Spring, or Bear Canyon Spring make up only a small fraction of the total water right held by HCIC.....Mitigation of any impacted water supply should be according to the flows recorded for the impacted source and not tied to the total combined water right since the water right in this case has been combined for both those surface and ground water sources which could potentially be impacted as well as those which have little to no potential for impact such as Birch and Bear Canyon Spring."*

It is reasonable to conclude that mitigation agreements should be based on actual, historic flows or rights. However, it has been established that the Tie

Fork wells are the only culinary water source which could reasonably be affected by mining activities beneath Gentry Ridge. The inclusion of Birch Spring and Bear Canyon Spring in this discussion is confusing.

CHAPTER 3

WATER RIGHTS INVENTORY

A listing of water rights recorded with the UDWR was obtained and compared with rights listed in Table 724.100 and Map 731.800a (groundwater rights) and in Table 724.200b and Map 731.800b (surface water rights) of the CPMC mine plan. The list obtained for this review was current as of February 22, 1993.

Of a total of 59 surface water rights on the CPMC list, only 33 appear on the UDWR list. Because the CPMC list was compiled in March 1991, the rights "missing" from the current list have probably lapsed or otherwise changed status. Only one surface water right (No. 91-4727) was found on the UDWR list but not in the CPMC compilations. The right is identified as Serviceberry Creek, is owned by the Bureau of Land Management, and is located approximately 5 miles northeast of the Tie Fork wells.

Of the 85 groundwater rights compiled in the CPMC list (exclusive of the Tie Fork wells), 53 appeared on the UDWR current list. Again, because the CPMC list was compiled in April 1991, the rights "missing" from the current list have probably changed status. Only one groundwater right (No. 91-990) found on the UDWR list was not in the CPMC compilations. The right (the "Head of First Water Spring") is owned by the U.S. Forest Service, and is located approximately 7 miles due north of the Tie Fork wells.

According to the UDWR listing, current Tie Fork wells water rights held by the Huntington-Cleveland Irrigation Company include: 93-2220, 93-2221, 93-2222, 93-3657, and 93-3658. Of these, rights 93-3657 and 93-3658 are not included in Table 728a of the CPMC PHC document. Clarification of the status of these rights would be appropriate. Water rights information for these HCIC rights are summarized in Table 3-1 of this report. As indicated in the table, no information is available for rights 93-3657 and 93-3658.

In summary, it is concluded from the water rights search that most water rights relevant to HCIC holdings are contained in the PHC document. However, inclusion of current water rights listings within the CPMC mine plan and surrounding area would update and improve the PHC.

TABLE 3-1

Summary of the Huntington-Cleveland Irrigation Company Water Rights

Right Number	Owner Name	Source Location	Amount	Use	Period of Use
93-219	HCIC	Tie Fork Springs	150 cfs	Irr., Stock, Domestic, Power	1/1-12/31
93-2220	HCIC	Tie Fork Springs	45 cfs	Domestic, Municipal	1/1-12/31
93-2221	HCIC	Tie Fork Springs	77.25 cfs	Domestic, Municipal	1/1-12/31
93-2222	HCIC	Tie Fork Springs	80 cfs	Domestic, Municipal	1/1-12/31
93-3657	HCIC	Tie Fork Springs	-	-	-
93-3658	HCIC	Tie Fork Springs	-	-	-

CHAPTER 4

EVALUATION OF DEWATERING IMPACTS

An evaluation of the effects of mine dewatering was conducted in an attempt to estimate the following:

- o impact on Tie Fork wells
- o impact on streams and springs
- o duration of impact
- o height of water table recovery

4.1 IMPACTS

The potential impacts to the groundwater system include the potential for the mine to intercept groundwater (either in fractures or unfractured bedrock) and the associated decrease in water levels and flows at adjacent springs, wells, or streams. If the mine intercepts water conducted in fractures (particularly those associated with the eastern margin of the Pleasant Valley Graben), it is possible that the resulting diversion could impact flows at the Tie Fork wells and other downgradient fracture-related springs. Although CPMC states that exploratory horizontal drilling will be performed as the mine is advanced and that fractures will be avoided when detected, considering the complexity of faulting inferred for the east margin of the Pleasant Valley Graben, it is unlikely that an exploratory drilling program could detect every fracture and that every fracture could be avoided. Based on information presented in the PHC, which indicates that the possible fracture-related inflows might be as much as 800 to 900 gpm (page 700-82g, paragraph 4), the impact to fracture-related downgradient springs and wells may be significant and may result in the elimination of flows from the Tie Fork wells.

An evaluation of potential non-fracture-related inflow to the mine was performed for this review by assuming that groundwater in the Blackhawk Formation and Star Point Sandstone represents a continuous aquifer. This assumption is in agreement with the conceptual model of Lines (1985). It was also assumed that waters from the Tie Fork wells, the springs in the area downgradient from the mine, and the streams in the drainages downgradient from the mine are all derived from this continuous aquifer. It is recognized that these assumptions allow for a conservative assessment of the impact.

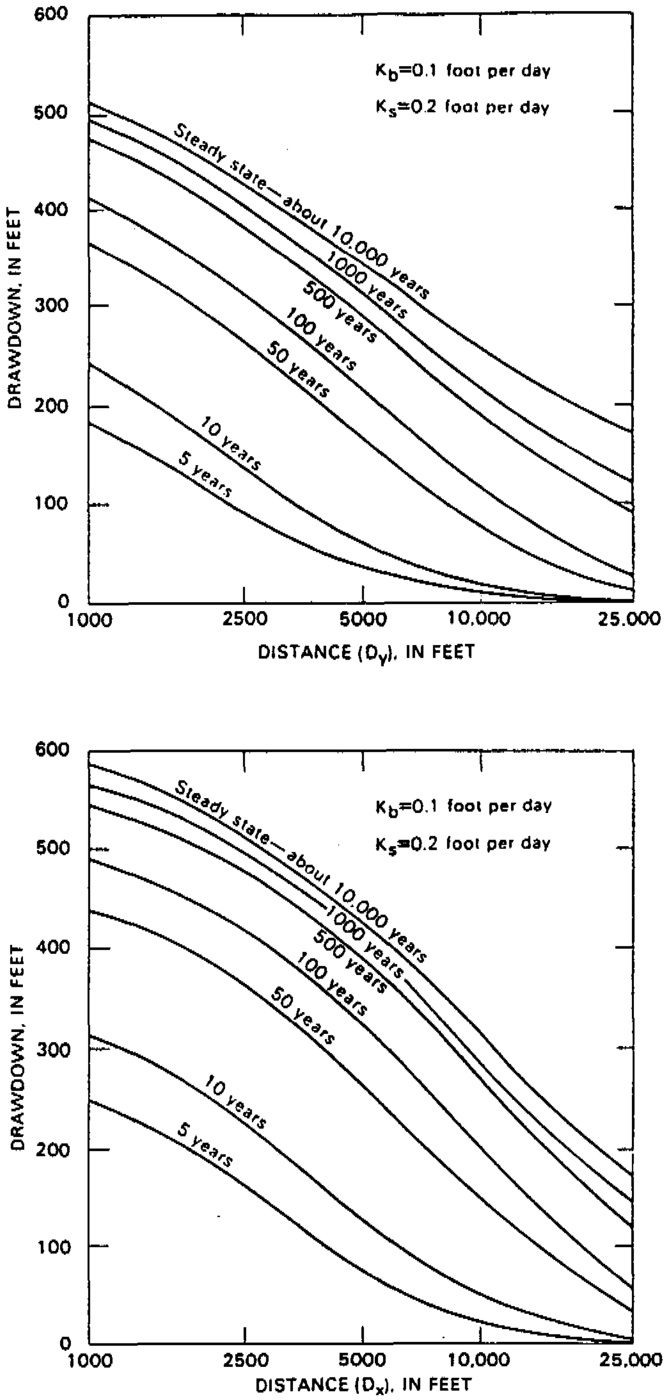
Based on these assumed conditions, the method presented by Lines (1985) can be used to estimate the affect a mine will have on the surrounding areas. Lines (1985) numerically modeled the influence of underground coal mining on groundwater conditions in the Trail Mountain area, located approximately 12 miles southwest of the CPMC mine in an area of similar hydrogeologic conditions. Based on the results of this modeling effort, Lines (1985) produced a set of curves describing the drawdown within the aquifer versus distance from the mine. These curves, and the assumptions used in the modeling effort, are presented herein as Figure 4-1. The method allows drawdown values to be estimated for various distances due to dewatering of a hypothetical underground mine located in the lower Blackhawk Formation. It is also recognized that this method provides an order-of-magnitude estimation of the drawdown values.

The site conditions in the area of the CPMC Star Point Mine are similar to the conditions in the Trail Mountain area. As with the Lines(1985) study, the Star Point Mine is located in the lower Blackhawk Formation and the aquifer is considered to be part of the Star Point-Blackhawk aquifer. Lines' (1985) assumptions differ from the site conditions in two areas. In the Lines (1985) model, the hydraulic gradient was 0.065 feet per foot and the average hydraulic conductivity was 0.2 feet per day. The site conditions in the area of the CPMC mine have a hydraulic gradient of 0.021 feet per foot and an average hydraulic conductivity (based on the re-analyzed data presented in this review) of 0.61 feet per day. The hydraulic gradient of the Trail Mountain site is approximately 3 times the gradient of the CPMC site and the hydraulic conductivity of the CPMC site is about 3 time the conductivity of the Trail Mountain site. While these parameter values are different, under an assumption of Darcian flow, the ratio of these differences is approximately one to one, suggesting that the predictions of the Lines (1985) model should be valid for the CPMC site.

The use of these curves is based on the assumption that the maximum open area resulting from mining will occur in mid-1996 (i.e., approximately 3.5 years), the timeframe that CPMC is planning on completing the longwall mining of the Gentry Ridge area. Therefore, as a conservative estimate of the maximum dewatering period, it was assumed that the maximum amount of dewatering would occur in five years. The effect of this dewatering will be a significant lowering of the water table in the immediate area of the mine and a progressive reduction of water table lowering with distance from the mine.

Based on the curves presented in Figure 4-1 and data presented in Appendix D of this review, the effect of mine dewatering to the south of the mine after five years is expected to extend to a distance of about 20,000 feet. To the west and east of the mine, the theoretical dewatering effect after five years is also estimated to extend to a distance of approximately 25,000 feet. Beyond these distances, drawdown from mine dewatering is not expected. Five feet of drawdown is expected at a distance of about 17,100 feet from the mine along the length of the mine, while along the width of the mine, five feet of drawdown is expected at a distance of about 13,000 feet. At a distance of about 6,000 feet, the approximate distance from the anticipated southern limit of mining beneath Gentry Ridge to the Tie Fork wells, a drawdown of approximately 25 feet may occur from mine dewatering, according to the Lines (1985) model.

These estimates of drawdown extent are theoretical and will be affected by climatic variations. For example, detection of drawdown impacts may be affected by natural seasonal fluctuations of the groundwater table. The climatic regime and the trends of surrounding wells and springs need to be evaluated to determine the overall response of the hydrogeologic



SOURCE: LINES (1985)

FIGURE 4-1. Semilogarithmic curves for various hydraulic conductivities of the Blackhawk Formation (K_b) and Star Point Sandstone (K_s) showing drawdown produced at specified distances from a hypothetical horizontal underground mine at the base of the Blackhawk Formation that has been dewatered for various lengths of time. (Premining horizontal hydraulic gradient, 0.065; mine width, 1,000 feet; mine length, 10,000 feet; specific yield, 0.05; storage coefficient, 1×10^{-6} per foot of confined aquifer.)

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system. If, for example, a well experiences a two-foot rise, while other wells on the mountain generally show a seven- to ten-foot rise, this may be indicative of a five- to eight-foot dewatering impact. Conversely, if a well shows a five-foot drop, while the other wells on the mountain show a seven- to ten-foot decline, that specific well may have shown recovery due to localized recharge and not a dewatering impact. Therefore, drawdown measurements do not necessarily indicate a mine impact.

These estimated drawdown values can be used to evaluate the impact of projected dewatering on the Tie Fork wells. No piezometric head values are available for the Tie Fork wells. However, based on observed flows and site conditions at the wells, it is estimated that heads on the various wells are not greater than 10 to 15 feet. Therefore, a 25-foot reduction in head from mine dewatering would result in the elimination of artesian flow from the wells. Without mitigation, this would result in the loss of the average flow reported in the PHC (Exhibit 728a) of 84.8 gpm.

The effect of these estimated drawdown values on stream and spring flows was evaluated using the Darcy equation, which describes groundwater flow under saturated conditions. Based on this evaluation (presented in Appendix D of this review), it is estimated that non-fracture-related flow in the aquifer downgradient from the mine will be reduced by a rate of 0.0009 gallons per minute (gpm) per foot of mine dewatering cone width in the approximately 275-foot-thick zone which might be affected. The width of the zone to be affected is determined by the maximum extent of the drawdown cone and the width of the mine.

Estimates of spring flow and stream flow reduction are calculated in Appendix D of this review. Applying the unit reduction rate to determine the non-fractured affect on downgradient springs and seeps, several assumptions had to be made. First, it was assumed that the springs were not fracture-related. Second, it was assumed that the area drained by a typical spring or seep, which was not associated with significant secondary porosity, is variable and controlled largely by the geology of the area. Based on the variable nature of the

Blackhawk Formation and the Star Point Sandstone, it was estimated that a typical spring would be capable of draining an area of about a one acre. Based on a cross-section of one acre, the flow reduction expected at a downgradient spring is about 0.19 gpm (see Appendix D of this review). For streams, the reduction in flow was determined over a one mile reach of the stream to be approximately 4.75 gpm (0.01 cfs) (see Appendix D of this review).

No supported quantitative estimates of potential mining-related affects to the Tie Fork wells or other downgradient springs and streams are provided in the PHC. However, based on the estimated spring flow and stream flow reductions from drawdown effects discussed above, an estimate of the expected reduction in irrigation and culinary water sources is provided (see Appendix E of this review). Assuming that mining beneath Gentry Ridge is completed in mid-1996 (as predicted by CPMC), the estimated cumulative reduction to springs, streams, and wells is estimated to be 133 gpm.

The proposed compensation from CPMC mining in the Gentry Ridge area, for HCIC water supply, is 300 shares per year of water from Huntington Creek (100 ac-ft). As a water supply for various purposes, the compensation water, is available throughout the year, and is approximately equivalent to 62 gpm (see Appendix E). Based on the estimated cumulative reductions in flow, the volume proposed by CPMC would not cover the possible losses. Therefore, given that the estimated potential impact presented herein is greater than the flow-value of the shares, HCIC should consider additional alternatives to supplement for the possible loss of flows.

4.2 RECOVERY

Following the dewatering period, when pumping from the Gentry Ridge area is discontinued, the mine workings will begin to flood. The flooding will assist in returning the water table to a static level approximating the pre-mining level. This recovery will be supplemented for a period after completion of mining by increased water inflow due to subsidence effects. During this period, a portion of the perched groundwater above the mine will be intercepted by subsidence effects (Pages 700-82 and 700-82a of the PHC).

No estimate is provided in the PHC for the duration of the potential impact resulting from dewatering the mine. The difficulty in projecting the timeframe for water table recovery is that the recovery is not linear. Rather, the rate of mine flooding is reduced at a rate proportional to the rate of recovery of the water level to its pre-mining level. To estimate the actual mine recovery time frame would be costly and would require much more data than is currently available. Conservative estimates for underground mine flooding, in similar geology and areas to the Star Point Mine, range from several tens to a few hundred years.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Mining operations at the CPMC Star Point Mine under Gentry Ridge have been evaluated. The conclusions include:

- Mine inflows, in the proposed Gentry Ridge section of the mine, are estimated to range from 62 gpm to approximately 1100 gpm. The lower end of the range is from non-fracture-related inflows, while the upper end of the range is from anticipated inflows if the fractures associated with the eastern margin of the Pleasant Valley Graben are intersected.

- Significant inflows to the mine could be encountered from the fractures along the eastern margin of the Pleasant Valley Graben. The inflow rate from these fractures may be as high as 800 to 900 gpm. If these flows are encountered, the downgradient Tie Fork wells and other fracture-related water sources may be significantly affected.

- Dewatering from the mine is expected to result in drawdown that will be measurable a maximum distance of 20,000 feet to the south of the mine and 25,000 feet to the east and west of the mine. This is a theoretical extent and may be affected by topography and the continuity of the aquifer.

- Maximum drawdown at the Tie Fork wells, resulting from the anticipated mine dewatering, is estimated to be 25 feet. Such a head reduction would likely result in discontinuance of artesian flow from the wells.

- Dewatering will reduce the gradient of the water table south of the mine and is estimated to reduce the non-fracture related flow of groundwater downgradient of the mine by a rate of 0.0009 gpm per foot of aquifer width. Within the area of drawdown, a typical spring might anticipate 0.19 gpm reduction in flow and the stream flows might be reduced by 4.75 gpm per mile of stream.

- Using the anticipated spring, stream, and well flow reductions, the estimated total cumulative impact of mine dewatering within the maximum drawdown area is calculated to be approximately 133 gpm. The total potential impact to HCIC water rights is estimated to be a flow reduction of about 85 gpm.

- The potential exists for long-term downgradient water quality impacts. The time frame for movement of a contaminant plume could be rapid if it entered the fractures of the graben-bounding fault systems on either side of the Gentry Ridge mining area or extremely slow as interstitial migration. Migration of toxic or carcinogenic constituents, used and spilled within the mine, could have a significant effect on a culinary water source. Based on the analysis in the PHC, the concentrations of some contaminants could be high enough to cause health concerns.

- The proposed 62 gpm (300 shares) compensation water may be inadequate considering the estimated potential impact is greater than the proposed compensation water flows.

5.2 RECOMMENDATIONS

The following recommendations are offered to ensure that the water sources for HCIC are protected:

1) The full effects of dewatering and other diversion during and after mining are difficult to project. Based on the anticipated theoretical impacts, it would be prudent for HCIC to require CPMC to consider options for protection of the Tie Fork wells. It is recommended that an agreement be developed with CPMC which specifically addresses potential impacts to the Tie Fork wells.

One simple option would be to ensure that regular and accurate flow measurements are collected at the Tie Fork wells. These measurements could be the basis for any compensation based on actual impacts to the average (or an agreed-upon minimum) flow. The compensation could be in the form of water rights, replacement wells, pump installation and operation costs, etc.

As indicated in Exhibit 728a of the PHC, combined flow at the wells has averaged about 85 gpm between 1983 and 1992, excluding erratic flows inferred to be related to earthquake activity in 1988. According to the graphs contained in Exhibit 728a, flow at the wells during that period has been consistently greater than 82.5 gpm. This flow rate could be used as a baseline against which future flows are compared.

2) It is recommended that a water-quality monitoring program be developed for the downgradient culinary water sources. This monitoring program should be developed based on the results of an inventory of all chemical compounds used underground at the mines.

REFERENCES

Freeze, R.A. and J. A. Cherry. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, N.J.

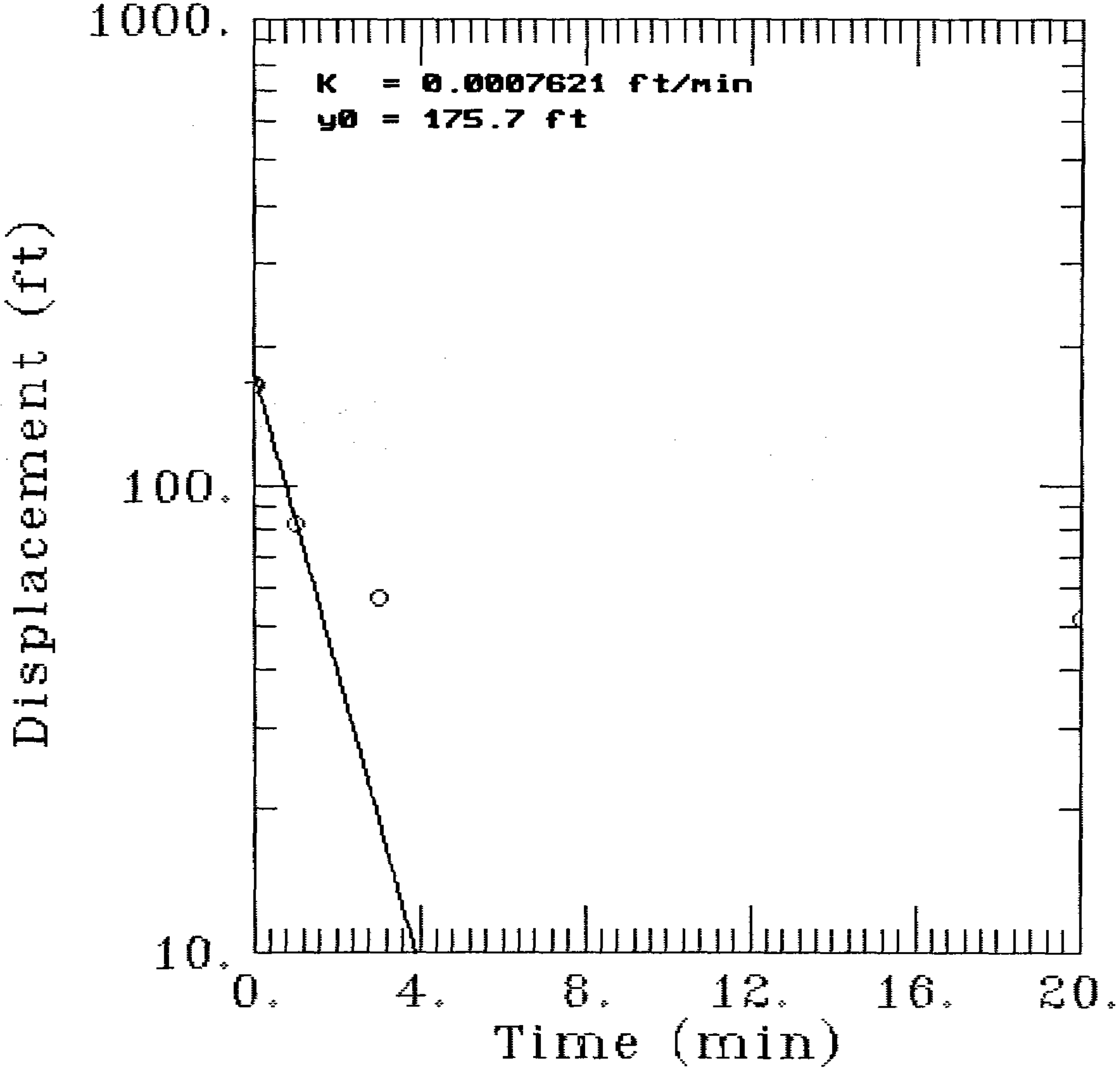
Lines, G.C. 1985. The Ground-Water System and Possible Effects of Underground Coal Mining in the Trail Mountain Area, Central Utah. U. S. Geological Survey Water-Supply Paper 2259. Prepared in cooperation with the U.S. Bureau of Land Management. U.S. Government Printing Office. Washington, D.C.

Noonan, D.C. and J.T. Curtis. 1990. Groundwater Remediation and Petroleum. Lewis Publishers. Chelsea, Michigan.

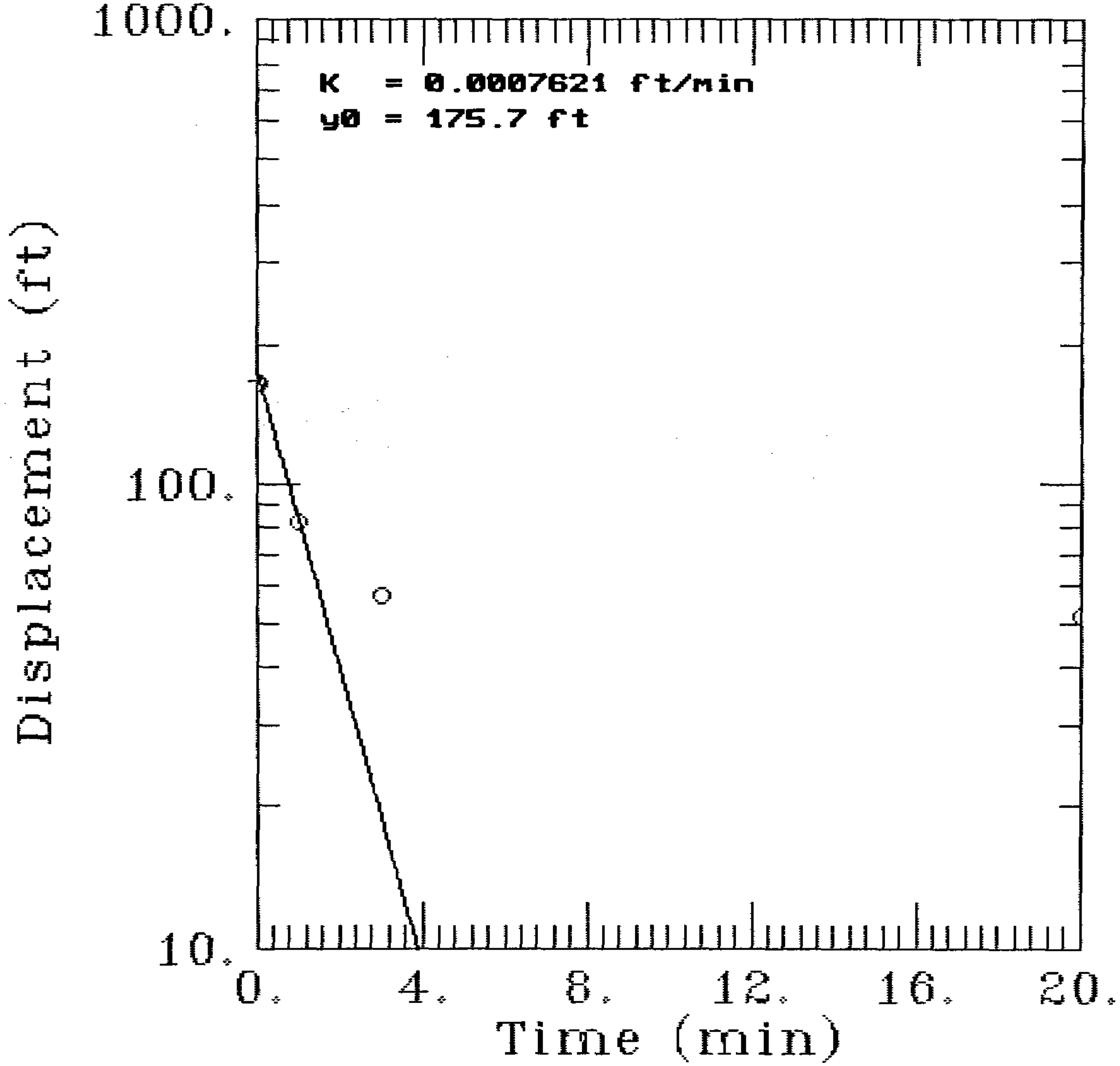
APPENDIX A

Slug Test Re-analyses

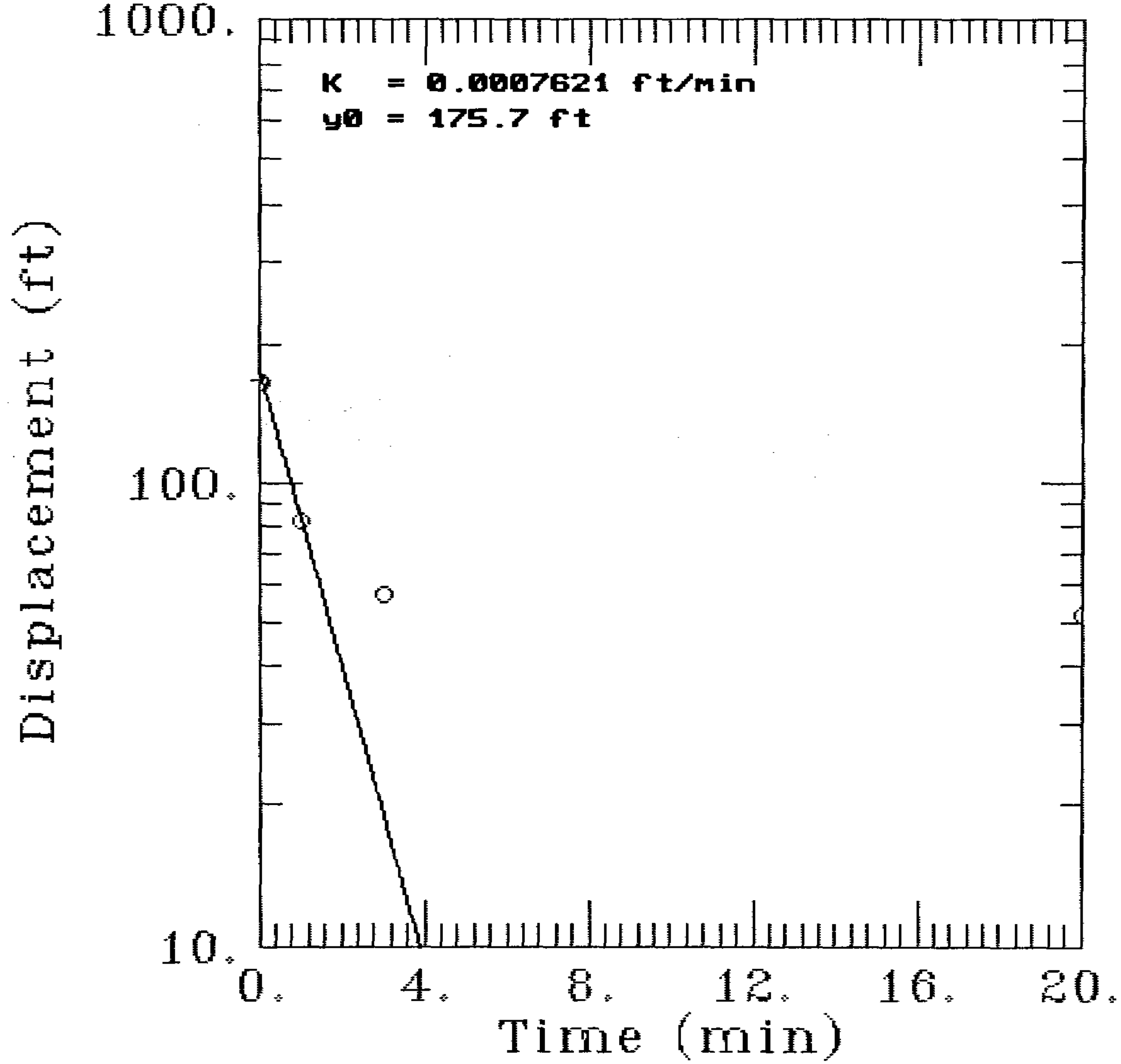
Well 92-01C-WD INJECTION TEST



Well 92-01C-WD INJECTION TEST



Well 92-01C-WD INJECTION TEST



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A Q T E S O L V

A Program for

Automatic Estimation of Aquifer Coefficients

From Aquifer Test Data

By:

Glenn M. Duffield
and
James O. Rumbaugh, III

Geraghty & Miller Modeling Group
1895 Preston White Drive, Suite 301
Reston, VA 22091

(703) 476 - 0335

A Q T E S O L V is a user-friendly program designed to analyze data from aquifer tests automatically. Aquifer coefficients for a variety of aquifer test conditions can be estimated by A Q T E S O L V , including the following:

- confined aquifers, unconfined aquifers, and leaky aquifers
- pumping tests, injection tests, recovery tests, and slug tests

Features:

- Interactive, menu-driven program design
- Nonlinear least-squares estimation of aquifer coefficients
- Statistical analysis of results
- Complete graphical display of results

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A Q T E S O L V   R E S U L T S

Version 1.10

02/23/93 10:22:08

TEST DESCRIPTION

Data set........... 9201cwd.aqt
Data set title..... Well 92-01C-WD INJECTION TEST

Knowns and Constants:

```
   No. of data points.................. 4
   Radius of well casing............... 0.08334
   Radius of well...................... 0.2292
   Aquifer saturated thickness......... 131.3
   Well screen length.................. 15
   Static height of water in well...... 131.3
   Log(Re/Rw).......................... 4.509
   A, B, C.............................  0.000,  0.000,  3.179
```

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

RESULTS FROM STATISTICAL CURVE MATCHING

STATISTICAL MATCH PARAMETER ESTIMATES

	Estimate		Std. Error
K =	4.7699E-004	+/-	2.2293E-004
y0 =	1.6282E+002	+/-	2.9330E+001

ANALYSIS OF MODEL RESIDUALS

residual = calculated - observed
weighted residual = residual * weight

Weighted Residual Statistics:

```
   Number of residuals............... 3
   Number of estimated parameters.... 2
   Degrees of freedom................ 1
   Residual mean..................... 1.604
   Residual standard deviation....... 27.85
   Residual variance................. 775.8
```

Model Residuals:

Time	Observed	Calculated	Residual	Weight
0.1	165	155.55	9.4535	1
1	82.4	103.1	-20.701	1
3	57.4	41.341	16.059	1

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	4.7699E-004
y0 =	1.6282E+002

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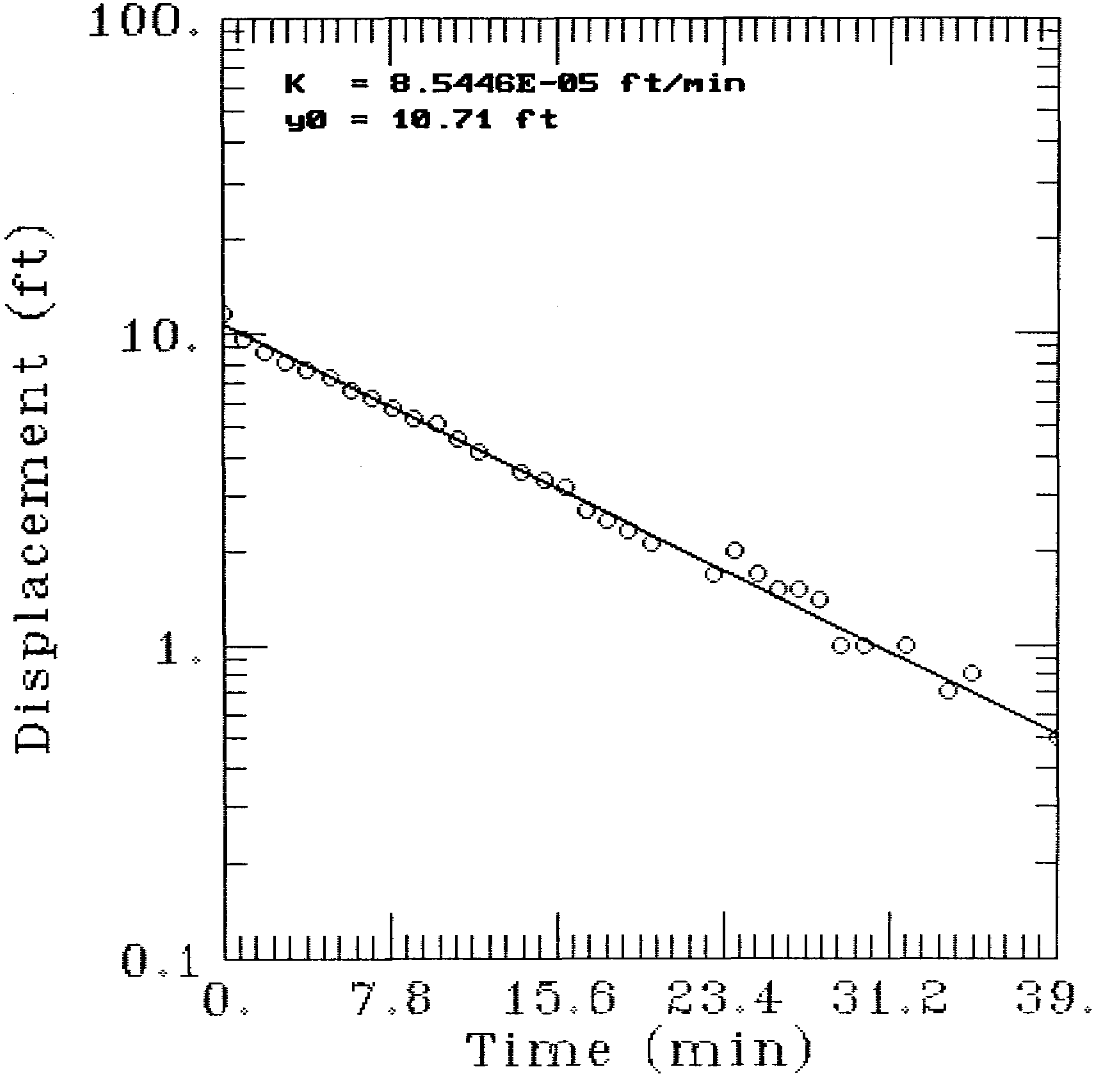
Well 92-02-WD Recovery Test



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Features:

- o Interactive, menu-driven program design
- o Nonlinear least-squares estimation of aquifer coefficients
- o Statistical analysis of results
- o Complete graphical display of results

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A Q T E S O L V   R E S U L T S
Version 1.10

02/23/93 10:16:43

TEST DESCRIPTION

Data set........... 9202wd.aqt
Data set title..... Well 92-02-WD Recovery Test

Knowns and Constants:
- No. of data points.................. 32
- Radius of well casing............... 0.08333
- Radius of well...................... 0.2292
- Aquifer saturated thickness......... 194.8
- Well screen length.................. 15
- Static height of water in well...... 194.8
- Log(Re/Rw)......................... 4.725
- A, B, C............................. 0.000, 0.000, 3.179

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

RESULTS FROM STATISTICAL CURVE MATCHING

STATISTICAL MATCH PARAMETER ESTIMATES

	Estimate		Std. Error
K =	8.5446E-005	+/-	1.7219E-006
y0 =	1.0711E+001	+/-	1.3222E-001

ANALYSIS OF MODEL RESIDUALS

residual = calculated - observed
weighted residual = residual * weight

Weighted Residual Statistics:
- Number of residuals............... 32
- Number of estimated parameters.... 2
- Degrees of freedom................ 30
- Residual mean..................... 0.0144
- Residual standard deviation....... 0.2458
- Residual variance................. 0.06043

Model Residuals:

Time	Observed	Calculated	Residual	Weight
0.1	11.6	10.627	0.9727	1
1	9.66	9.9057	-0.24574	1
2	8.75	9.1613	-0.41132	1
3	8.1	8.4728	-0.37285	1
4	7.7	7.8361	-0.13611	1
5	7.2	7.2472	-0.047222	1
6	6.5	6.7026	-0.20259	1
7	6.2	6.1989	0.0011114	1
8	5.7	5.733	-0.03304	1
9	5.3	5.3022	-0.0022001	1
10	5.1	4.9037	0.19626	1
11	4.6	4.5352	0.06478	1
12	4.2	4.1944	0.0056029	1
14	3.6	3.5877	0.012336	1
15	3.4	3.3181	0.08195	1
16	3.2	3.0687	0.1313	1
17	2.7	2.8381	-0.13808	1
18	2.5	2.6248	-0.1248	1
19	2.3	2.4275	-0.12755	1
20	2.1	2.2451	-0.14512	1
23	1.7	1.776	-0.076037	1
24	2	1.6426	0.35743	1
25	1.7	1.5191	0.18087	1
26	1.5	1.405	0.095035	1
27	1.5	1.2994	0.20062	1
28	1.4	1.2017	0.19827	1
29	1	1.1114	-0.11142	1
30	1	1.0279	-0.027898	1
32	1	0.87921	0.12079	1
34	0.7	0.75203	-0.052029	1
35	0.8	0.69551	0.10449	1
39	0.5	0.50885	-0.0088507	1

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	8.5446E-005
y0 =	1.0711E+001

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APPENDIX B

Inflow Estimates

EVALUATION OF TIME TO DRAIN OVERBURDEN & PERCHED ZONE.

EXHIBIT 728e PROVIDES AN ESTIMATE OF POTENTIAL INFLOW VOLUME TO MINE:

Vol = 2565 AC-FT

ADDITIONALLY, ESTIMATES ARE MADE OF THE RATE OF INFLOW TO MINE:

q_{min} = 135 gpm
q_{max} = 400 gpm
} NON-FAULT RELATED

q_{max} = 1000 TO 1100 gpm FAULT RELATED.

BASED ON THESE RATES, WHAT IS THE TIME REQUIRED TO DRAIN THIS WATER TO THE MINE:

@ a RATE OF 135 gpm

$$\frac{\text{Vol}}{\text{Rate}} = \text{Time} = \frac{2565 \text{ AC-FT} * 43560 \text{ FT}^3/\text{AC-FT}}{135 \text{ gpm} * 7.4805\text{ g}/\text{FT}^3}$$

= 6,195,713.0 min

= 11.8 yrs ≃ 12 yrs

@ a RATE OF 400 gpm

$\frac{\text{VOL}}{\text{RATE}} = \frac{2565 \text{ Ac-FT}}{400 \text{ gpm}} = \text{TIME} = 2091053.2 \text{ min}$

$= 3.97 \text{ yrs}$

$\approx$ **4 yrs**

@ a rate OF 1000 gpm

$\frac{\text{VOL}}{\text{RATE}} = \frac{2565}{1000} = \text{TIME} = 836,421.3 \text{ min}$

$= 1.6 \text{ yrs}$

$\sim$ **1.5 yrs**

REEVALUATION OF TOTAL INFLOW

HYDRAULIC CONDUCTIVITY (FROM APPENDIX - A) $= \left(\frac{1.1 + 0.12}{2}\right) = 0.61$ FT/day

$= 4.57$ gpd/FT²

ASSUME: (FROM PHC EXHIBIT 723e)

GROUNDWATER GRADIENT = 0.0208 FT/FT

CROSS-SECTIONAL FLOW AREA = 936,000 FT²

INFLOW: (DARCY'S LAW)

$Q = K i A$

$= 4.57 \text{ gpd/FT}^2 * 0.0208 * 936{,}000 \text{ FT}^2 * \frac{1 \text{ d}}{24 \text{ hr}} * \frac{1 \text{ hr}}{60 \text{ m}}$

$= 62$ gpm

TRIPLE FOR MINOR SECONDARY PERMEABILITY EFFECTS

RANGE OF POTENTIAL INFLOWS = 62 TO 185 gpm

REANALYSIS OF INFLOW TIMEFRAME:

USE REVISED INFLOW OF:

$q_{min} = 62$ gpm

$q_{max} = 185$ gpm

TIME TO DRAIN 2,565 AC-FT OF WATER:

@ a RATE OF 62 gpm

$$\frac{VOL}{RATE} = TIME = \frac{2565 \text{ ac-ft} * 43560 \text{ ft}^3/\text{ac-ft}}{62 \text{ gpm} * 1/7.486 \text{ g}/\text{ft}^3}$$

$= 13,490,666$ MIN

$= 25.7$ YRS

$\approx$ 26 YRS

@ a RATE OF 185 gpm

$$\frac{VOL}{RATE} = TIME = \frac{2565 \text{ ac-ft}}{185 \text{ gpm}} = 4,521,196 \text{ min}$$

$= 8.6$ YRS

$\sim$ 9 yrs

APPENDIX C

Migration Rate Estimates

MIGRATION RATE ESTIMATE

ASSUME: $K = 0.61$ FT/dAY < AVERAGE OF REANALYZED HYDRAULIC CONDUCTIVITY VALUES

$n = 0.15$ < BASED ON FREEZE + CHERRY, 1979, FOR SANDSTONE (0.05 TO 0.3) w/ MUDSTONE & SILTSTONE INTERBEDS USE 0.15.

PREMINE

$$\frac{dh}{dL} = 0.0208 \text{ FT/FT}$$ < FROM CPMC PHC DOCUMENT CALCULATIONS, EXHIBIT 728e, PAGE 3.

DEWATERED

$$\frac{dh}{dL} = 0.0198 \text{ FT/FT}$$ < SEE ATTACHED

AVERAGE LINEAR VELOCITY

PRE-MINING

$$\bar{V} = \frac{-K}{n} \frac{dh}{dL}$$

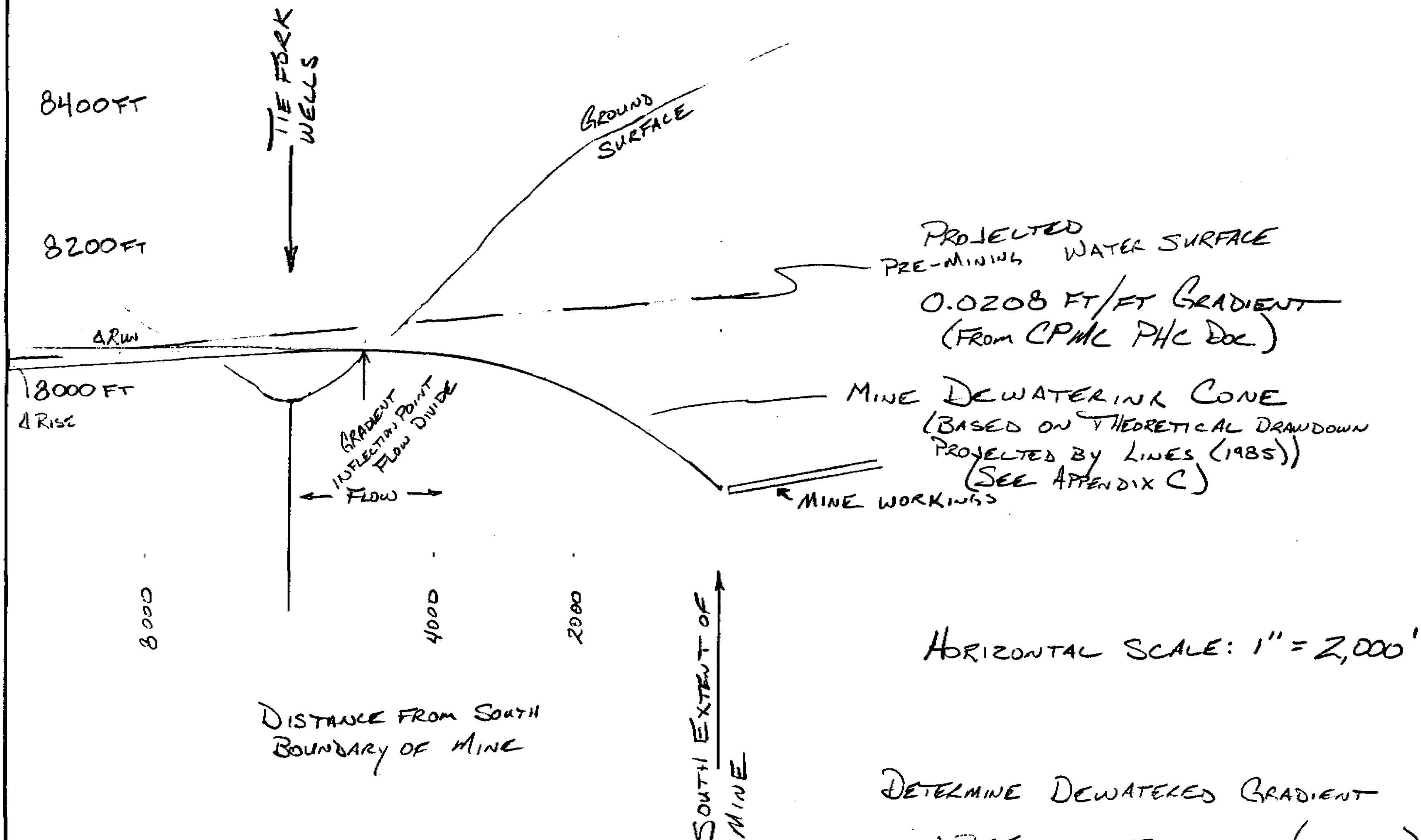
$$= \frac{0.61 \text{ FT/day}}{0.15} 0.0208 \text{ FT/FT}$$

$$= 0.085 \text{ FT/dAY}$$ — PRE MINING

POST-MINING

$$\bar{V} = \frac{0.61}{0.15} 0.0198$$

$$= 0.081 \text{ FT/dAY}$$



Determine Dewatered Gradient

$$\frac{\Delta Rise}{\Delta Run} = \frac{-15 + 10 + (5000 * .0208)}{(10000 - 5{,}000)}$$

$$= 0.0198 \text{ FT/FT}$$

TRAVEL TIME

TRAVEL DISTANCE TO TIE FORK WELLS
≈ 6,000 FT

PRE-MINE

$$T.T. = \frac{6{,}000\ FT}{0.085\ FT/day} = 70{,}583.2\ d$$

$$= 193.3\ YRS$$

$$\approx 190\ YRS$$

DEWATERED

$$T.T. \ \frac{6{,}000}{0.081} = 74{,}515.6\ d$$

$$= 204.1\ YRS$$

$$\approx 200\ YRS$$

APPENDIX D

Evaluation of Mine Dewatering on
Downgradient Water Sources

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EVALUATION OF MINE DEWATERING ON DOWNGRADIENT WATER SOURCES.

THE MINE DEWATERING WILL HAVE THE GREATEST AFFECT IN THE AREA IMMEDIATELY ADJACENT TO THE MINE. THE EFFECT WILL DIMINISH WITH DISTANCE FROM THE MINE.

BASED ON LINES (1985) METHODOLOGY, THE CURVES (ATTACHED) FOR K = 0.2 FT/day FOR STAR POINT AQUIFER WERE USED TO DETERMINE DOWNGRADIENT + CROSS-GRADIENT EFFECTS. (Dx = CROSS-GRADIENT & Dy = DOWNGRADIENT)

MAXIMUM THEORETICAL DRAWDOWN

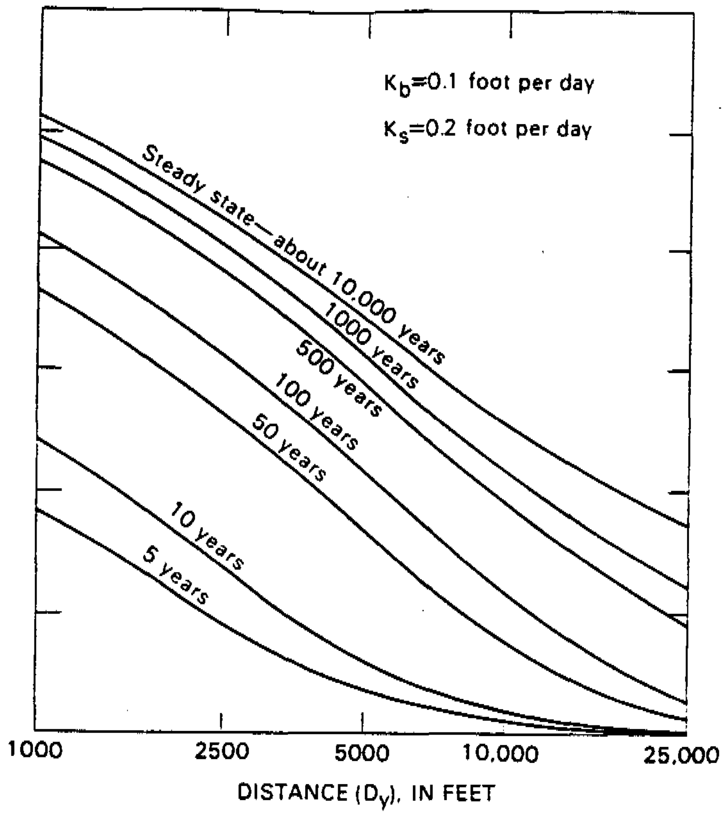
	DIST	DRAWDOWN
Dx =	25,000 FT	1 FT
Dy =	20,000 FT	1 FT

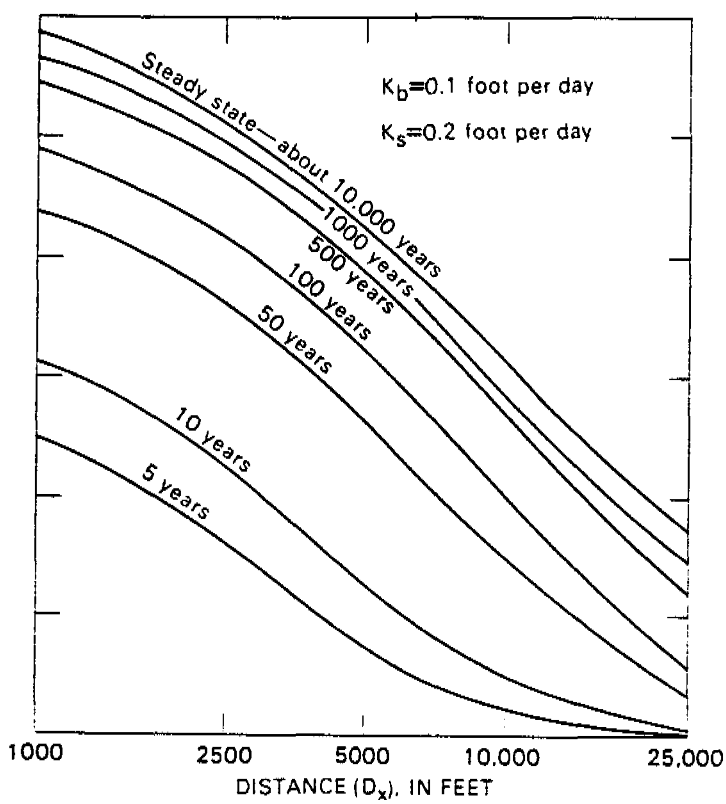
5 FOOT DRAWDOWN

	DIST	DRAWDOWN
Dx =	17,100 FT	5 FT
Dy =	13,000 FT	5 FT

AT TIE FORK WELLS

	DIST	
Dy =	6,000 FT	25 FT


Kb=0.1 foot per day
Ks=0.2 foot per day
Steady state—about 10,000 years
1000 years
500 years
100 years
50 years
10 years
5 years
1000
2500
5000
10,000
25,000
DISTANCE (Dy), IN FEET


Kb=0.1 foot per day
Ks=0.2 foot per day
Steady state—about 10,000 years
1000 years
500 years
100 years
50 years
10 years
5 years
1000
2500
5000
10,000
25,000
DISTANCE (Dx), IN FEET

EFFECT ON GROUNDWATER FLOW

$Q = k\,i\,A$

ASSUME: $K = 0.61$ FT/day (AVERAGE FROM WELL TESTS IN SPRING CANYON. SEE APPENDIX A)

$A = (2(25{,}000) + 3500\text{ FT}) * 275\text{ FT}$

$= 14{,}712{,}500\text{ FT}^2$ (EXTENT OF DEWATERING EFFECT FROM APPENDIX B)

PRE-MINING

$i = 0.0208$ FT/FT (FROM PHC)

$Q = 0.61\text{ FT/day} * 0.0208\text{ FT/FT} \times 14{,}712{,}500\text{ FT}^2$

$= 186672\text{ FT}^3/\text{d} * \frac{\text{d}}{24\text{ hr}} * \frac{\text{hr}}{60\text{ min}} * 7.48\text{ g/FT}^3$

$= 970$ gpm

MAXIMUM DEWATERING

$i = 0.0198$ FT/FT (FROM APPENDIX B)

$Q = 177698\text{ FT}^3/\text{d}$

$= 920$ gpm

REDUCTION OF 50 gpm OVER 53,500 FT STRETCH.

0.0009 gpm/FT REDUCTION

ESTIMATE ON SPRINGS + STREAMS

SPRINGS

ASSUME SPRING ACTS AS DISCHARGE POINT FOR 1 ACRES WIDE AREAS. WIDTH OF TYPICAL DRAINAGE AREA IS:

$$\text{WIDTH} = 1 \times (43560)^{.5} = 1 \times 208.7 \text{ FT}$$
$$= 208.7 \text{ FT}$$

$$\Delta q \text{ FROM SPRING} = 0.0009 \text{ gpm/FT} * 208.7 \text{ FT}$$
$$= \underline{0.19 \text{ gpm}}$$

STREAMS

ASSUME STREAM RECEIVES BASEFLOW ALONG ITS ENTIRE LENGTH.

ASSUME FOR A ONE MILE REACH:

$$\Delta q \text{ FOR STREAM/MILE} = 0.0009 \text{ gpm/FT} * 5280 \text{ FT}$$
$$= \underline{4.75 \text{ gpm}}$$
$$= \underline{0.01 \text{ CFS}}$$

APPENDIX E

Spring and Stream Flow Reduction Estimates

COMPARISON OF SPRING AND STREAM FLOW REDUCTIONS WITH PROPOSED COMPENSATION WATER.

BASED ON A REDUCTION OF 0.19 GPM PER SPRING AND 4.75 GPM / MILE OF STREAM THE FOLLOWING IMPACTS CAN BE PROJECTED:

POTENTIALLY IMPACTED RESOURCES:

FROM PLATE 728a OF THE PHC DOCUMENT:

3 WELLS - TIE FORK WELLS.

3 REACHES OF STREAM

- WILD CATTLE HOLLOW - 7500 FT
- GENTRY HOLLOW - 8500 FT
- TIE FORK CREEK - 7500 FT

39 SPRINGS AND SEEPS LOCATED SOUTH OF THE SOUTHERN MINE BOUNDARY.

WELLS

ESTIMATED HEAD ON THE TIE FORK WELLS IS APPROXIMATELY 10 TO 15 FEET.

IF 25 FT OF DRAWDOWN OCCURRED AT THE WELLS, THE HEAD LOSS WOULD STOP ARTESIAN FLOW OF THE WELLS.

$\Delta q = 84.8$ gpm (AVERAGE FLOW EXHIBIT 728a)

STREAMS

W.R.H / U.S.F.S.	TIE FORK CANYON Δq	= 4.75 * (7500/5280) = 7 gpm
MISC.	HUNTINGTON CREEK Δq	= 4.75 * 20,000/5230 = 18 gpm
U.S.F.S.	GENTRY HOLLOW Δq	= 4.75 * (8500/5280) = 8 gpm
U.S.F.S.	WILD CATTLE HOLLOW Δq	= 4.75 * (7500/5280) = 7 gpm

TOTAL = 7 + 8 + 18 + 7 = 41 gpm

SPRINGS

39 SPRINGS * 0.19 gpm/SPRING = 7.4 gpm ≃ 7 gpm

ESTIMATE CUMMULATIVE IMPACT

84.8 gpm + 41 gpm + 7 gpm ≃ 133 gpm

HCIC WATER RIGHT POTENTIAL IMPACT

84.8 gpm + 0.19 gpm = 85 gpm

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COMPENSATION WATER

300 SHARES IRRIGATION WATER = 100 AC-FT

AVAILABLE 365 days PER YEAR DUE TO FLOW + STORAGE.

(INFO. TELECON W/ CRAIG SMITH)

$$q = \frac{100\ \text{AC-FT} * 43560\ \text{FT}^3/\text{AC-FT} * 7.486\ \text{GAL}/\text{FT}^3}{365\ \text{days} * 24\ \text{hrs/day} * 60\ \text{MIN/HR}}$$

$$= 62.0\ \text{gpm}$$