Outlook

[EXTERNAL] Copper Flat reopening

From Cindy Dallas <animascreekhoneyandherbfarm@gmail.com>
Date Thu 9/17/2026 12:54 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from animascreekhoneyandherbfarm@gmail.com. Learn why this is important

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I am strongly opposed to the opening of Copper Flat mine. Our small organic farm is located downstream on Animas Creek Road, we have been operating since 2010 supplying the town of Hillsboro as well as Bullocks grocery store in Truth or Consequences with fresh organic veggies .
The absence of seasonal water in the creek for years alone should be a sign that we do not need a mine . The sycamore trees that are next to the creek are losing leaves prematurely while the sycamores on our farm that we are watering are surviving and have leaves.
.We have chose not to grow our well known vegetables for the past 2 summers as the extreme heat and the amount of water needed to get the plants to survive and not even thrive was needed more by our existing mature trees.We do not need a mine using and contaminating millions of gallons of water while farms like ours are conserving until the weather dictates that we should expand so that we can supply food for people.
The mine says it will use a process that will not require as much water ...yet dry stack will allow toxins to be blown into our air and toxins will still end up leaching into our water supply. A mine is not a good idea for anyone . Do not let the greed of this mine devastate the lives of so many for generations ....
Sincerely -Cindy Yarmal

[redacted]

Animas Creek Honey & Herb Farm
****

Outlook

[EXTERNAL] Copper Flat Mine Revised Application, permit no SI027RN

From Philip J. Taccetta <pjtaccetta@gmail.com>
Date Thu 9/17/2026 3:37 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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To: Director Aguilera, New Mexico Mining and Minerals Division, MMD.MARP@emnrd.nm.gov
Re: Copper Flat Mine Revised Application, permit no SI027RN

Dear Director Aguilera,

I urge the New Mexico Mining and Minerals Division (MMD) not to approve New Mexico Copper Corporation's revised application for the Copper Flat Mine. Serious questions remain about whether the revised proposal adequately protects downstream water users.

Citizens of the State of New Mexico, current and future generations, deserve diligent assurance from state regulators that the proposed project will not cause irreparable harm to our homes, livelihoods and futures. Residents who depend on the Las Animas Creek watershed are especially threatened by degradation to the quality and availability of ground water.

The revised proposal has not demonstrated that sufficient water is legally and physically available for both mine operations and reclamation at proposed production rates. The company must demonstrate that the water sources it relies upon are legally available for mine operations and that sufficient water will remain available throughout the life of the project and through reclamation.

MMD must fully account for the effects of the project's water use beyond the mine boundary. Groundwater pumping and other mine-related depletion could affect nearby wells and springs, Las Animas Creek, and other downstream water users. The adequacy of the mine's water supply cannot be evaluated separately from its effects on people and ecosystems that depend on the same water resources.

The revised application has also not adequately demonstrated the long-term stability and safety of the proposed filtered Tailings Storage Facility (TSF). Before approving a facility intended to permanently contain mine waste, MMD should require sufficient analysis to determine how the TSF will perform during operations, closure, and long-term reclamation, including the consequences of a potential catastrophic failure. The MMD must also require sufficient analysis of potential air pollution from wind transported tailings, along with noise and light pollution associated with mine operation.

The revised proposal also undermines a central assumption of the company's plan for reclamation of the open pit. The reclamation plan relies on rapidly filling the pit with groundwater to limit acid formation. Under the revised proposal, however, filling the pit is expected to take more than 2.5 years rather than approximately six months as previously proposed. That substantial change raises serious concerns about the likelihood of an acidic pit lake and the adequacy of the proposed reclamation plan.

MMD should not accept a reclamation strategy that depends on rapid pit filling when the revised water supply no longer allows the pit to be filled rapidly. Backfilling the open pit should be fully evaluated as an alternative to the current proposal.

Taken together, these are not minor details that can be resolved after a permit is issued. They go to whether the proposed mine has the resources necessary to operate and reclaim the site, whether its permanent mine waste facility can be safely constructed and maintained, and whether surrounding water users and groundwater can be protected over the long term.

We therefore urge MMD not to approve the revised Copper Flat application unless and until the applicant:

- Demonstrates that its projected water savings from filtered tailings are realistic and adequately supported;
- Demonstrates that sufficient and legally available water exists for the full needs of mine operations, closure, and reclamation;
- Fully evaluates the effects of groundwater pumping and other mine-related depletion on wells, springs, Las Animas Creek, downstream water users, and the Lower Rio Grande;
- Provides the site-specific geotechnical and seismic analysis necessary to demonstrate the stability and long-term safety of the proposed Tailings Storage Facility;
- Adequately evaluates the consequences of a potential TSF failure;
- Demonstrates that its revised pit reclamation strategy can prevent the formation of an acidic pit lake despite the substantially longer proposed filling period; and
- Fully evaluates backfilling the open pit as an alternative reclamation approach.

The communities surrounding Copper Flat would live with the consequences of this project long after mining ends. MMD has a responsibility to ensure these fundamental questions are resolved before, not after, a decision is made. The proposed operation of Copper Flat has the potential to irreparably harm nearby communities.

We urge the Division to require the information and analysis necessary to address these concerns and not approve the revised application as currently proposed.

Sincerely,

Philip Taccetta

Las Animas Creek

Caballo
Sierra County NM

Director Anna Aguilera
NM Mining and Minerals Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Dear Director Aguilera,
I am a long-time resident and property owner in Sierra County New Mexico and am sending this comment on the copper mine project at Copper Flat.

This new mine work has been discussed for many years. **The most critical issue <u>cannot</u> be resolved: Water**. As I watch the drought for the southwest and particularly southern New Mexico worsen each year, I am astounded that our water is not seen as the precious commodity that it is. The exorbitant amount of water, even with the modifications proposed, is absolutely unacceptable. This use of water will likely have serious impacts on local riparian systems, to residents and farmers along Animas Creek, and ultimately on the Rio Grande watershed. The project's own updated hydrological analysis recognizes the cost to other users from groundwater pumping and other mine-related water depletion, including impacts to wells and springs near the project. Most of these are long-time Sierra County residents!

I spoke at a hearing about this mine operation many years ago. Water was my critical concern then, is now, and is one that has only intensified with Climate Change. I am aware that the company holds approximately 1,100 acre-feet per year of groundwater rights, while its mining operation would depend heavily on repeatedly recycling water throughout the mining process. Local communities have raised concerns about whether the company's projected water savings are realistic, whether it has enough water for both mining and reclamation. Water use too, for dust management, is a massive use of our precious water.

In addition to these blaring facts, I have other serious concerns. I am well aware that copper is a resource we all use. However, this company and this project are not ones I can support. The economic benefits to our County and the actual jobs created do not begin to offset the astounding *negatives* of this mine project.

Finally, two last points:
-Dealing with waste? The revised proposal would permanently store mine waste in a large Tailings Storage Facility. I see that engineering studies identified unanswered questions about the stability of the facility, including whether existing information about the underlying soils and the tailings themselves is sufficient to fully evaluate its long-term stability and seismic risks.

-What will happen *after* mining? I understand that the proposed open pit would eventually be about 1,000 feet deep and 2,800 feet wide. The reclamation plan calls for filling the pit with **groundwater** to limit acid formation, but I understand that the revised plan estimates that process would take more than 2.5 years rather than the few months originally envisioned. **More serious issues with our precious water.**

The costs are much to great for a very *short-term* and questionable gain. The company does not care about our area, they are not local, and this project is absolutely not acceptable for Sierra County.

Thank you for your attention,

Nichole Trushell M.S.
[redacted]
[redacted] [redacted]

State of New Mexico
House of Representatives
Santa Fé

GAIL ARMSTRONG
MINORITY FLOOR LEADER
R - Catron, Sierra, Socorro & Valencia
District 49

P.O. Box 326
Magdalena, NM 87825
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September 17, 2026

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Legislative Finance

Ms. Anna Aguilera
Director
Mining and Mineral Division
New Mexico Energy, Minerals, and natural Resources Department
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Dear Director Aguilera:

I am writing to express my support for New Mexico Copper Corporation's (NMCC) amended application for a new mining permit for the Copper Flat Mine located in Sierra County. I believe issuing this new mining permit, as well as the resulting reopening of the mine, will provide a significant economic boost to Sierra County and the State of New Mexico.

According to an economic analysis conducted by the Arrowhead Center at New Mexico State University, the reopening the Copper Flat Mine will generate during mine construction 1,156 total jobs (direct, indirect, induced across New Mexico. The analysis also identified that during the operational phase of the mine 270 full-time jobs would be created and approximately 368 – 407 total jobs (direct, indirect, induced) would be realized. These new jobs, both mine construction and operational jobs, are desperately needed in Sierra County and the surrounding communities. For example, the current unemployment rate in Sierra County is 6.4%, in Socorro County the unemployment rate is 6.4%, and in Catron County the unemployment rate is 7.4% --- all of these rates are above state's current unemployment rate of 4.8%.

It is also important to note the reopening of the mine will add nearly $56 million to statewide labor income and nearly $80 million to the values of material and goods produced within the state.

In response to concerns about how reopening the mine may impact the environment and water usage, it is my understanding NMCC's plans are designed to meet or exceed all health, safety, and environmental regulatory requirements. Plus, the amended application

for the new mining permit now proposes the use of a dry stack tailing facility that will significantly reduce water usage compared to a previous mining permit application that envisioned a wet tailing facility.

Therefore, I urge the Mining and Mineral Division to issue this new mining permit for the Copper Flat Mine so that Sierra County and the surrounding areas of the state can enjoy the many economic benefits this multi-million-dollar project will produce.

Thank you for your consideration of my support for this important employment and economic development opportunity.

Respectfully yours,

Gail Armstrong
House Republican Leader
District 48

State of New Mexico
House of Representatives
Santa Fé

REBECCA DOW
REPUBLICAN CAUCUS CHAIR
R - Doña Ana, Sierra & Socorro
District 38

1309 N. Riverside Drive
Truth or Consequences, NM 87901
Office: (505) 986-4758
Cell: (575) 571-1056
E-mail: Rebecca.Dow@nmlegis.gov

September 17, 2026

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Ms. Anna Aguilera
Director
Mining and Minerals Division
New Mexico Energy, Minerals and Natural Resources Department
Santa Fe, New Mexico 87505

Re: Copper Flat Mine – Amended Mining Permit Application

Dear Director:

I am writing regarding the New Mexico Copper Corporation's amended application for a new mining permit for the Copper Flat Mine in Sierra County.

As the Mining and Minerals Division considers the amended application, I believe it is important to recognize the potential economic significance of the project to Sierra County and the surrounding region, as well as the substantial changes that have been made to the proposed operation since the project was initially proposed.

The Copper Flat project has been under development and permitting consideration for more than a decade. According to the Division's permitting chronology, the original permit application was submitted in 2012, and the project has subsequently undergone extensive agency review, public hearings, environmental analysis, and revisions. The current amended application incorporates a substantially different tailings-management approach, using filtered dry-stack tailings.

The economic considerations are particularly significant for Sierra County. Current U.S. Census Bureau data place the county's median household income at approximately $41,600. A major industrial operation providing well-paying jobs, benefits, and retirement opportunities could therefore represent a meaningful addition to the county's economic base.

The experience of Grant County also demonstrates the economic importance that copper mining can have in southwest New Mexico. Grant County is home to the Chino copper mine, an active copper operation that continues to be an important part of the regional economy. Historical estimates of the gross receipts tax generated by copper mining in Grant County have often been cited as exceeding $1 million per day. I recognize that such figures vary according to production, copper prices, tax rates, and the particular year being measured; nevertheless, the economic contribution of copper mining to southwest New Mexico is well established.

Water use is another important consideration in evaluating the amended Copper Flat proposal. The original mine design contemplated approximately 6,100 acre-feet of groundwater pumping annually. The amended design's use of filtered dry-stack tailings reduces the projected annual groundwater requirement to less than approximately 1,050 acre-feet, a reduction of roughly 80 percent. The project documents explain that water recovered during the dewatering process can be reused in the mineral-processing operation.

This change is particularly relevant in a state where water availability is one of the most important considerations in economic development. The proposed use of dry-stack technology demonstrates how advances in mining and mineral-processing technology can materially change the water requirements associated with a project that was originally designed more than a decade ago.

Copper Flat is also located within a historically significant mining district. Mining activity in the surrounding Chloride Flat Mining District dates back to the nineteenth century, with copper, gold, and particularly silver having been extracted from the district during periods of significant historical production. Copper Flat itself was operated previously, including a period of production in 1982.

The project therefore represents not simply a new industrial use of the area, but a proposed modern redevelopment of a historically mined region using substantially different technologies and environmental controls than were available during earlier periods of mining.

I also understand that positions among interested parties have evolved during the lengthy permitting process. In considering the amended application, the Division should take into account the current positions of affected water users, landowners, local governments, and other interested parties, rather than relying solely on positions expressed many years ago.

Finally, the demand for copper is an important consideration in the broader economic and industrial context. Copper is an essential material for electrical infrastructure, manufacturing, transportation, and numerous emerging technologies. At the same time,

improvements in mineral-processing and tailings technology have created opportunities to reduce water requirements compared with earlier mine designs.

For these reasons, I respectfully ask the Mining and Minerals Division consider the economic opportunities presented by the Copper Flat project, the project's history and significance to Sierra County, the employment and tax-base implications, and the substantial reduction in projected water use reflected in the amended application.

Thank you for the Division's careful review of the application and its consideration of the interests of Sierra County and the broader region.

Sincerely,



Rebecca Dow
State Representative
District 38

Outlook

[EXTERNAL] new comment on Copper Flat Mine

From Veronique De Jaegher & Bill Lindenau <verobill@mac.com>
Date Fri 9/18/2026 4:10 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

[You don't often get email from verobill@mac.com. Learn why this is important at https://aka.ms/LearnAboutSenderIdentification]

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Dear Mrs Aguilera,
I sent you a written comment 9/16 which was to be my comment yesterday at the hearing in Hillsboro ,NM.
The hearing was badly managed as a lot of time was given the mine people to expose their plan and very little time was given after that to the 100 or so people who were present and wanted to talk including the people who were making a presentation like Max Yeh and Allyson Siwik. Very frustrating. So much for a “hearing”!
Here is the amended version which I ended up not delivering yesterday because at 8:30pm I still did not get a chance to come up and speak and my husband was not feeling well so I had to go home. I got early at the hearing (4:45) to be able to put my name high up on the list.. So we spent 4 hours + there and were not able to speak.

My name is Veronique De Jaegher and I live in Kingston.

3 days ago some Hillsboro residents were waiting for the delivery of boxes of food from the Roadrunner truck. Well it got stopped on Hwy 152 by some authority (not the sheriff so I assume DOT). Why because they said the truck was too heavy and they had to turn around to the great disappointment of many citizen.
Now the mine proposition talks about 30 thousand tons of ore extracted EVERY DAY that would be transported on the same hwy 152!!! How can the state of New Mexico allow 90 heavy trucks daily on Hwy 152 and not a food delivery truck? That road is NOT designed for such heavy traffic.
Another piece of news is that this area has been under flood watching alert for a few days.
Now when we are blessed with rain it usually comes in clusters of storms sometimes very violent with hail . Totally unpredictable.
What allowances are being made by the mine for such catastrophic disasters?
I am also very concerned by toxic dust as this is a very windy place as well as noise and bright lights.
Last but not least 1050 acre feet a year of water does not seem sufficient to process those 30000 tons of ore per day and keep the tailings wet against the dust.
Nevertheless that is about 1 million gallon a day a huge amount of water coming from a greatly reduced water table in time of a long term draught and as the Rio Grande southern basin has to greatly diminish its allocation of water. Frankly I would prefer this water to be given to farmers than a foreign corporation.
Thank you for your attention.

Outlook

[EXTERNAL]

From Liz Tudor <lagartia@gmail.com>
Date Sat 9/19/2026 3:37 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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Hello ,
My name is Elizabeth Tudor.
I am a Sierra County resident.
I consider Kingston , Hillsboro , Animas Creek , Palomas and T or C all to be sister communities.
I found the first person from MMD to be quite slick at his talk . And most certainly doing his job well. An excellent sales pitch, down to possibly recruiting kids from the High School to be open to mining.
What I found so much more impressive and from the heart and with awareness of reality and sustainability,were my community members with deep love and reverence for our area. With solid and clear knowledge regarding the long term ramifications of copper flats mine.
I will do whatever I can, whatever is in my power to keep copper flats mine out.
No one lives in these areas for an economic boom and certainly not for exploitation of our natural resources.
Water .....water is the new gold and you all are coming for ours.
I say No, this drought is obvious to everyone even you all but you do not care. You want your money you serve your investors.
This is a really old game, a really old story of exploitation on multiple levels.
Short term gains . Long term devastation.
Greed greed and more greed.
Yawn.
Cost benefit ratio absolutely horrible for our communities and our ecosystems.
No No No
No copper flats mine
Sincerely,
Elizabeth Tudor

Sent from my iPhone

Anna Aguilera
Director
Mining and Minerals Division
NM Energy, Mining, Minerals and Natural Resources Dept.
1220 South St. Francis Drive
Santa Fe, NM 87505

September 19, 2026

Re. Copper Flat Mine

Dear Director Aguilera,

My name is Steve Dobrott. I am a resident of Hillsboro and have lived in this area since 1992. I respectfully submit the following comment regarding the permitting of the Copper Flat Mine in Sierra County for your consideration.

I was employed by Turner Enterprises Inc. as manager of the Ladder Ranch for twenty-four years and served as an ambassador for Ted Turner Expeditions (now Ted Turner Reserves) before retiring in 2018. Prior to this I was a Wildlife Biologist with the USFWS for seven years.

Because of the close proximity of the Ladder Ranch to the Copper Flat Mine (mine). I have on multiple occasions testified on the ranches behalf defending the owner's property and water rights that could be affected by this mine. The key arguments in opposition to the mine through the duration of three successive mine ownerships included potential ground water depletion of five Ladder wells, and potential water table reduction in Animas Creek. The prospect of several other potential adverse affects to the ranch bison production, commercial hunting and ecotourism business were also of concern. Affects that would significantly reduce the quality of life and environment that the owner desired.

Though now retired from the Turner organization, I still have concerns that pertain not only to the Ladder but to the community of Hillsboro where I now reside. As stated, historically, the main issues were related to the mines potential impacts on water and specifically ground water. I have listened to multiple testimonies by expert witnesses on both sides of this issue. I remain unconvinced that the mine will have minimal or no effect on neighboring ranches and communities as the NMCC experts purport.

I still have concerns over what could happen to groundwater levels in several Ladder Ranch and Pitchfork Ranch wells and other private wells on lower Animas Creek adjacent to the mine's main production wells. At risk are stock wells on nearby ranches that are within the influence of the cone of depression that will result from the 700-1000 foot deep pit that will constantly have to be dewatered pulling groundwater from surrounding springs and aquifers affecting established water rights of others. Water rights that are senior to those issued to the mine. Although NMCC says that the new

dry stack recovery method will require less water than originally planned, and based on years of listening to expert testimony, I remain convinced that the pit will have an influence on ground water levels within range of the cone of depression, the term used to describe the attraction of ground water towards the pit at or below existing water table levels. Thus, the high likelihood of lowering or depleting water levels of surrounding private wells could occur. This taking of water from wells that are senior in water rights such as those on the Pitchfork and Ladder Ranch is not only unconscionable, it is unlawful and subject to further litigation in protest for this action by those affected both neighboring ranches, landowners and downstream water user within the Lower Rio Grande Basin.

Additionally, I remain concerned that any drawdown of Animas Creek by either source of water extraction or diversion will adversely affect this biologically diverse riparian woodland that includes the eastern most stand of Arizona Sycamores. This important corridor affords habitat for a multitude of neotropical birds that nest there and at least one federally listed endangered species. It would be a travesty to lose the most important life supporting elements of this unique stream system to potential drawdowns of existing water flows for the short-term purposes of the mine.

I remain concerned about the affects of blasting on the historic homes and buildings on the Ladder Ranch just three miles north the mine. Likewise, the historic adobe homes in Hillsboro are just three miles to the southwest of the mine. The vibrations from dynamite blasting could create structural damage of these buildings over time.

I am concerned about the harmful dust particulates that will travel downwind affecting not only the Ladder, its wildlife, livestock and ranch employees who live and work there but possibly as distant as Truth or Consequences. These entities are directly down wind of the prevalent southwest winds that blow from that direction most strongly in the spring. Hillsboro could be affected with a reverse change in wind direction coming from the northeast in winter. Exposure to the toxic dust particulates emanating from the mine and the dry stack mineral recovery method could be devastating if not successfully and diligently managed. I'not convinced that this has been adequately addressed by NMCC or assessed by NMED. I am not convinced that the dry stack modeling has been thoroughly assessed by MMD or NMED and that NMCC has not provided adequate testing of the safety of the dry stack tailings.

Further, there has been insufficient assessment of the potential of seismic activity in the area that could affect the stability of the dry stack tailings, the failure of which could lead to exposure of the tailings and further movement of the underlying concentration of heavy metals by rain and wind events.

I remain concerned for the safety of our citizens on Highway 152 with the increase in traffic on a highway that was not designed or built to withstand the daily heavy loads of ore trucks and the increase in mine employee traffic. Additionally, highway 152 is one of the most favored routes by cyclists traveling across the souther United States,

providing additional tourism spending for Hillsboro. The increase in vehicle traffic from the mine will heighten the risk of accidents for cyclists choosing this route.

There are several reasons why this mine does not make sense for this part of New Mexico. The most compelling argument is the added stress to the water supply and downstream users in the Lower Rio Grande Basin during a time when New Mexico's water reserves are depleted from drought. How much worse will it get, nobody knows. I suggest that deferring the issuance of a permit to mine until environmental conditions improve and water balances are more conducive to the mine's needs is a prudent action at this time.

I understand that air and water quality issues are handled by the NM Environment Dept. and that ground water use and distribution is the responsibility of the NM Office of the Sate Engineer and that surface flows is the Interstate Stream Commission and that these matters are not in the prevue of NMMD per se. But for I and many others who have questioned the wisdom of having this mine for over 25 years, it could mean a significant change to our quality of life and the unspoiled environment that makes Hillsboro and Kingston a pleasant and healthy place to live and a destination for tourists.

Although water is still an issue and a major concern to the residents of this community, now we are faced with the unknown affects of dry stack mining on the pure air that we are blessed to breath in this area. This method for handling processed ore is a new twist in the attempt to revive a mine that has proven marginally profitable and whose affects to the environment and air quality could out-way perceived benefits to our local economy and those attributes that make it a joy to those who live here. Attributes like solitude, dark and starry night skies, fresh clean air, ample clean water, diverse wildlife, a multitude of outdoor recreational opportunities and a sense of community that is hard to find nowadays. All of which could be significantly affected by the presence and closeness of a large and potentially impactful copper mine.

Therefore, I urge MMD to take into consideration the important points voiced by the residents of Hillsboro during the hearing in Hillsboro on September 17, 2026. There are several inconsistencies and lack of answers to legitimate questions concerning the responsible and safe operation of the mine both during its operating life and afterwards that need to be addressed prior to the issuing a permit to proceed. For example, why is a new EE not appropriate at this time considering changes in the mine environment since the FEIS was published? Why hasn't there been a more complete assessment of the environmental impacts of the new dry stack method of extracting copper and other minerals at this site? Questions that need to be addressed prior to recommending the issuance of this permit to BLM.

Respectfully,

Steve J. Dobrott

Outlook

[EXTERNAL] On the Copper Flat Project

From F L <franklyspeaking404@gmail.com>
Date Sun 9/20/2026 4:12 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from franklyspeaking404@gmail.com. Learn why this is important

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We desperately need this project to be shut down! Buying water rights from the Apaches up north and applying them here is just fancy book keeping. We are going dry down here and the acre feet they require will not suffice to keep the airborne dust suppressed, and it will drain us dry with the cone of depression that will be created.
All the supposed jobs they talk about creating is B.S. and the profits are going to Australia.
The light pollution will obscure our beautiful dark skies, the truck traffic will destroy Highway 152 , and this extraction mentality is pure arrogance. Nothing about this project will stand up to an updated environmental review. Please reject the plan.
Sincerely, Frank Livoti
[redacted]

Outlook

[EXTERNAL] additional comments on Copper Flat Mine

From Don & Mary <cardynavery@gmail.com>
Date Mon 9/21/2026 2:09 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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On September 17, I gave testimony about my opposition to the Copper Flat Mine at the meeting in Hillsboro, New Mexico. I would like to add my comments to the record:

Copper Flat Mine has had a history of being sold. What guarantee do we have that the mine won't be sold in the future. And if it is, what happens any commitments to the citizens? Corporations are NOT people. They exist to make money. In the end, the mine will make decisions that serve its interests and not the interests of the people.
Sincerely,
Mary E. Cardyn

Anna Aguilera
Mining and Minerals Division
NM Energy, Minerals and Natural Resources Department
1220 South St. Francis Drive
Santa Fe, NM 87505

Regarding Copper Flats mine.



I guess it is still true. Water flows to money. For the rest of us, oh well.

Thank you

Ms. Anna Aguilera, Director
NM Mining and Minerals Division
NM Energy, Minerals and Natural Resources Department
1220 South St., Francis Dr.
Santa Fe, NM 87505

Dear Ms. Aguilera,

As a seasonal visitor and resident of Hillsboro, NM and a retired employee from the State of Colorado, Department of Natural Resources, I would implore the New Mexico Mining and Minerals Division (MMD) not to approve New Mexico Copper Corporation's revised application for the Copper Flat Mine. I believe that there are a number of questions that remain about whether the revised proposal has proven that there exists sufficient water for mine operations and reclamation, that the plan submitted adequately protects downstream water users, and that the plan demonstrates the long-term safety of the proposed Tailings Storage Facility.

The most recent proposal changes how mine waste would be managed, replacing conventional wet tailings with filtered tailings and projecting significantly lower water use. However, the most recent proposal has not resolved the fundamental concerns about the project.

The latest proposal has not shown that sufficient water is legally and physically available for both mine operations and reclamation at the stated production rates. The project would rely heavily on recycling water throughout mine operations, and questions remain about whether the projected water savings associated with filtered tailings are valid and adequately supported by proven documentation. The most recent plan has yet to demonstrate that the water sources it relies upon are legally available for mine operations and that sufficient water will remain available throughout the life of the project, especially lasting through a fully complete and approved reclamation.

Also, has the MMD fully accounted for the effects of the project's water use beyond the mine boundary? It would seem logical that groundwater pumping and other mine-related depletions could affect nearby wells and springs, Las Animas Creek, downstream water users, and ultimately the Lower Rio Grande River. I would stress that the adequacy of the mine's water supply cannot be evaluated separately from its effects on people and ecosystems that depend on the same water resources.

I also believe that the revised application has also not adequately demonstrated the long-term stability and safety of the proposed filtered Tailings Storage Facility (TSF). I believe that technical review has identified the need for additional site-specific information and analysis, including information about subsurface conditions and seismic hazards necessary to evaluate the slope stability. Before approving a facility intended to permanently contain mine waste, I believe that the MMD should require sufficient analysis to determine how the TSF will perform during operations, closure, and long-term reclamation, including the consequences of any potential catastrophic failures.

The most recent proposal also does not support a central assumption of the company's plan for reclamation of the open pit. As I understand, the pit would ultimately be approximately 1,000 feet deep and 2,800 feet wide. The reclamation plan relies on

rapidly filling the pit with groundwater to limit acid formation. Under the current proposal, filling the pit is expected to take more than 2.5 years rather than the six months as previously proposed. That substantial change raises serious concerns about the likelihood of an acidic pit lake and the effectiveness of the reclamation plan.

I do not believe that the MMD should not approve a reclamation plan that depends on rapid pit filling when the revised water supply no longer allows the pit to be filled rapidly. Backfilling the open pit needs to be fully evaluated as an alternative to the most recent proposal.

Please note that I do not believe that these concerns can be resolved after a permit is issued. They raise important questions as to whether the proposed mine has the resources necessary to operate and reclaim the site, whether its permanent mine waste facility can be safely constructed and maintained, and whether surrounding water users and groundwater can be protected over the long term.

I would request that MMD not approve the revised Copper Flat application unless and until the applicant:

- Has completely evaluated the effects of groundwater pumping and other mine-related depletion on wells, springs, Las Animas Creek, downstream water users, and the Lower Rio Grande River.
- Has proven that its revised pit reclamation strategy can prevent the formation of an acidic pit lake despite the substantially longer proposed filling period.
- Has submitted the site-specific geotechnical and seismic analysis necessary to demonstrate the stability and long-term safety of the proposed Tailings Storage Facility.
- Has proven that sufficient and legally available water exists for the full needs of mine operations, closure, and reclamation.
- Has shown that its projected water savings from filtered tailings are valid and fully supported.
- Has completely evaluated the consequences of a potential TSF failure.

The people living around Copper Flat, as well the generations that follow, will have to live with the consequences of this project long after mining ends. I believe that MMD has a responsibility to ensure these fundamental questions are fully evaluated before any type of approval by any NM governmental agency is provided.

Sincerely,



Robert J. White

[redacted]



Outlook

[EXTERNAL] Post-Hearing Comment on SI027RN

From Max Yeh <maxwyeh@gmail.com>

Date Mon 9/21/2026 1:34 PM

To Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>; Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>; Corey Durr <cdurr@blm.gov>; Cathey, Craig D., OSE <craig.cathey@ose.nm.gov>; Serrano, Ryan, OSE <Ryan.Serrano@ose.nm.gov>

Cc Bob Cunningham <bcunni4668@aol.com>; jsmith <jsmith@ebid-nm.org>; allysonsiwik <allysonsiwik@gmail.com>; Dustin Long (TEI-Ladder) <Dustin.Long@tedturner.com>; Greg Daviet <LegalReview@ebid-nm.org>; Carter Kruse (TEI - Montana) <Carter.Kruse@retranches.com>; Tessa Davidson <ttd@tessadavidson.com>; Tea Davidson <tea@tessadavidson.com>; David Salopek <dpsalo@zianet.com>; Kathy McKinney <kathymckinney@sbcglobal.net>; jpking <jpking@kingengr.com>

1 attachment (217 KB)

Post Hearing Water Calculation.pdf;

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Hello, Evan,

Hope you have recovered from the Hearing. Based on the new information about water use for dust control,and ore processing, I've recalculated NMCC's water needs. Please see the attached comment. It does not seem that given its own numbers on how much water will be in the tailings (which is the major part of the water needed from the wells) the recycling of process water through filtering the tailings will be save enough water to mine. This become abundantly clear when one adds to their water needs the water used for dust control. I have an argument about why the number for dust control water given at the Hearing is wrong, but even accepting it, the 1,050 AFY rights will not cover the mining needs.

If NMCC has submitted to MMD its new water budget, I'd like to see it, since it is quite different from what industry standards Dr. Emerman presented. He did say in his video that with a 13% water content in the tailings, there might be enough water for processing, but, of course, that simply ignores the other water needs, which are significant. Even with no dust control, the normal life of the mine needs would put NMCC's water use over their rights. That "Other" category of non-recyled water use is important because they operate their equipment in an essentially acidic environment, and that requires equipment washing to prevent corrosion.

--
Max

To: Ms. Anna Aguilera, Director
Mining and Minerals Division
Environment, Minerals, and Natural Resources Department
From: Max Yeh
maxwyeh@gmail.com
Date: September 21, 2026
Re: SI027RN
Post-Hearing Calculation of Water Use

Cake Stack Filtered Tailings Tailings Filtration and Conveyance (TFC): Prefeasibility Report (New Mexico Mining and Minerals Division, NMMMD), 8/18/2025. APPENDIX A: *PFS Drawings & Deliverables*, p. 1.

Description	Units	Value	Source	Reference	Comments
General					
Operation					
Annual plant throughput	stpy	10,804,000	A		PDC, MB, PFDs
Daily plant throughput	stpd	29,600	C		
Process plant availability	%	92.5	A		PDC, MB, PFDs
Process plant operating hours per day	h/d	22.2	C		
Process plant nominal hourly throughput	stph	1,333	C		
Tailings Characteristics					
Tailings hourly throughput	stph	1,322	A		PFDs rougher tailings, includes 1st cleaner scavenger tails.
Tailings % solids to filtration plant	% w/w	29.2	A		PFDs rougher tailings
Solids SG	-	2.67	S		PFDs rougher tailings
Combined Flotation Tails P90	µm	153	A		Pocock Testwork - Metcon
Combined Flotation Tails P80	µm	126	A		Pocock Testwork - Metcon
Combined Flotation Tails % - 25 µm	%	32.09	A		Pocock Testwork - Metcon

The feed of copper ore into the flotation process is given here as 29,600 tpd. This feed will produce tailings at the hourly throughput of 1,322 tons for an operating period of 22.2 hours.

The **daily throughput of tailings** is, therefore, 1,322 tons/hour x 22.2 hours/day = **29,348.4 tons per day**.

The **concentrate**, then, would have a daily throughput of 29,600 tons/d – 29,348 tons/d = **252 tons/d**.

That results in a very unusual **concentration ratio** of 29,600/252 = **117:1**

If the water left in the filtered tailings is filtered to 12% to 15% by weight, as declared at the Hearing, then the range of water content in the filtered tailings will be between 29,348 tons/day x 12% and 29,348 tons/day x 15%, or a **range from 3,522 tons/day to 4,402 tons/day.**

In pounds, this range of water left in the tailings is from 7,044,000 lbs./day to 8,804,000 lbs/day.

In gallons, this range of water left in the tailings is from **844,604 gallons/day to 1,055,635 gallons/day.**

In acre feet: from 2.59 af/d to 3.24 af/d or **from 946.08 AFY to 1172.74 AFY.**

Water retained in concentrate is given in 2-29 of the FEIS (2019) as **13 AFY.** This estimate should not change since no alteration of the flotation process has been indicated.

Total processing water loss at the output from the filter presses would range from **959.08 AFY to 1185.74 AFY,** far exceeding the estimate given at the Hearing of about 730 AFY.

The actual day to day adjustment of the filtration presses will depend on the effectiveness of stack compaction. Given the high local evaporation rate due to heat, aridity, and an open conveyor belt system, one should consider the upper part of the range of tailings water content to be more probable. The drying out of the tailings cakes after leaving the filtration presses may, in fact, push the upper limits of the range higher.

In addition to these water losses during the recycling process, water loss during mining must include dust control water, sanitation (which will increase with a larger workforce), equipment washing (which will also increase due to more equipment), and other non-recycled water uses which are totally lost to the system.

NMCC presented dust control water use in its revised water budget at the 9/17/2026 Public Hearing as approximately 120 AFY. This is a drastic, 83% reduction from the 726 AFY given in Table 2-29, FEIS. Since the previous MORP was touted as a state of the art project in water savings, including the use of dust suppression chemicals, the reduction is hardly credible, especially with the added use of water for both dust control during stack buildout and for irrigation during concurrent reclamation.[1]

Just considering dust control on 250 acres, that is, the tailings at half buildout, without considering the haul roads, 120 AFY would mean less that 6 inches of watering a year, less than ½ inch a month, less than 1/8 inch a week. Even if application intervals are extended by the use of dust suppressants to a month, we doubt that ½ inch of water is sufficient for a deep enough soaking of the soil, considering that evaporation rate at the mine is said to be 50 inches per year [SRK's report *Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, NM* (May, 2018), Section 3.1.6]. That is over 4 inches per month. The 120 AFY dust water use seems reasonably inadequate.

We prefer the earlier 726 AFY figure from Table 2-29 and also its estimate for other non-recycled water use, 242 AFY.

Therefore, we suggest MMD consider non-cycled water use to be **968 AFY**, as in the original MORP.

---

[1]The use of chemical dust suppressants can dramatically reduce water use in dust control. The use of magnesium chloride can reduce water use by 99% over using only water according to Alvaro Gonzalez *et al*, "Reducing mine water use in arid areas through the use of a byproduct road dust suppressant," *Journal of Cleaner Production* (9/1/2019). The use of lignosulfonate can reduce water use by 50.2% from plain water according to J.J.L du Plessis, *et al.,"Effectiveness of applying dust suppression palliatives on haul roads," Proceedings of the 2015 MVSSA Conference - Cost Reduction & Milestones Achievements* (2015). The use of biodegradable oil can reduce water use by 90% over the use of plain water according to the manufacturers of Epic DS dust suppressant. The use of biodegradable polymers can reduce water use by 85% over plain water according to the manufacturers of DUST/BLOKR. Since NMCC planned to use a dust suppressant in its original application (see footnote 2 of Table 2-29, FEIS), and since these reductions were all available to NMCC at the time of the original estimate of water use, we believe that the estimate of 726 AFY was based on a water saving plan that incorporated these possible savings rather than an estimate of plain water dust control. NMCC's new estimate of dust control water seems to have resulted from assuming that the 726 AFY estimate was for plain water dust control and thus reduced the amount even further by another 83% because of the use of polymers. Until NMCC can demonstrate how its new estimate can be achieved, we think MMD should accept the number used in the FEIS.

Total water loss in the revised application that must be replaced by groundwater ranges from 1,927.08 AFY to 2,153.74 AFY.

Even accepting the new estimate of abut 120 AFY for dust control, the fresh water need range would exceed NMCC's water rights: from 1,321.08 AFY to 2,153.74 AFY.

NMCC does not have the water rights to operate the mine as proposed in its PAP. The application violates the Director's Order of June 5, 2020.

Outlook

[EXTERNAL] Copper Flat Mine Revised Application, Permit No. SI027RN

From Carrie <carriemargaret@gmail.com>
Date Fri 9/25/2026 9:56 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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Dear Director Aguilera,

I urge the New Mexico Mining and Minerals Division not to approve New Mexico Copper Corporation's revised application for the Copper Flat Mine as currently proposed. Although the revised plan replaces conventional wet tailings with filtered tailings and projects substantially lower water use, serious questions remain about water availability, long-term tailings safety, reclamation of the open pit, and the lasting effects of this project on surrounding communities, wildlife, and ecosystems.

Water remains one of the most significant concerns. The applicant has not adequately demonstrated that sufficient, legally available water exists to operate the mine at the proposed scale and complete reclamation afterward. The revised plan relies heavily on water recycling and projected savings from filtered tailings, but those assumptions need to be demonstrated—not simply projected.

Just as importantly, MMD must consider what that water use means beyond the mine boundary. Groundwater pumping and mine-related depletion have the potential to affect wells, springs, Las Animas Creek, downstream users, and the ecosystems that depend on those waters. In an arid state where water is already scarce and increasingly stressed, a mine's water supply cannot reasonably be evaluated separately from its effects on the surrounding watershed.

The proposed filtered Tailings Storage Facility also warrants greater scrutiny. A facility intended to contain enormous quantities of mine waste permanently should not be approved without adequate site-specific geotechnical and seismic information demonstrating its stability during operation, closure, and long-term reclamation. The consequences of a major failure must also be fully evaluated before permitting, rather than addressed after the fact.

The revised proposal creates another significant problem for reclamation of the roughly 1,000-foot-deep open pit. The reclamation strategy has relied on relatively rapid groundwater filling to limit acid formation, yet the revised plan now anticipates filling the pit over more than 2.5 years rather than approximately six months. MMD should require the applicant to demonstrate that this approach can actually prevent an acidic pit lake under the revised conditions and should fully evaluate backfilling the pit as an alternative.

I am also concerned that the environmental consequences of this project extend well beyond engineering questions at the mine site. This landscape provides habitat and movement corridors for wildlife and supports sensitive desert, grassland, riparian, and aquatic ecosystems in which relatively

small changes in water availability, disturbance, dust, noise, lighting, and traffic can have outsized effects. Industrial development on this scale would fragment habitat and fundamentally alter a landscape that wildlife and nearby communities currently experience very differently.

Those effects on people deserve consideration as well. Rural public lands provide something increasingly difficult to replace: quiet, dark skies, undeveloped views, wildlife, and access to places where people can experience genuine solitude. These are not merely aesthetic amenities. They are part of the ecological and cultural character of southern New Mexico and an important reason people live in and visit these communities. The cumulative effects of industrial traffic, noise, dust, lighting, habitat disturbance, and a large permanent mine footprint should be weighed alongside the project's technical impacts.

These concerns are not minor details that can be resolved after a permit is issued. They go to whether the mine has adequate water to operate and reclaim the site, whether its waste can be safely contained over the long term, whether reclamation will actually protect water quality, and what permanent costs the project could impose on surrounding ecosystems and communities.

I therefore urge MMD to require the applicant, before approval, to demonstrate adequate and legally available water for operations and reclamation; fully evaluate impacts to groundwater, surface water, wildlife, and downstream users; provide sufficient geotechnical and seismic analysis of the Tailings Storage Facility and the consequences of a potential failure; demonstrate that the revised pit reclamation strategy will protect long-term water quality; and meaningfully evaluate backfilling as an alternative.

There is also a larger question here about New Mexico’s long-term relationship with extractive industry. Minerals removed from our landscape are a one-time resource, while the environmental and community consequences of extracting them can persist for generations. We cannot simply restore groundwater, intact habitat, or an undisturbed landscape once they are lost. New Mexico should be increasingly deliberate about whether short-term extraction justifies long-term costs, particularly when those costs are borne by communities and ecosystems long after the economic activity has ended.

The communities and ecosystems surrounding Copper Flat would live with the consequences of this project long after mining ends. MMD has a responsibility to ensure that these fundamental questions are resolved before—not after—a permit decision is made.

For these reasons, I urge the Division not to approve the revised Copper Flat application as currently proposed.

Sincerely,

Carrie Anderson

[redacted]

[redacted]

[redacted]

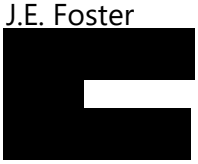
Outlook

[EXTERNAL] Copper Flat MIne

From J.E. Foster <scoopdjour@gmail.com>
Date Fri 9/25/2026 5:53 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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I'm not a scientist, by no means an expert, but I've read and understood enough to know that the Copper Flat Mine will negatively impact the water situation in New Mexico, that it will disturb delicate native flora and fauna. The comments from the public hearing on September 17 at the Hillsboro Community Center tell me this is bad for us, and bad for our state.
NO Copper Flat Mine!
J.E. Foster

--
"Pay attention. Be astonished. Tell others." ~Mary Oliver

Outlook

[EXTERNAL] Copper Flat Mine Revised Application, Permit No. SI027RN

From Roxanne VanWormer <chillyrodent@gmail.com>
Date Fri 9/25/2026 11:12 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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Director Aguilera:

I am concerned that the mining operations proposed here would be a tragic and irredeemable misstep.

Water is too scarce and precious here to be turned over to a questionable process, by a company with only its bottom line in mind. Once the water supply is depleted or tainted, there is no re-do, and New Mexico Copper Company, or its purchaser, will say only "Copper Flats who?" from the comfort of anywhere but here.

Sincerely,
Roxanne VanWormer
Truth or Consequences, Sierra County

Outlook

[EXTERNAL] Copper Flat Mine Revised Application, permit no SI027RN

From shannon donnelly <sdonnellynm@gmail.com>
Date Fri 9/25/2026 5:44 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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Director Aguilera,

I urge the New Mexico MMD to block and disapprove New Mexico Copper Corporation's revised application for the Copper Flat Mine.

New Mexico is dealing with extreme drought conditions--we need water for people, livestock, and crops. The Copper Flat Mine has not shown they have sufficient water for mine operations and reclamation or adequately protection of downstream water users. Their Tailings Storage Facility is not sufficient, and they do not have adequate plan for reclamation work.

Their changes to their proposal has not resolved the fundamental concerns surrounding the project.

The project would rely heavily on recycling water throughout mine operations, and questions remain if any of this is realistic.

Groundwater pumping will affect nearby wells and springs, Las Animas Creek, and ultimately the Lower Rio Grande.

The proposed pit would ultimately be approximately 1,000 feet deep and 2,800 feet wide--that is a huge scar on the land. Reclamation would take years and cost a great deal, and what guarantees are there that the company would not abandon it?

These are not minor details that can be resolved after permitting.

Please do NOT approve the revised Copper Flat application.

The communities surrounding Copper Flat would live with the consequences of this project long after mining ends

Shannon Donnelly
T or C, Sierra County

Outlook

[EXTERNAL] Copper Flats proposal

From Will Kinney <will.kinney7@gmail.com>
Date Mon 9/28/2026 12:25 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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1I see nothing in the proposal regarding where the employees are supposed to live.
2) if they are all going to be living in Truth or Consequences is the Mine providing transportation to and from the mine entrance?
3) there isn't space for any mine employees to live west of the mine,
nor is there water or postal service available near the mine entrance
4) what is the mine going to do to protect the rural environment impacted by an influx of employees three times the current population?

Will Kinney
Hillsboro, New Mexico

Outlook

[EXTERNAL] SI027RN

From Max Yeh <maxwyeh@gmail.com>
Date Mon 9/28/2026 11:19 AM
To Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>
Cc Cathey, Craig D., OSE <craig.cathey@ose.nm.gov>; Serrano, Ryan, OSE <Ryan.Serrano@ose.nm.gov>

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Hi, Evan,

In my earlier comment on Copper Flat mine dated 6/18/2026, I said that the hydrological basis of the mine's Updated Hydrological Report was outdated. I submitted as evidence the Hearing Officer's report from the OSE Hearing on the mine's application for transfer of water rights. I referred several times to new geological evidence on the connection between the Las Animas Creek flows and the deep aquifer of the Santa Fe Group. I would like to submit, for the record, that geological study: Daniel Koning, Andy Jochems, and Colin Cikoski, *Geologic Map of the Skute Stone Arroyo, 7.5-minute Quadrangle, Sierra County, New Mexico (May, 2015)*. It's a large file; so. here is a link:

https://drive.google.com/drive/folders/1rUd3qwMfN7XAyp-4onIIrv9srvDFrT8J?usp=sharing.

The possibility that Las Animas Creek and its shallow aquifer are dependent on the Santa Fe Group aquifer would cast doubt on the assumption throughout the earlier and present discussion of local geohydrology that the shallow aquifer of Las Animas Creek is perched so that the mine's water use would not affect either the creek flow or the shallow wells along the creek or affect them only in minor ways. In fact, the BLM's *Record of Decision* specifically affirms that as a hydrological fact: "The BLM understands that a particular concern is the seasonal flow that occurs along the perched reach of Las Animas Creek, which supports irrigation, vegetation, and habitat. No direct impact to the highly valued resource in this reach is expected to result from the project. This conclusion results from the fact that the shallow groundwater in the reach is not hydrologically connected to the regional aquifer which is the source of water to the wells that would supply the project, although it is subject to a small reduction in water supply due to upstream effects. Indeed, the perched water table would not exist if there were a connection to the main regional aquifer, which at present lies at substantial depth below the river." Such a view results from the Jones aquifer study which formed the basis of the Updated PHC in the present PAP.

However, the Koning, *et al.,* report on Skute Stone Arroyo devotes two illustrated pages to show the possibility and even likelihood that Las Animas Creek flows come from upwelling of water from the Santa Fe Group aquifer caused by a fault that crosses the creek. Koning gives as evidence of this upwelling the existence of the Arizona Sycamore groves along the reach of the creek just below the fault. See pp. 24-25, especially the illustrations of the mechanism of the upwelling and the discussion of the Sycamore trees.

If this hypothesis is true, then the mine's plan to pump 300+ AFY from wells at the mine site may, in fact, cause a greater impact on Las Animas Creek watershed than pumping that rate from its production wells, which are a mile down gradient of the fault. I do think that we need a hydro study of

the impacts of their groundwater withdrawals especially on the withdrawals at the mine since only with pitlake evaporation, their previous model already showed serious impairments of local wells and springs on the Ladder Ranch and on the Hillsboro Pitchfork Ranch. With the much increased use of minesite wells for production water that impact is multiplied many-fold times.

--
Max

To: Anna Aquilera, Director
Mining and Minerals Division
From: Max Yeh
Percha/Animas Watershed Association
Date: September 28, 2026
Re: **Other Permits**

19.10.6.606B(2) NMAC states that MMD Director shall not issue a permit until the Director finds, in writing, that: "The applicant has provided evidence that all other applicable state and federal permits required to be obtained by the new mining operation either have been or will be issued before the activities subject to those permits begin."

1) While the Department of Interior (BLM) has issued a permit (Record of Decision, or ROD), that permit is conditional. One of its conditions states:

> The approval of this project is conditional on the proponent acquiring the necessary water rights to operate the mine. Surface disturbance will not be allowed until sufficient water rights are acquired. (Pdf, p. 7.)

Also:

> The BLM will authorize this mine project and any operations are premised on the acquisition of necessary water rights under the authority of the OSE for the life of the mine plan. (Pdf, p. 9.)

Will the Director of MMD respect this condition and also withhold approval of the operation until demonstration of the necessary water rights, as in the June 5, 2020, Director's Order.?

2) The ROD also stipulates:

> NMCC's appropriation of water is thus subject to the OSE's conclusion that any water appropriation by NMCC would not impair existing water rights, is not contrary to conservation of water within the state and is not detrimental to the public welfare of the state. (*Id.)*

Will the Director of MMD respect this further condition, which goes beyond the NMCC/MMD Agreement in the June 5, 2020, Director's Order, and withhold approval until demonstration of non-impairment of existing rights, conservation of water, and non-harm to public welfare, in spite of NMCC's claim that its adjudicated water rights allow impairment of existing rights?

3) The FEIS requires that "the pitlake water chemistry shall meet applicable water quality standards during the post-mining monitoring period, which is defined as 30 years after completion of reclamation at the Copper Flat mine" (p. 3-36). Further, "The proponent shall provide a preliminary pit lake water quality management plan, which describes reclamation, water quality management, and monitoring activities that would be conducted to facilitate compliance with applicable water quality standards during the post-mining monitoring period."

If it is shown that water quality standards do apply, will the Director require such a preliminary water quality management plan for the pitlake?

4) Since the mine's open pit is below the water table, has the Director evidence that the State Engineer has approved a dewatering permit for Copper Flat Mine?

5) If NMCC plans to use water from the pit, that is, use the pit as a Point of Diversion (OSE well number LRG-04652-S-17), does the Director have evidence that the OSE has granted permission to extract more than the adjudicated 5.52 AFY for dust control and 34.65 AFY for evaporation for that POD?

6) 19.10.6.606B(3) NMAC: No permit shall be issued until the Director finds, in writing, that:: "The Secretary of the Environment Department has provided a written determination stating that the permit applicant has demonstrated that the activities to be permitted or authorized will be expected to achieve compliance with all applicable air, water quality and other environmental standards if carried out as described in the permit application. This determination shall address applicable standards for air, surface water and ground water protection enforced by the Environment Department, or for which the Environment Department is otherwise responsible."

a) NMCC received a New Source Review Permit (#0365-M3) from the Air Quality Bureau in 2013. While this permit has no expiration date, the terms under which the permit was issued have significantly changed. First, the application was made for a 25,000 tpd operation and not the 30,000 tpd operation in the present PAP. Second, the application was made for a wet tailings process instead of the filtered tailings process, which may significantly increase air quality pollution. See, FEIS, Appendix B, where the application and the permit are reproduced. The dispersion modeling on which the permit was issued will have to be redone. The permit requires a Significant Permit Revision (20.2.72.219D NMAC). See Permit, B101 A,B, and C. That revision is discussed in the FEIS 3.2.2.3 in regard to the increased throughput. The change to filtered tailings processing adds to this concern.

Will the Director of MMD request that NMCC apply for such a revision from the Air Quality Bureau?

b) If the pitlake is determined not to be constantly and permanently a hydrologic evaporative sink but also from time to time a flow-through pit, will the Director require a permit from the surface water bureau of the NMED? See my comment of September 26, 2026, re: Copper Flat Mine Pit Reclamation.

Outlook

[EXTERNAL] SI027RN and DP-1840

From Max Yeh <maxwyeh@gmail.com>
Date Tue 9/29/2026 11:47 AM
To Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>; Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>; Ennis, David, EMNRD <david.ennis@emnrd.nm.gov>; Reid, Brad, ENV <brad.reid@env.nm.gov>

1 attachment (297 KB)
Pitlake reclamation.pdf;

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Hello, Evan, Jordan, DJ, and Brad,

The attached comment is another joint submission to MMD and NMED.

I have included DJ and Brad in this submission because I spoke to both of you at the MMD hearing in Hillsboro about water level fluctuations in the future pitlake. Both of you, separately, had the same initial response, that movement into groundwater was miniscule and negligible. I think that's an understandable response. However, the present comment is a considered reply, arguing that the amount will be significant. Part of my reply is a runoff calculation for a 1-inch rainstorm, which would raise the pitlake level so much that it would take 48 days to return to balance. To put that into experiential terms, you may remember that when you were in Hillsboro on the 17th, we were in a flood watch, and indeed that weekend, the road to Deming was impassable at 5 different places. Since then, actually since September 15th, 4.10 inches of rain have been recorded in Truth or Consequences. At 50 inches/year evaporation rate, that is, one full year when the future pitlake would not be an evaporative sink.

This comment sets all my previous comments on the pit into a single, continuous argument with new calculations and legal considerations. It ends with suggestions of additions to NMED's Draft Wastewater Permit which I hope you will find supported by the argument.

--
Max

To: Anna Aguilera, Director
Mining and Minerals Division, EMNRD
James Kenney, Secretary
Environment Department
From: Max Yeh
Percha/Animas Watershed Association
Date: September 26, 2026
Re: Copper Flat Mine Pit Reclamation

Pit reclamation is a difficult problem which may not have a reasonable solution. I will argue that creating a hydrologically balanced pitlake is not the best possible solution to this problem.

I. I assert some basic facts and their corollaries. These must be held in mind throughout this argument:

A) The primary concern in reclaiming the pit is reducing the risk of groundwater pollution. This aim means that when we speak of "water," we understand that at issue is, in fact, a chemical solution; that is, our primary concern is with the solutes dissolved in the water solvent.

B) Physically, there is no surface between pitlake water and groundwater. The distinction between pitlake water and groundwater is a legal creation, like political borders and boundaries. As with political borders, when there is a matching physical formation to reinforce that legal boundary, we tend to imagine that boundary as real, but it is not. In the pitlake, the pit's rock walls give the illusion that the pitlake is physically contained, but the fact that the pitwalls are fissured, that there is groundwater in the rocks, demonstrates the reality that, as far as water is concerned, the boundary is conceptual. In thinking about that imaginary interface, we must remember that pitlake water and groundwater are a single body of water. In a still body of water, diffusion will cause solutes to spread throughout the water (though gravity may cause vertical separation by mass). The concentration of solutes on the two sides of the imaginary, legal boundary between the pitlake and groundwater will be the same.

C) In the context of this calculation, I use the term "hydrologic balance" to refer to a situation in which the outflow from the pitlake (evaporation) equals the inflow (precipitation and groundwater inflow).

D) A "hydrologic balance" defines the difference in the Copper Rule between a "hydrologic evaporative sink" and a "flow-through pit," that is, defines the difference between pitlakes not subject to the water quality standards of 20.6.2.3103 NMAC after closure and pitlakes subject to those standards.

E) "Hydrologic balance" does not represent an equilibrium at the imaginary interface between the pitlake and groundwater. At that interface, when "hydrologic balance" is reached there is not an equilibrium (or balance) of forces but a pressure difference which causes a constant flow into the pitlake.

F) The legal definition of "hydrologic balance" is based on annual averages of precipitation and evaporation. But since the evaporative rate constantly changes due to fluctuations of temperature, humidity, sunshine, wind speed, etc., the "balance" itself changes constantly, resulting in a constant fluctuation of the pitlake water level: for example, there is a constantly

repeated, 356-days-a-year fluctuation between day and night. These fluctuations mean that the flow into the pitlake is often reversed although overall the flow goes from groundwater to pitlake. While this reverse flow of pitwater into groundwater may seem, at first, to be very small in quantity, that is not true. Because these fluctuations are constant and permanent, the accumulative effect is significant. Also, because the pitlake is a catchment pond for some 300 acres of drainage, a small precipitation can cause the "constant" flow into the pitlake to be reversed for long periods of time. See the runoff calculation below in section III. By the Copper Rule, the future pitlake at Copper Flat Mine will be both a hydrologic evaporative sink and a flow-through pit and both subject to and not subject to water quality standards.

G) The pressure difference at the boundary between the pitlake and groundwater is controlled not by the regional phreatic surface elevation and the resulting weight of water above the pitlake/groundwater boundary but by the elevation of the pitlake surface, that is on the depth of water in the pitlake creating the pressure from the water's weight and atmospheric pressure on the water. That is because of the ground's high resistance to water flow as indicated by its low conductivity, which explains why groundwater flow into the pitlake is more like a seep than a flow.

II. There are two ways in which solutes in the pitlake enter the groundwater:

A) When the internal pressures of the pitlake and groundwater are at equilibrium at their interface (not at "hydrologic balance") solutes enter groundwater by diffusion. How far they travel and in what quantity depends on the molecular forces of diffusion of the chemicals themselves. These can be known and should be analyzed. When the internal pressures are not equal, either under "hydrologic balance" or under the constantly recurring reverse flows, solute transport by diffusion is either inhibited or increased. A reasonable and doable calculation should be done to ascertain whether the "constant" flow of water into the pitlake under the "hydrologic balance" is sufficient (that is, the pressure gradient is sufficient) to prevent diffusion of solutes into groundwater. If not, then the whole scheme fails.

B) Besides diffusion, the constant back and forth movement of pitwater solution into and out of groundwater is another way in which solutes enter groundwater. Here, my essentially molecular analysis differs markedly from a hydrological analysis.

1) When solutes are bulk carried from the pitlake into groundwater, the solutes may be carried further away by the normal regional groundwater flow around the pit. Also, the adhesion of the solutes to the surfaces of the ground media (sorption) could reduce the solute concentration when water returns from groundwater to the pitlake. That is, the small water movements back and forth across the imaginary boundary between pitlake and groundwater would constantly leave behind in groundwater a bit of solute. The water that returns to the pit is not necessarily the same water that left the pit.

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of water. All discussions of pitwater movement in this application has assumed the hydrological viewpoint, but in terms of solute transport, that assumption is somewhat off target.

III. Here is a demonstration that reverse flow, from pitlake into groundwater is numerically significant:

A) Calculation of runoff from 1 inch rain storm using an updated USDA runoff equation

$$Q = (P - 0.05S_{0.05})^2 / (P + 0.95S_{0.05}),$$

where Q is the runoff in inches.
P is the rainfall in inches, = 1 inch.
S is a measure of soil moisture. Traditionally, this number was said to be related to the Initial Abstraction (I_a, precipitation caught on vegetation and infiltrated into the soil) by the Initial Abstraction ratio, $I_a / S = 0.2$. However the USDA has found evidence that the ratio is closer to 0.05. See the Wikipedia article on Runoff Curve Number for a quick explanation of the revision. I am using the updated runoff equation incorporating the revised Initial Abstraction ratio.
$S_{0.20}$ is calculated from the Curve Number (CN), which specifies the type of terrain, by the relationship $S_{0.20} = (1000/CN) - 10$. I have chosen to use in this calculation the CN = 90, a CN for desert hardpan, grass and brush land with very little capacity for percolation.
$S_{0.05}$ is calculated from $S_{0.20}$ by the proportion $S_{0.05} = 1.33\ S_{0.20}$.

B) Following the procedure described in the Wikipedia article

$S_{0.20} = (1000/90) - 10 = 11.11 - 10 = 1.11$
$S_{0.05} = 1.33\ S_{010} = 1.48$
$Q = [1 - 0.05\ (1.48)]^2 / [1 + 0.95\ (1.48)] = 0.926 / 2.41 = 0.384$ inches.

C) The runoff area totals 327 acres, of which 21 acres form the catch-basin pitlake. Therefore, the runoff from 306 acres is 306 acres x 0.384 inches = 117.58 acre inches. This amount of water added to the 21 acre pitlake will raise the pitlake level 117.58 acre inches / 21 acres = 5.60 inches. Since one inch of rainfall will also fall directly into the pitlake, the total rise in the pitlake is **6.60 inches.**

D) The 6.60 inch rise seems reasonable given the statement in the 2025 PHC Update that a 3.29 inch precipitation (the 100 year storm event design standard) would cause a rise of the pitlake water level of 2 to 3 feet. See the 2025 PHC Update, p. 23.

E) With an evaporation rate of 50 inches a year (50 inches/365 days = 0.137 inches per day), the 6.60 inch rise in pitlake level resulting from one inch of rainfall **will take 48.2 days to abate, returning the level to hydrologic balance**. In the meantime, the pitlake water solution will flow into groundwater. According to the 2013 Shoemaker *Model of Groundwater Flow in the Animas Uplift and Palomas Basin, Copper Flat Project, Sierra County, New Mexico,* one-inch storms occur on average twice a year, cited in the *Record of Decision* (2019*),* Appendix A: Biologic Opinion. A 100 year storm would take over 6 months to return to balance.

F) The filling of the pit to hydrologic balance will not prevent pitlake water from mixing with groundwater, and it will not prevent solute transport into groundwater.

IV. Given the significant amount of solute that can move from the pitlake to groundwater, the future chemical makeup of the pitlake is important, and we should know if these chemicals will surpass legal standards. Thus, it seems NMED and MMD should seriously consider the argument here which attempts to demonstrate that the future pitlake may not be a permanent "hydrological evaporative sink" and therefore should not be exempt from 20.6.2.3103 NMAC.

V. A most sophisticated and detailed predictive study of the chemical makeup of the future pitlake is given in *Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico* (SRK, 2018). However, much of the study's predictive value depends on the filling of the pit with good quality water from the mine's production wells. Under the new water regime, over 300 AFY of fill water will be pumped from wells at the mine site, amounting to over 1/3 of the rapid fill water. This water is of unknown and reasonably dubious quality since the wells are located down gradient of the former tailings pond, site of a known pollution plume.

In addition, Section 3.10 (p. 35) of that study explains in detail that the purpose of the study is to demonstrate that the future pitlake will be chemically similar to the existing pitlake. That purpose is motivated by the assumption that the only regulations that apply to the pitlake are MMD's concerns on hydrologic balance (used in a general sense rather than my use of the term above). The study assumes that state surface water and groundwater standards do not apply because the pitlake will be on private land and because the pitlake is a hydrologic evaporative sink.

A) However, the assumptions are wrong on both counts. I have attempted to demonstrate that the pitlake is not always a hydrologic evaporative sink. Its water should be subject to water standards. The other assumption, the private water issue, is more complicated and requires a detour to understand.

B) 20.6.4.7(S)(5) NMAC defines, for environmental regulations, "surface water(s) of the state" to mean "all surface waters situated wholly or partly within or bordering upon the state," with the exception of "private waters that do not combine with other surface or subsurface water" (subsection c). The fact that the pitlake is on private land does not make its water private for environmental concerns because generally all waters of the state are subject ot quality standards.[1] Pitlake water is a combination of groundwater and runoff water, both of which are public, state waters. One might think that the exemption does not apply to the pitlake at Copper Flat Mine, and thus does not exempt its water from state pollution standards. However, the courts have specifically understood the word "combine" in this code in another way.

NMED's approval of the original DP-1840, the discharge permit for Copper Flat Mine, was contested in court partly on the issue of the meaning of "water of the state." That litigation was decided by the Court of Appeals in 2022 in favor of the Commission and NMED: *EBID v. NMWQCC*, 2022-NMCA-045. The court ruled that NMED was correct in declaring that "water of the state" did not apply to the future pitlake at Copper Flat Mine. The court based its decision on two reasons. First, it deferred to NMED's expertise. Second, it ruled that NMED's understanding that the exception applied only when water moved from the pitlake into groundwater and did not apply when groundwater moved into the pitlake was correct and not arbitrary, capricious, or otherwise not in accordance with the law. See *EBID v. NMWQCC*, 2022-NMCA-045, §24.

The court's decision collapses the two assumptions of NMCC's predictive model of pitlake water chemistry – of private waters and of a hydrologic evaporative sink. At issue is only whether pitlake water moves into groundwater, and I have demonstrated that in terms of

1 The definition of "water(s) of the state" in Title 20 differs from its use under under 72-2-1 NMSA defining the authority of the State Engineer. Its meaning in 72-2-1 NMSA derives from 72-1-1 and 72-12-1 NMSA.

solute transport rather than water volume, pitlake solutions do move into groundwater, not only creating at times a flow-through pit but making the pitlake state water and thus not exempt from surface water standards.

C) To return to the predictive modeling study, recognition that the future pitlake is not always and constantly an evaporative sink would change the projected dilution of elements. I have already mentioned that under the amended application, the rapid fill water is of unknown purity. To that alteration of predictive value should be added the change in the expected volume of groundwater inflow.

D) The study's aim of demonstrating similarity between the present pitlake chemistry and the future pitlake chemistry ignores the history of the present pitlake's acidity, which the study itself documents. Figure 1-10 shows the pH data from the present pitlake.

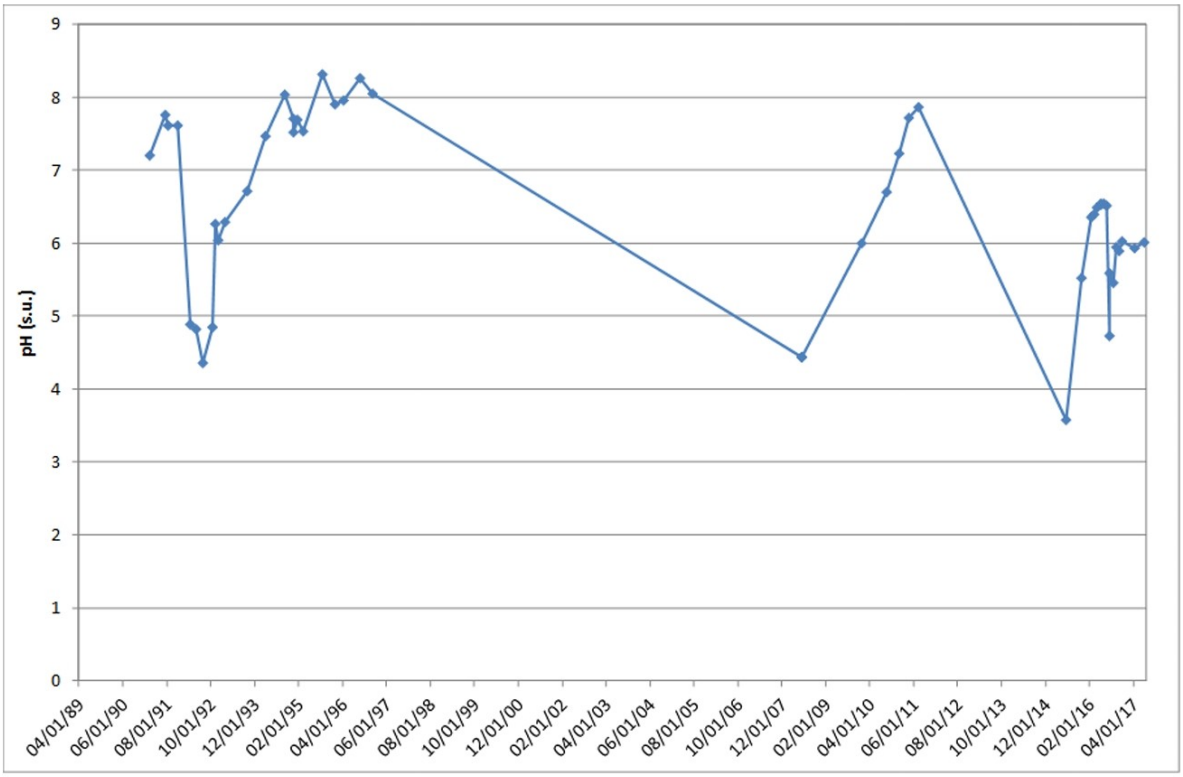


Figure 1-10: Plot of pH in Existing Pit Lake

The four sudden drops in pH are described in the text as "periodic Acid Wall Seep (AWS) events" (p. 15). That explanation is not helpful. I have discussed the first acid event and its neutralization as the result of weather conditions. See my submitted comment of June 10, 2026 oo pit reclamation. I have not tried to find the cause of the others because the data seem insufficient, especially the 9 or 10 year gap in the middle. The more recent information on acidity is ambiguous because of the report in the record that NMCC was chemically neutralizing pitwater acidity. However, if such AWS events are periodic, then

we expect to see these spikes in acidity in the future pitlake as well, putting some doubt on the conclusion that the future pitlake chemistry is essentially benign.

E) Compare the above graph to Figure 6-5 below, which shows the projected pitlake pH. Do they look similar?

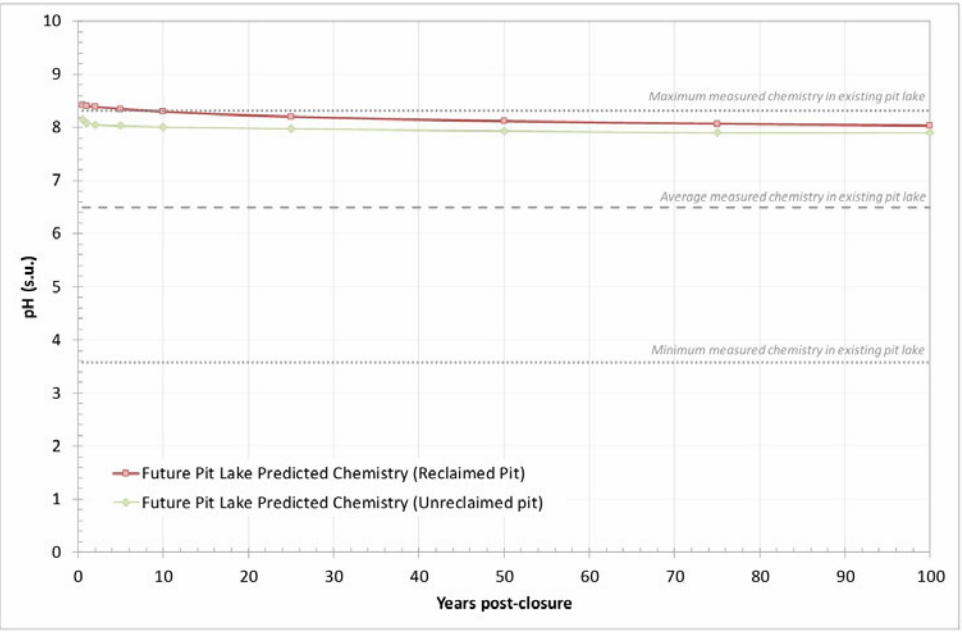


Figure 6-5: Time-series Plot of Predicted pH for the Reclaimed Pit Model

VI. Conclusion: A significant amount of pitwater entailing dissolved solutes can be expected to move into groundwater from the future pitlake at Copper Flat Mine, making the pitlake at times a flow-through pit and waters of the state and thus subject to water quality standards of 20.6.2.3103 NMAC after closure. NMCC's reclamation plan must take this possibility into account. Since it does not, MMD should require it to do so. NMED's *Draft Discharge Permit Renewal and Modification; DP-1840* (9/11/2026) allows the possibility of the application of surface water standards in subsection C115, E: "Surface water quality standards will not apply to the pit lake water body that will exist at closure so long as the pit lake remains a hydrologic evaporative sink and the pit lake water body remains wholly on private land (20.6.4.7(S)(5) NMAC)." [NMED should not confuse private land with the private water issue.] However, nowhere does the permit discuss how these exemption conditions will be determined. Its expertise should allow NMED to monitor (or require NMCC to monitor) both water and solution migration into and out of the pitlake.

A reasonable discussion of water quality in the future pitlake is presented in BLM's FEIS (2019), pp. 3-34 through 3-38. The BLM cautions against using NMCC's predictive model as the sole component in assessing the future pitlake. It introduces, we think wisely, the possibility of future changes in standards. It requires the creation of a management plan which initially will cover a period of 30 years after the beginning of reclamation and a final management plan submitted one year prior to closure. As far as I know such a management plan for the pitlake does not exist. The pitlake should be monitored directly, not just through the monitoring wells, and a plan for such monitoring as well as an abatement plan for remedying exceedances of standards should be in place before the issuance of any permit by MMD or by NMED.

VII. My suggestion for mitigation of this possible risk is to include direct monitoring of pitlake chemistry, monitoring of pitlake surface level, and monitoring of the pressure gradient at the hypothetical surface between the pitlake and groundwater. This suggestion is based on several considerations:

A) Movement of water in the bedrock aquifer at the pit is, presumably, irregular, proceeding through fractures, fissures, channels, and between pockets of saturated breccia. That movement is further complicated by the existence of two prominent faults that cross the pit, providing four open passages for water movement through the bedrock. See Dunn's description of sludge and wet cement like material in the faults, Peter G. Dunn, "Geology of the Copper Flat Porphyry Copper Deposit," in Titley (ed.), *Advances in the Geology of Porphyry Copper Deposits* (1982). Thus, monitoring well data in the bedrock aquifer is less reliable than normal.

B) Given the variety of different estimates of the hydrologic balance level of future pitlake (the predictive chemical studies give three, as I remember), we can get a better ASL elevation by direct measurement.

C) Pressure transducers set at the same ASL elevation in the pitlake and in a monitoring well can give internal pressure differences at the hypothetical boundary between pit water and groundwater and thus show the direction of flow. This data will also give the ASL elevation of the pitlake surface so that an accurate hydrologic balance level can be determined. We don't need to speculate about evaporative sinks and flow-through pits.

D) Incorporated into a management plan, these monitoring arrangements will be more accurate and safer than than the simple monitoring of the monitoring wells to determine groundwater pollution and whether the evaporative sink idea works or not.

Outlook

[EXTERNAL] Correction on SI027RN and DP-1840 comment

From Max Yeh <maxwyeh@gmail.com>
Date Wed 9/30/2026 6:39 PM
To Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>; Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>
Cc Reid, Brad, ENV <brad.reid@env.nm.gov>; Ennis, David, EMNRD <david.ennis@emnrd.nm.gov>

1 attachment (299 KB)
Pitlake reclamation.cor.pdf;

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Sorry, Evan and Jordan,

My submission of September 26, 2026, is missing a footnote entry. Section IIIE should have the following footnote: “The calculated times for the pitlake levels to return to hydrologic balance are offered rhetorically since they are based on the assumption that water only leaves the pitlake by way of evaporation. My whole point is that when pitlake water level rises, water also leaves the pitlake by flowing into groundwater. Thus, the actual time for abatement of pitlake level rises is much less since a good deal of water is actually flowing into groundwater.”

A corrected version is attached.

--
Max

To: Anna Aguilera, Director
Mining and Minerals Division, EMNRD
James Kenney, Secretary
Environment Department
From: Max Yeh
Percha/Animas Watershed Association
Date: September 30, 2026
Re: Copper Flat Mine Pit Reclamation, corrected version

Pit reclamation is a difficult problem which may not have a reasonable solution. I will argue that creating a hydrologically balanced pitlake is not the best possible solution to this problem.

I. I assert some basic facts and their corollaries. These must be held in mind throughout this argument:

A) The primary concern in reclaiming the pit is reducing the risk of groundwater pollution. This aim means that when we speak of "water," we understand that at issue is, in fact, a chemical solution; that is, our primary concern is with the solutes dissolved in the water solvent.

B) Physically, there is no surface between pitlake water and groundwater. The distinction between pitlake water and groundwater is a legal creation, like political borders and boundaries. As with political borders, when there is a matching physical formation to reinforce that legal boundary, we tend to imagine that boundary as real, but it is not. In the pitlake, the pit's rock walls give the illusion that the pitlake is physically contained, but the fact that the pitwalls are fissured, that there is groundwater in the rocks, demonstrates the reality that, as far as water is concerned, the boundary is conceptual. In thinking about that imaginary interface, we must remember that pitlake water and groundwater are a single body of water. In a still body of water, diffusion will cause solutes to spread throughout the water (though gravity may cause vertical separation by mass). The concentration of solutes on the two sides of the imaginary, legal boundary between the pitlake and groundwater will be the same.

C) In the context of this calculation, I use the term "hydrologic balance" to refer to a situation in which the outflow from the pitlake (evaporation) equals the inflow (precipitation and groundwater inflow).

D) A "hydrologic balance" defines the difference in the Copper Rule between a "hydrologic evaporative sink" and a "flow-through pit," that is, defines the difference between pitlakes not subject to the water quality standards of 20.6.2.3103 NMAC after closure and pitlakes subject to those standards.

E) "Hydrologic balance" does not represent an equilibrium at the imaginary interface between the pitlake and groundwater. At that interface, when "hydrologic balance" is reached there is not an equilibrium (or balance) of forces but a pressure difference which causes a constant flow into the pitlake.

F) The legal definition of "hydrologic balance" is based on annual averages of precipitation and evaporation. But since the evaporative rate constantly changes due to fluctuations of temperature, humidity, sunshine, wind speed, etc., the "balance" itself changes constantly, resulting in a constant fluctuation of the pitlake water level: for example, there is a constantly

repeated, 356-days-a-year fluctuation between day and night. These fluctuations mean that the flow into the pitlake is often reversed although overall the flow goes from groundwater to pitlake. While this reverse flow of pitwater into groundwater may seem, at first, to be very small in quantity, that is not true. Because these fluctuations are constant and permanent, the accumulative effect is significant. Also, because the pitlake is a catchment pond for some 300 acres of drainage, a small precipitation can cause the "constant" flow into the pitlake to be reversed for long periods of time. See the runoff calculation below in section III. By the Copper Rule, the future pitlake at Copper Flat Mine will be both a hydrologic evaporative sink and a flow-through pit and both subject to and not subject to water quality standards.

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D) The 6.60 inch rise seems reasonable given the statement in the 2025 PHC Update that a 3.29 inch precipitation (the 100 year storm event design standard) would cause a rise of the pitlake water level of 2 to 3 feet. See the 2025 PHC Update, p. 23.

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In addition, Section 3.10 (p. 35) of that study explains in detail that the purpose of the study is to demonstrate that the future pitlake will be chemically similar to the existing pitlake. That purpose is motivated by the assumption that the only regulations that apply to the pitlake are MMD's concerns on hydrologic balance (used in a general sense rather than my use of the term above). The study assumes that state surface water and groundwater standards do not apply because the pitlake will be on private land and because the pitlake is a hydrologic evaporative sink.

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NMED's approval of the original DP-1840, the discharge permit for Copper Flat Mine, was contested in court partly on the issue of the meaning of "water of the state." That litigation was decided by the Court of Appeals in 2022 in favor of the Commission and NMED: *EBID v. NMWQCC,* 2022-NMCA-045. The court ruled that NMED was correct in declaring that "water of the state" did not apply to the future pitlake at Copper Flat Mine. The court based its decision on two reasons. First, it deferred to NMED's expertise. Second, it ruled that NMED's understanding that the exception applied only when water moved from the pitlake into groundwater and did not apply when groundwater moved into the pitlake was correct and not arbitrary, capricious, or otherwise not in accordance with the law. See *EBID v. NMWQCC,* 2022-NMCA-045, §24.

2 The definition of "water(s) of the state" in Title 20 differs from its use under under 72-2-1 NMSA defining the authority of the State Engineer. Its meaning in 72-2-1 NMSA derives from 72-1-1 and 72-12-1 NMSA.

The court's decision collapses the two assumptions of NMCC's predictive model of pitlake water chemistry – of private waters and of a hydrologic evaporative sink. At issue is only whether pitlake water moves into groundwater, and I have demonstrated that in terms of solute transport rather than water volume, pitlake solutions do move into groundwater, not only creating at times a flow-through pit but making the pitlake state water and thus not exempt from surface water standards.

C) To return to the predictive modeling study, recognition that the future pitlake is not always and constantly an evaporative sink would change the projected dilution of elements. I have already mentioned that under the amended application, the rapid fill water is of unknown purity. To that alteration of predictive value should be added the change in the expected volume of groundwater inflow.

D) The study's aim of demonstrating similarity between the present pitlake chemistry and the future pitlake chemistry ignores the history of the present pitlake's acidity, which the study itself documents. Figure 1-10 shows the pH data from the present pitlake.

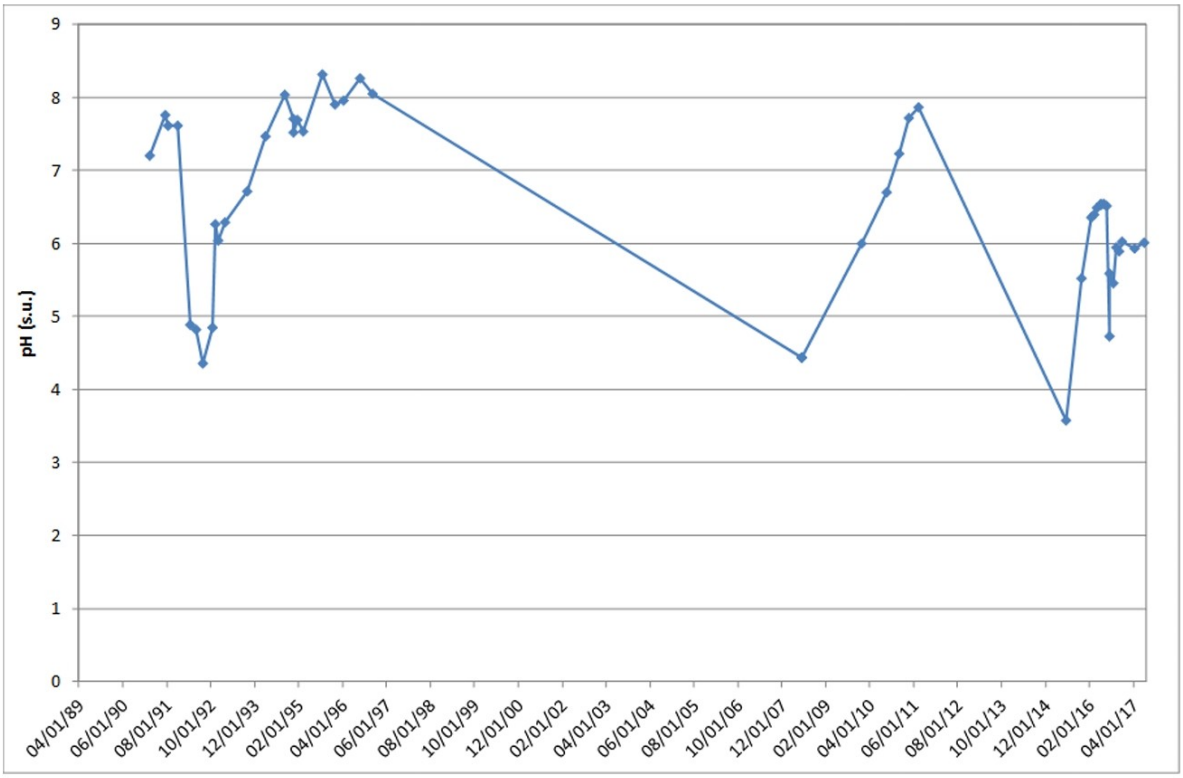


Figure 1-10: Plot of pH in Existing Pit Lake

The four sudden drops in pH are described in the text as "periodic Acid Wall Seep (AWS) events" (p. 15). That explanation is not helpful. I have discussed the first acid event and its neutralization as the result of weather conditions. See my submitted comment of June 10, 2026 oo pit reclamation. I have not tried to find the cause of the others because the data

seem insufficient, especially the 9 or 10 year gap in the middle. The more recent information on acidity is ambiguous because of the report in the record that NMCC was chemically neutralizing pitwater acidity. However, if such AWS events are periodic, then we expect to see these spikes in acidity in the future pitlake as well, putting some doubt on the conclusion that the future pitlake chemistry is essentially benign.

E) Compare the above graph to Figure 6-5 below, which shows the projected pitlake pH. Do they look similar?

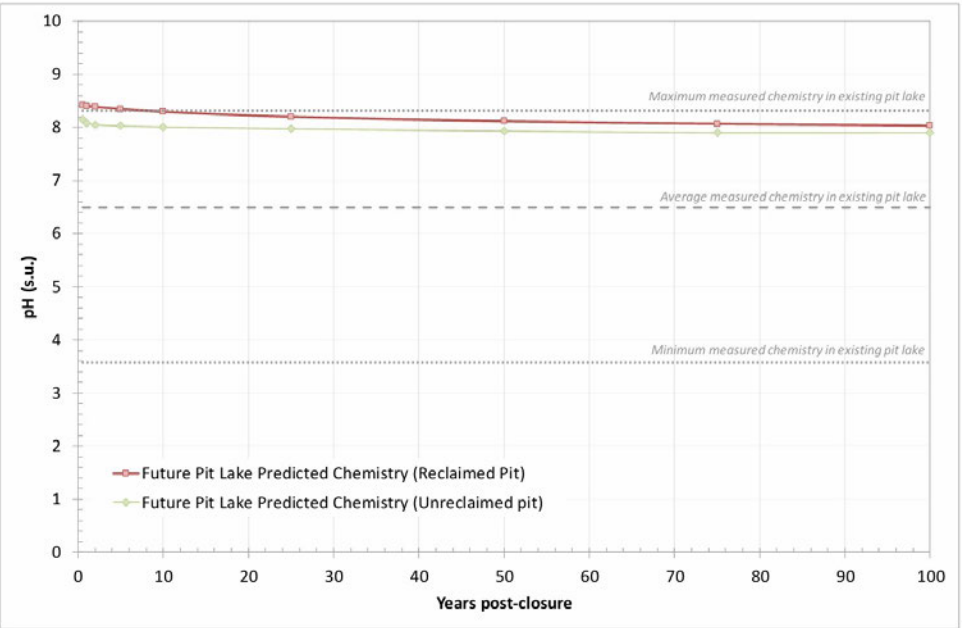


Figure 6-5: Time-series Plot of Predicted pH for the Reclaimed Pit Model

VI. Conclusion: A significant amount of pitwater entailing dissolved solutes can be expected to move into groundwater from the future pitlake at Copper Flat Mine, making the pitlake at times a flow-through pit and waters of the state and thus subject to water quality standards of 20.6.2.3103 NMAC after closure. NMCC's reclamation plan must take this possibility into account. Since it does not, MMD should require it to do so. NMED's *Draft Discharge Permit Renewal and Modification; DP-1840* (9/11/2026) allows the possibility of the application of surface water standards in subsection C115, E: "Surface water quality standards will not apply to the pit lake water body that will exist at closure so long as the pit lake remains a hydrologic evaporative sink and the pit lake water body remains wholly on private land (20.6.4.7(S)(5) NMAC)." [NMED should not confuse private land with the private water issue.] However, nowhere does the permit discuss how these exemption conditions will be determined. Its expertise should allow NMED to monitor (or require NMCC to monitor) both water and solution migration into and out of the pitlake.

A reasonable discussion of water quality in the future pitlake is presented in BLM's FEIS (2019), pp. 3-34 through 3-38. The BLM cautions against using NMCC's predictive model as the sole component in assessing the future pitlake. It introduces, we think wisely, the possibility of future changes in standards. It requires the creation of a management plan which initially will cover a period of 30 years after the beginning of reclamation and a final management plan submitted one year prior to closure. As far as I know such a management plan for the pitlake does not exist. The pitlake should be monitored directly, not just through the monitoring wells, and a plan for such monitoring as well as

an abatement plan for remedying exceedances of standards should be in place before the issuance of any permit by MMD or by NMED.

VII. My suggestion for mitigation of this possible risk is to include direct monitoring of pitlake chemistry, monitoring of pitlake surface level, and monitoring of the pressure gradient at the hypothetical surface between the pitlake and groundwater. This suggestion is based on several considerations:

A) Movement of water in the bedrock aquifer at the pit is, presumably, irregular, proceeding through fractures, fissures, channels, and between pockets of saturated breccia. That movement is further complicated by the existence of two prominent faults that cross the pit, providing four open passages for water movement through the bedrock. See Dunn's description of sludge and wet cement like material in the faults, Peter G. Dunn, "Geology of the Copper Flat Porphyry Copper Deposit," in Titley (ed.), *Advances in the Geology of Porphyry Copper Deposits* (1982). Thus, monitoring well data in the bedrock aquifer is less reliable than normal.

B) Given the variety of different estimates of the hydrologic balance level of future pitlake (the predictive chemical studies give three, as I remember), we can get a better ASL elevation by direct measurement.

C) Pressure transducers set at the same ASL elevation in the pitlake and in a monitoring well can give internal pressure differences at the hypothetical boundary between pit water and groundwater and thus show the direction of flow. This data will also give the ASL elevation of the pitlake surface so that an accurate hydrologic balance level can be determined. We don't need to speculate about evaporative sinks and flow-through pits.

D) Incorporated into a management plan, these monitoring arrangements will be more accurate and safer than than the simple monitoring of the monitoring wells to determine groundwater pollution and whether the evaporative sink idea works or not.

Mr. Evan Owen, Permit Lead
Mining Act Reclamation Program
Mining and Minerals Division
1220 South Francis Drive
Santa Fe, New Mexico 87505

October 2, 2026
1313 Mangas Trail
Hillsboro, New Mexico 88042

Re: Copper Flat Mine, Sierra County, New Mexico
2025 Amended Application
Permit No. SI027RN

Dear Mr. Evans:

I attended the Public Hearing in Hillsboro, New Mexico on September 17, 2026 and was one of the speakers. I understand my hearing comments have been entered into the meeting records.

I would like to reiterate, as a professional geotechnical engineer, with 50 years of experience with mine waste disposal and reclamation, the design, construction compliance and operation and maintenance oversight of the proposed Copper Flat Mine dry stack tailing facility, should not be left strictly to the Mine owners and their consultants, as it appears to be the case now. These activities should come under the purview of the Dam Safety Division of the Office of the State Engineer (OSE), even though the dry stack tailings facility does not include a water retention dam.

Large scale dry stacking of mine tailings is a relatively new technology for US Mining companies and the tailings disposal using the dry stack methods is new to New Mexico. This type of mine tailing disposal is not exempt from possible failure or breaching as has been claimed. Such a failure could be triggered by improper construction, seismic activity and/or unplanned stormwater accumulation on the tailings.

As presented in my hearing notes, the OSE should review in detail, the design of this mine waste management facility after a more site-specific seismic hazard study is completed and additional geotechnical site characterization drilling and engineering testing are done (consistent with recommendations by WSP).

Additionally, the deposition of mine tailings on Federal Land (BLM) has recently been the subject of a ruling by Judge James Soto, concerning the large new Rosemont Copper mine in southern Arizona. Though this ruling does not appear to directly apply to the Copper Flat Mine, since it is in a different court district, a permit by NMMMD should not be issued until this matter is fully resolved. I can send you a copy of the ruling if you would like to see it.

Thank you for your time and consideration of these important issues concerning the Copper Flat Mine permitting process.

Respectfully,

Wayne A. Ericson PE (New Mexico) No. 7870

Outlook

[EXTERNAL] Comment for SI027RN

From Max Yeh <maxwyeh@gmail.com>
Date Thu 10/8/2026 6:36 PM
To Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>
Cc Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>; Corey Durr <cdurr@blm.gov>; Cathey, Craig D., OSE <craig.cathey@ose.nm.gov>

1 attachment (14 MB)
Pitchfork Ranch-MDCC Report-Exhibit.pdf;

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Hello, Evan,

This submission is to fill an evidentiary lacuna in my previous comments. I have mentioned the threat of the pit excavation to dewater the Pitchfork Ranch well but I've not been able until now to supply expert testimony to that effect. Please see attachment. I should mention that this well is so close to the pit that it was once designated as a monitoring well for the pit. Considering that monitoring well GWQ 11-26 is expected to have a 300 foot drop in water level according to the FEIS, you can see the concern here.

--
Max

To: Anna Aguilera, Director
MMD
From: Max Yeh
Percha/Animas Watershed Association
Date: October 8, 2026
Re: SI027RN
Hillsboro Pitchfork Ranch Wells and Springs Impaired by Copper Flat Mine Pitlake

Hillsboro Pitchfork Ranch, LLC, is a working cattle ranch immediately adjacent to Copper Flat Mine. The Ranch was an active and major protestant in the Office of the State Engineer's hearing on the Tulla transfer application of NMCC, which was denied. For that hearing, Mustafa D. Chudnoff gave technical hydrogeological testimony on the impact of NMCC's proposed water use at Copper Flat Mine, modeling not only the impact of withdrawal of groundwater from its production wells but also the impact of excavating the open pit some 800 feet below the regional water table.

Mr. Chudnoff's analysis and testimony cover issues such as

1. Groundwater drawdown from mine dewatering and production wells.
2. Hydraulic connection between the Copper Flat well field and nearby ranch wells.
3. Potential impacts to springs and surface-water features in the Percha Creek watershed.
4. Reliability of groundwater models used by NMCC/Tulla.
5. Predicted impacts to neighboring water-right holders, including Hillsboro Pitchfork Ranch.
6. Whether impairment would occur under New Mexico water law.

One of the central conclusions of the report is that the Copper Flat project would affect:

- Stock wells
- Domestic wells
- Springs
- Riparian habitat
- Groundwater levels

on both the **Hillsboro Pitchfork Ranch** and the neighboring Ladder Ranch. He specifically states that "...impacts to springs and nearby wells that are located on the Hillsboro Pitchfork Ranch and Ladder Ranch properties..." would result from lowering the water table through excavation of the open pit mine.

Importantly, Mr. Chudnoff points out that these impacts are not merely his own speculation. He states that "Hydrologic impacts resulting from excavation of the mine pit on wells and springs located on the Hillsboro Pitchfork Ranch and Ladder Ranch properties will be evaluated using drawdown data calculated by JSAI (John Shomaker & Associates), NMCC's consultant." That is, the mine's own groundwater model gives evidence that impacts extend onto Pitchfork Ranch and Ladder Ranch.

The springs on the Pitchfork Ranch and the Ladder Ranch are considered as a category separate from but along with impacts on streams and wells. Furthermore, he considers the cumulative impacts on groundwater levels from both well-water extraction and mine pit excavation. That perspective is more important now under NMCC's new operating plan because one third of the well water extraction will be from wells at the mine site rather than from production wells 12 mines downgradient.

Because of the importance of this analysis of the impacts of pit excavation on groundwater levels, I am submitting for the record, Mr. Chudnoff's written report. Please note that the specific sections on the groundwater impact from excavation of the pit begins on p. 24, but the whole study is an important hydrological study of the area.

IN THE MATTER OF THE APPLICATION BY TULLA RESOURCES GROUP PTY LTD AND SANTA TERESA CAPITAL, LLC FOR A PERMIT TO CHANGE POINTS OF DIVERSION AND PLACE AND PURPOSE OF USE UNDER THE WATER USE LEASE ACT, NMSA 1978, §§ 72-6-1 TO -7 WITHIN THE LOWER RIO GRANDE UNDER- GROUND WATER BASIN IN THE STATE OF NEW MEXICO

Hearing No. 21-025

OSE File No. LRG-3150-E into LRG-17825

EXPERT REPORT

Mustafa D. Chudnoff
Sara M. Chudnoff, PG
Mustafa D. Chudnoff Consulting, LLC
Santa Fe, New Mexico
mustafa@chudnoffconsulting.com

Prepared for:

Turner Ranch Properties, LP; Hillsboro Pitchfork Ranch, LLC; Percha-Animas Watershed Association (PAWA); Gila Resources Information Project; and the Rio Grande Chapter of the Sierra Club

February 28, 2022

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Appendices

Appendix A. Summary of MDCC field observations

Appendix B. Selected well logs

I. Introduction

On August 16, 2019, Tulla Resources Group and Santa Teresa Capital, LLC (Applicants) filed with the Office of the State Engineer (OSE) application LRG-3150-E, for Permit to Change Points of Diversion and Place and Purpose of Use for 2,400 acre-feet per annum of groundwater under the Water Use Leasing Act (Application). Tulla Resources is the mine owner and Santa Teresa Capital is the water right owner. The subject water right will be used under a 10-year lease between the Applicants. The water right is purported to have been recently used for commercial growing of turf grass on approximately 129 acres and periodic construction uses within 32,020.56 acres of land located adjacent to the international boundary between the United States and Mexico and the boundary between New Mexico and Texas, in southern Doña Ana County.

If the Application is approved the water will be used for open-pit mining, milling and related purposes, including reclamation, at the Copper Flat mine site located in Sierra County near the unincorporated community of Hillsboro. The mine will be operated by New Mexico Copper Corporation (NMCC) a wholly owned subsidiary of THEMAC Resources Group.[1] The co-applicant Tulla Resources Group is the majority owner of THEMAC and is financing the development of the Copper Flat Mine.

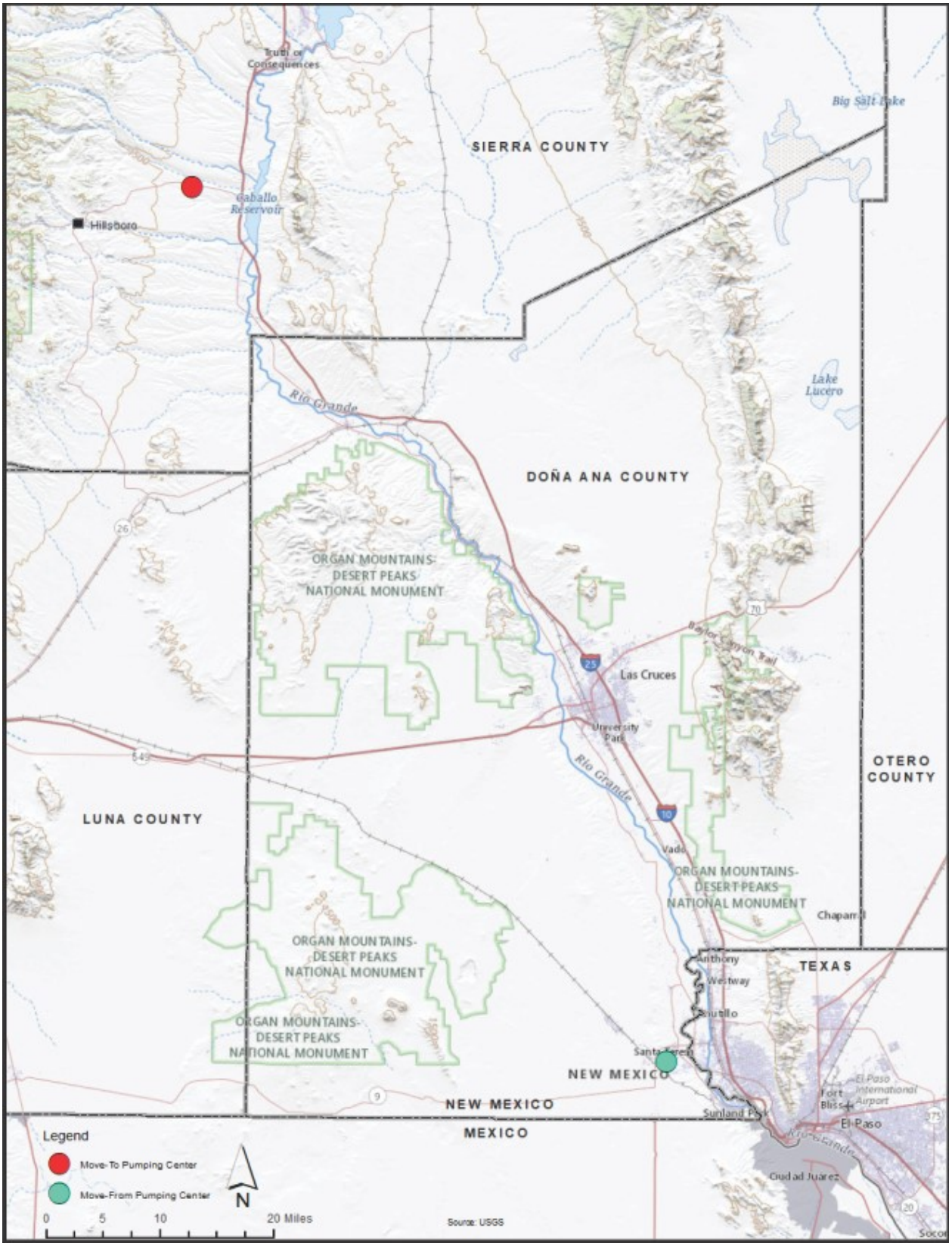
The leased water rights will be produced from four wells, LRG-4652, LRG-4652-S, LRG-4652-S-2, and LRG-4652-S-3 which have been identified by NMCC as PW-1, PW-2, PW-3 and PW-4, respectively. These wells are located approximately 87 miles north of the current place of use. The general locations of the move-from and move-to wells are shown in Figure 1 [on following page].

Seventy-two timely protests to the granting of the Application were filed, and as of February 2022, 58 protestants were either dismissed or withdrew from the proceeding. Protestants Turner Ranch Properties, LP; Hillsboro Pitchfork Ranch, LLC; Gila Resources Information Project, Percha-Animas Watershed Association (PAWA), and the Rio Grande Chapter of the Sierra Club through their attorneys, have retained Mustafa D. Chudnoff Consulting, LLC (MDCC) to analyze the water rights management and hydrologic implications of the Application. Turner Ranch Properties, as owner of the Ladder Ranch, Hillsboro Pitchfork Ranch, LLC and some of the PAWA membership own surface water and groundwater rights in the Project area. The protestants' water rights are more fully described in other exhibits submitted in the water rights administrative proceeding HU 21-025 before the State Engineer.

This report presents our evaluation and opinions of: (1) the probable hydrologic impacts that would result from granting the proposed Application and the associated use of the water rights and excavation of the mine pit, (2) availability of water and water rights for offsetting surface water depletions, (3) conservation of water in New Mexico, and (4) other matters relating to the public interest, including impacts to a critical riparian ecosystem.

[1] Hereafter, "NMCC" will also be used to mean Applicant or the Copper Flat mine owner.

Figure 1. Regional Setting



A. Nature of the Move-From water rights

The water rights under File LRG-3150-E originated with Declarations of Ownership of Underground Water Rights filed on August 14, 1981 and July 9, 1982 by the C.L. Crowder Investment Company ("Crowder"). The declarations claimed that between 1971 and 1977, the owners of the Santa Teresa Development Project drilled, completed and tested 33 wells intended to be used to divert a total of 110,712.85 acre-feet per year for residential, commercial, recreational, industrial and other uses on over 8,000 acres of land. The declared place of use was subsequently expanded to include approximately an additional 21,000 acres acquired by Crowder through a land trade with the United States.

The full extent of the claimed water rights based upon the Crowder declarations will ultimately be adjudicated by the courts. However, upon application with the State Engineer, it is the Applicant's burden to support its claims and it is the responsibility of the State Engineer to evaluate the extent of those claims based upon the intent of the development at the time the Lower Rio Grande Basin was declared in 1980 or the capability of the wells, whichever controls (Stone 1991). At this time, we reserve our opinions as to the nature and extent of the water rights under OSE file LRG-3150-E until after we have reviewed relevant documents and reports produced by the Applicant and the OSE in this proceeding. Questions pertaining to matters such as historical diversion, return flow and consumptive use have yet to be answered. Only the historical consumptive use component of this water right should be considered for transfer.

B. Net depletion of water within the State

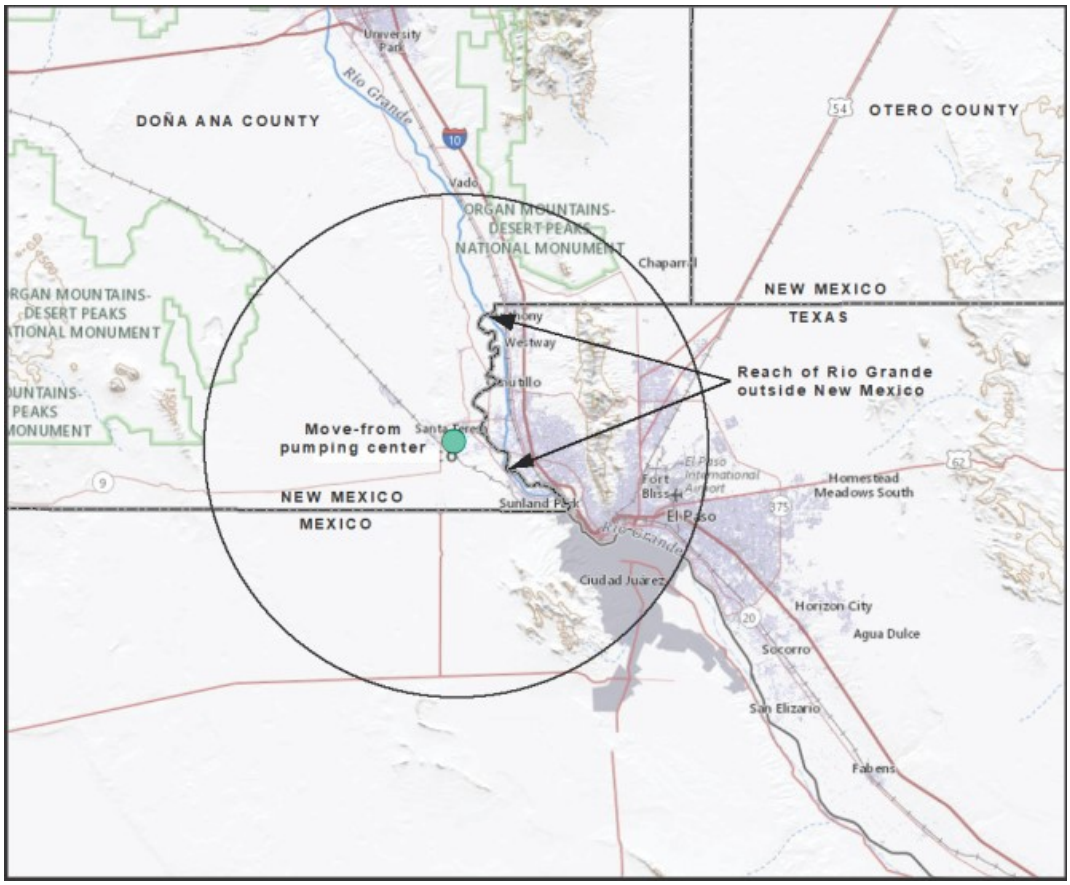
It is not clear why NMCC filed an application to transfer an existing groundwater right rather than filing an application for a new appropriation of groundwater. The move-from wells are located relatively close to the reach of the Rio Grande that is either located wholly within Texas or that forms the international boundary between the United States (Texas) and Mexico. Assuming radial flow in the aquifer, a reasonable assumption, a significant proportion of the surface water and groundwater depletions resulting from historic pumping by the move-from wells will not be on the waters of the State as shown in Figure 2 [see following page]. If these depletions were to be fully-credited to NMCC's move-to wells, a new depletion on the surface and ground waters of the State and the Lower Rio Grande administrative basin would result. Moving the subject groundwater right to a location 87 miles to the north of its current points of diversion and place of use within a fully appropriated basin has the practical effect of a new appropriation of the waters of the state.

C. Water supply and water rights requirements of the Copper Flat mine project

The subject Application is for the temporary transfer of 2,400 acre-feet of groundwater for a period of 10 years. NMCC has developed a number of water budgets in support of its applications seeking approval for the Copper Flat mine from the New Mexico Environment Department (NMED) and the Mining and Minerals Division of the New Mexico Energy,

Minerals and Natural Resources Department (MMD). The project has also required the approval of the Bureau of Land Management (BLM).

Figure 2. Relationship of the move-from wells to Texas and Mexico



In 2019 the BLM selected an "Approved Alternative" based on the agency's extensive NEPA-EIS analysis of the Project (BLM 2019b) and NMCC's own definitive feasibility study (M3, 2013). The Approved Alternative is "the alternative that best fulfills the agency's statutory mission and responsibilities, considering economic, environmental, technical, and other factors. The BLM has determined that implementation of this decision … will not cause unnecessary or undue degradation of the public lands" (Ibid.).

The selected alternative includes a commitment by NMCC's to acquire the necessary water rights, and to fully offset all of its pumping impacts on the Rio Grande, including years beyond year 29 (BLM 2019b). The project's feasibility was premised on the erroneous belief that NMCC would likely secure 7,481 acre-feet per year of declared water rights of which 1,267 acre-feet were thought to have been perfected through prior beneficial use (M3, 2013). However at this time, New Mexico courts have recognized the validity of only 861.84 acre-feet per year in the production wells.[2]

[2] Decision of the Court of Appeals of New Mexico filed 9/17/2021, No. A-I-CA-37258.

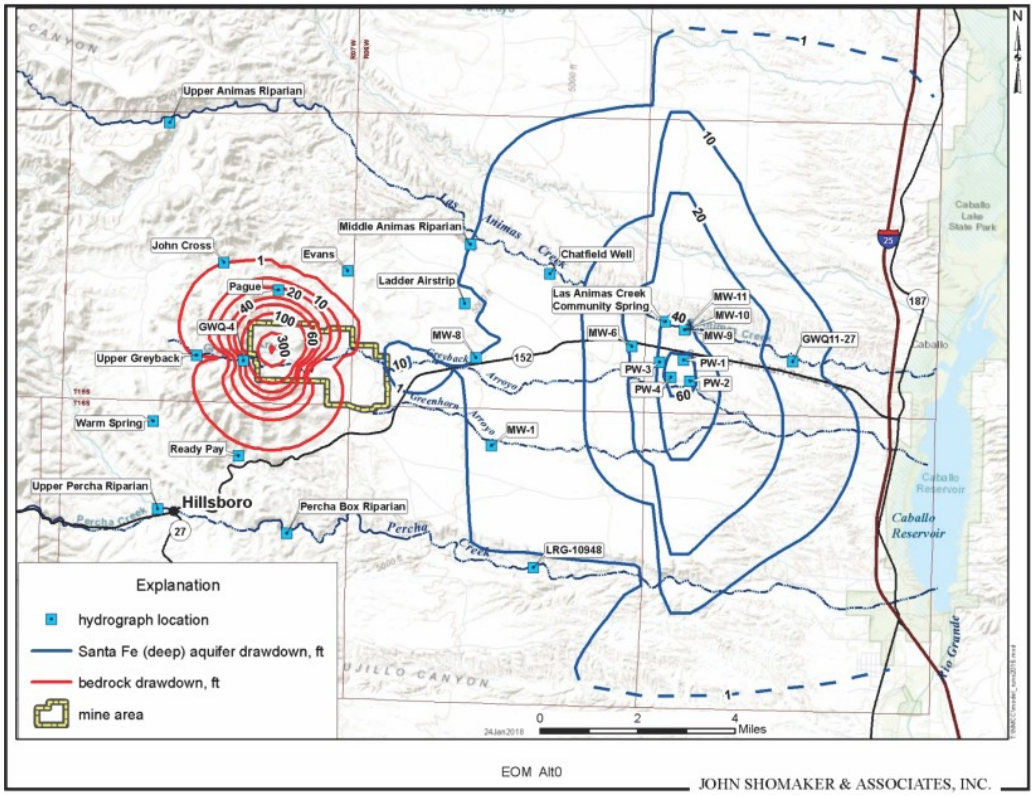
The mine's annual water budget approved by the BLM is set forth in the Project's final Environmental Impact Statement (BLM 2019a). NMCC will annually produce from its four water-supply wells 6,105 acre-feet of fresh water during the 12 years of the mine's operation. If approved, the pending Application would increase the NMCC's available groundwater rights to 3,261.84 acre-feet, which is only 53% of project demand. NMCC's water budget is analyzed in greater detail in a report prepared by James R. Kuipers.

Finally, NMCC cannot demonstrate that it can place the pending 2,400 acre-feet to beneficial use within a reasonable period of time. As of January 2022, NMCC has not filed any application with the OSE to develop the additional 2,843.16 acre-feet required for a viable project pursuant to its commitments to the BLM. The OSE should either deny the Application or stay any action until such time as NMCC files the required applications needed to cover the project's entire groundwater budget. A lease for San Juan-Chama Project water for depletion offsets is not a substitute to filing applications for a new groundwater appropriation or the retirement and transfer of existing valid water rights.

II. Methodology for quantifying hydrologic impacts

MDCC used two methods for analyzing and quantifying the hydrologic impacts that will result from granting the subject Application. The hydrologic interrelationship of these two facets of the Copper Flat mine project is reflected in Figure 3.

Figure 3. Water level declines in the SFG and bedrock aquifers



Source: BLM 2019a

First, for the purpose of analyzing the impact of the proposed production wells to the Santa Fe Group (SFG) aquifer, nearby wells, Las Animas Creek and the Rio Grande, MDCC developed a multi-layer, superposition groundwater flow model. The model is used to evaluate both the amount of water rights requested for transfer in the "Application" and the higher annual "Project Demand" of 6,105 acre-feet.

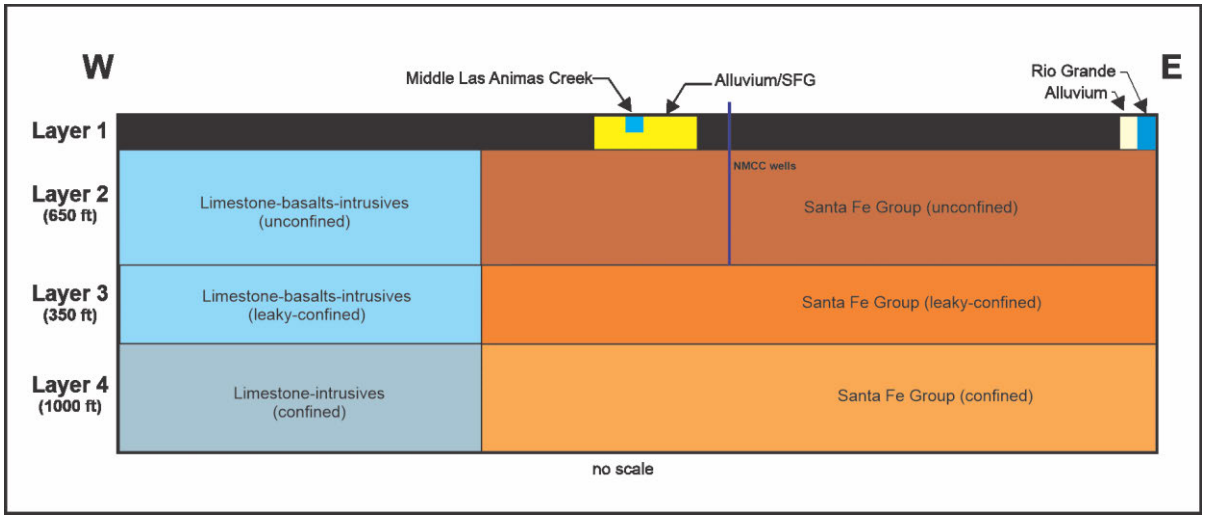
Second, the impacts to springs and nearby wells that are located on the Hillsboro Pitchfork Ranch and Ladder Ranch properties, resulting from lowering the water-table through the excavation of the open-pit mine, were analyzed using the results from the groundwater flow model developed for NMCC by their consultants John Shomaker and Associates, Inc. (JSAI 2018; BLM 2019). These impacts are directly related to the groundwater withdrawal from the SFG aquifer for mine water supply, and groundwater decline in the bedrock around the open pit resulting from its excavation into the water table.

The proposed NMCC Copper Flat mine production wells are completed into the SFG aquifer which together with Paleozoic rocks to the west and overlying saturated alluvium in valley bottoms form a complex aquifer system (Davie and Spiegel 1967). The surface water and groundwater hydrology of this area has been described in detail by Davie and Spiegel (1967) and Wilson (1981). More recently various consultants working on behalf of NMCC and its predecessors have undertaken significant efforts to characterize the hydrology of the Copper Flat area (JSAI 2014). Water level and potentiometric mapping by these investigators show that ground waters in the Paleozoic rocks, the intruded andesite and monzonite associated with the mine pit, the Santa Fe group, and alluvium are hydraulically connected to each other and to the surface flow of Las Animas Creek and the Rio Grande (i.e. Caballo Reservoir).

Groundwater modeling by JSAI (2014) demonstrates that the withdrawal of water from the SFG aquifer results in declines in water levels in both the SFG and valley alluvium aquifers. Davie and Spiegel (1967) have noted that the declines in water level in the SFG aquifer can result in a decrease in natural discharge from the alluvium to springs and Caballo Reservoir.

Model configuration: The model developed by MDCC is a four-layer superposition groundwater flow model prepared using the USGS-MODFLOW code (McDonald and Harbaugh, 1988). Model files were compiled and executed using the Groundwater Vistas (Version 8) computer program (Rumbaugh and Rumbaugh, 2020). The model grid consists of 135 rows and 117 columns. Row and column spacing range from 330 to 1320 feet, with the smaller spacing used around Las Animas Creek and the Application wells. The model grid is shown in Figure 5 [see next page]. Layer 1 is only active along Las Animas and La Percha Creeks and along the western edge of the Rio Grande and Caballo Reservoir. Layers 2 through 4 represent the SFG and various bedrock units located to the west. Figure 4 [on following page] is a generalized schematic of the MDCC model.

Figure 4. Schematic diagram of the Application model



Aquifer parameters: The hydraulic properties of the SFG and bedrock hydrologic units represented in the model were derived in part from the groundwater model developed in support of the Copper Flat mine project (JSAI, 2014). The characteristics of some of the bedrock units were adjusted to reflect the work by Trauger (1972) and Kilmer (2008). The characterization of the SFG was also derived in part from hydrologic and geologic models developed by the OSE (Barroll and Logan, 1998; McAda and Barroll, 2002) and by others for water resources management (Weeden and Maddock 1999; Hawley and Kennedy, 2004; Hawley et al., 2005; Sweetkind, 2017). Greater weight was given to the work by McAda and Barroll because of their stated intent to develop a conservative model for the administration of water rights developed in the SFG aquifer system. The distribution of transmissivity (T) and storage (S) values for model layers 1 through 4 is shown in figures 6 through 9 [on following pages].

The leakance factor between layers 1 and 2, 2 and 3 and 3 and 4 was estimated as: vertical hydraulic conductivity (K_z) ÷ distance between the midpoints of the affected layers. Excepting the alluvium and limestone zones, K_z was estimated by applying a horizontal to vertical anisotropy ratio of 150:1 (McAda and Barroll, 2002).

Figure 5. Model grid

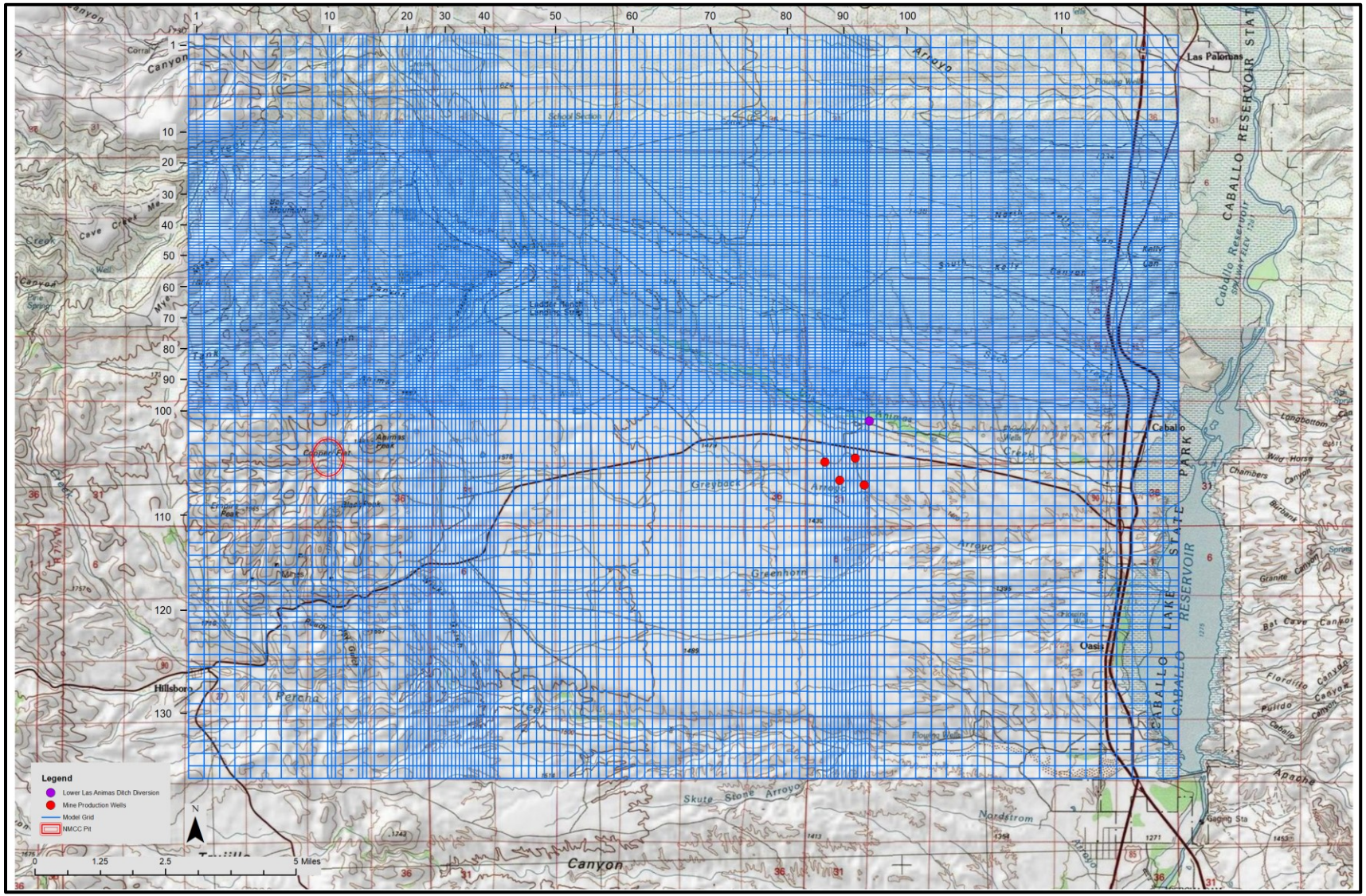


Figure 6. Layer 1 model boundary conditions and hydrologic properties

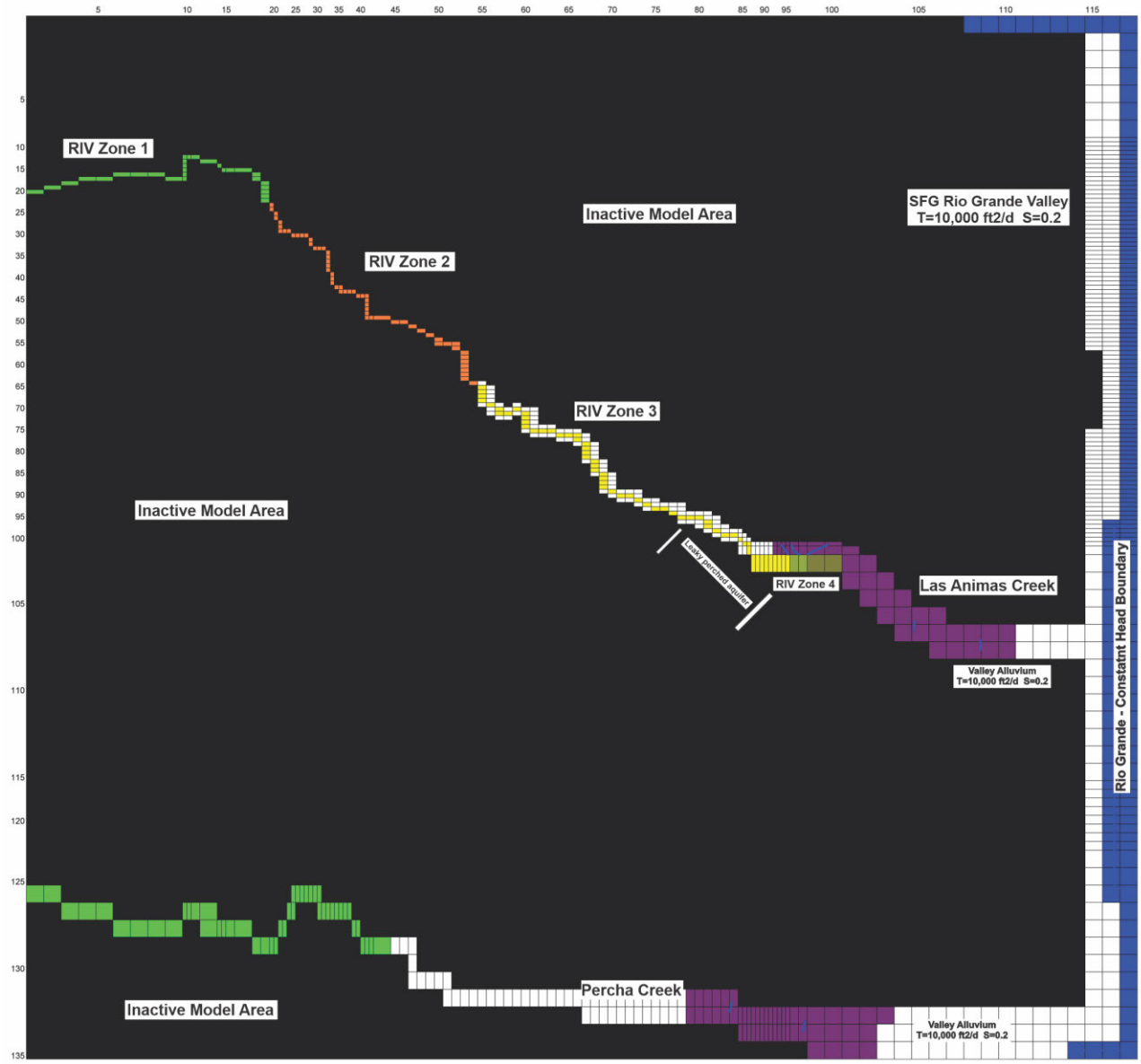


Figure 7. Layer 2 model hydrologic properties

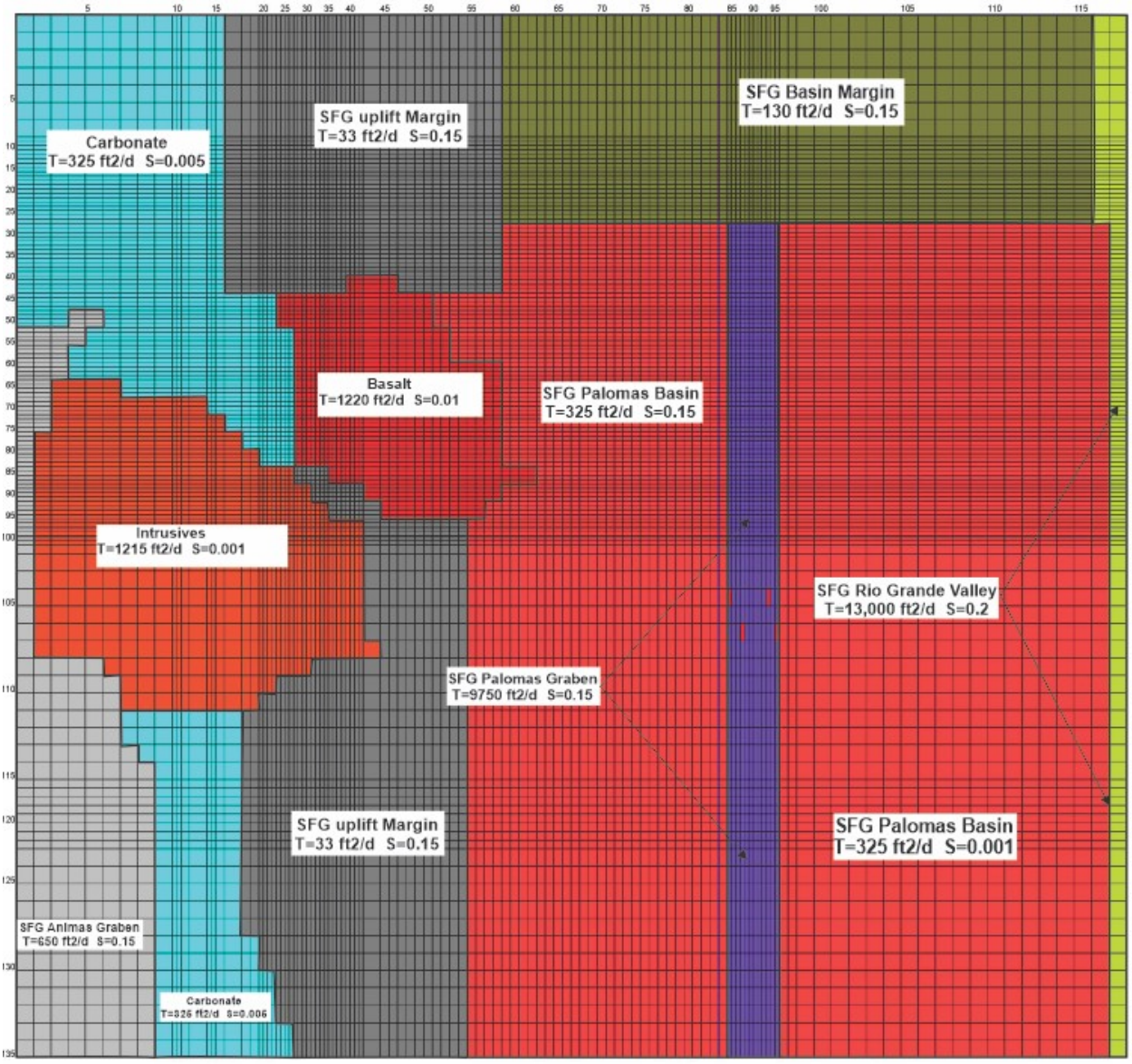


Figure 8. Layer 3 model hydrologic properties

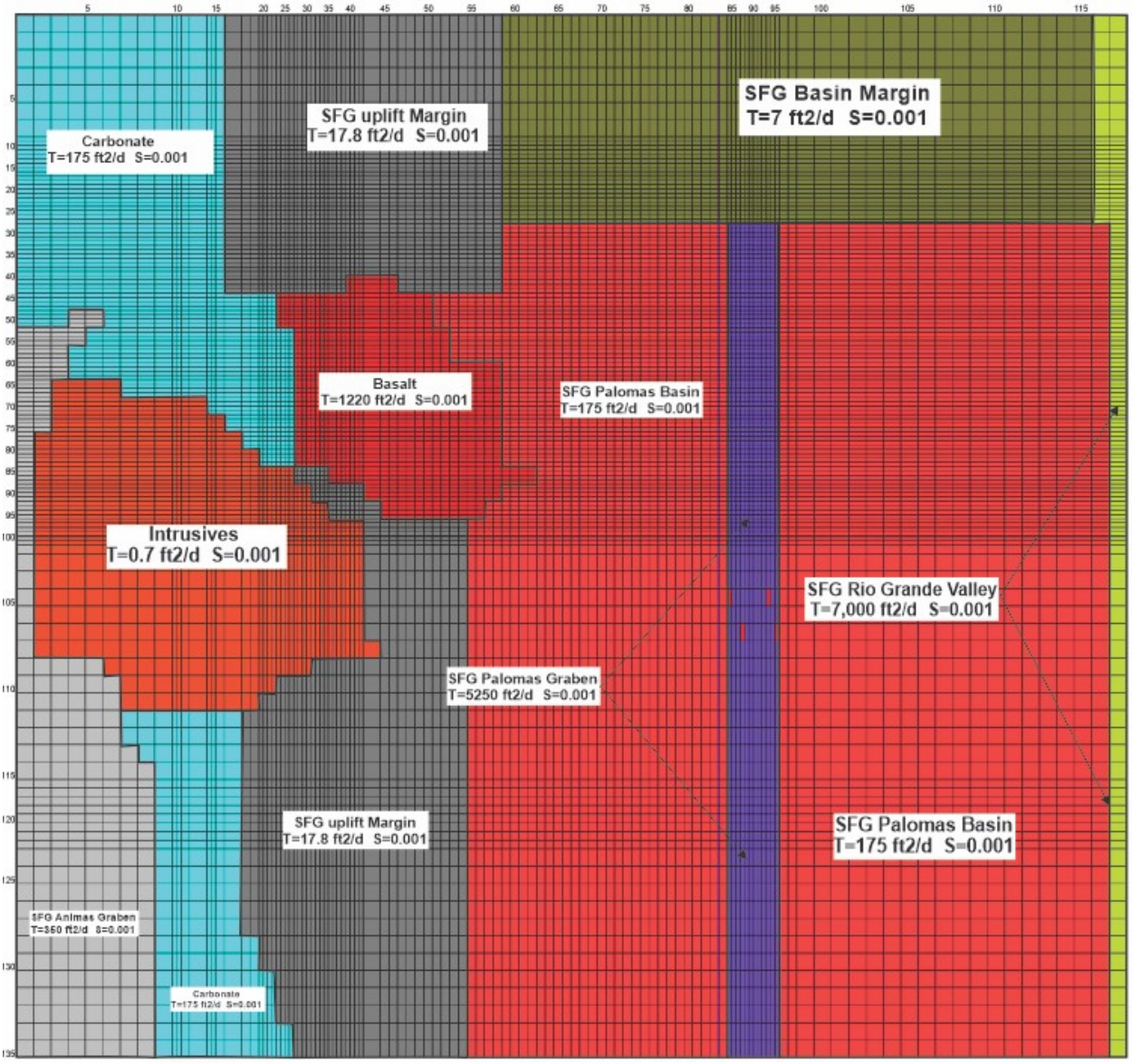
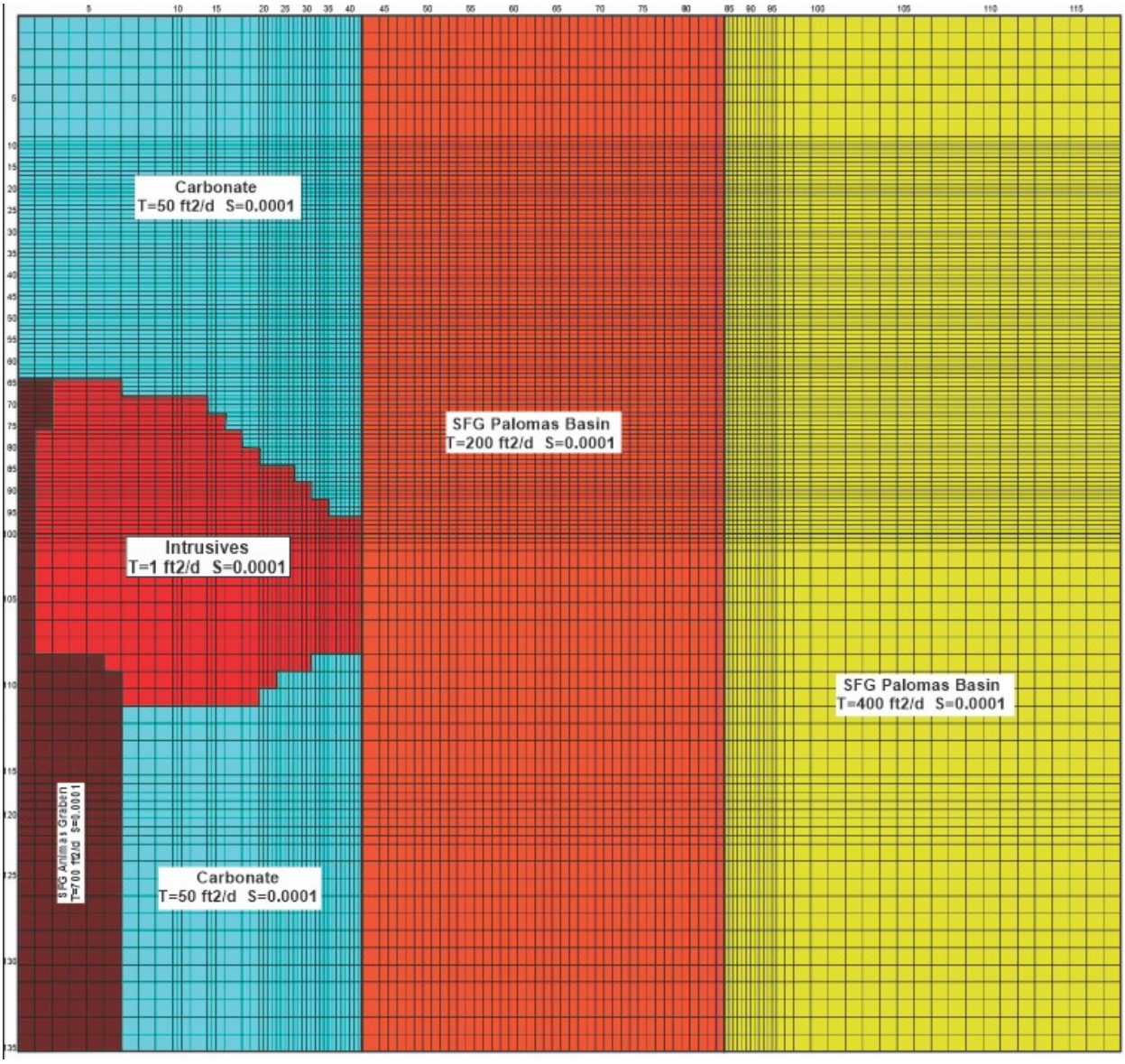


Figure 9. Layer 4 model hydrologic properties



Palomas graben: Wilson et al. (1981) identified two parallel north-trending geomorphic lineaments, which are 1.5 miles apart and located approximately 5 miles west of the Rio Grande. The area bounded by these lineaments could be interpreted as either a fault bounded graben as suggested by JSAI (2014) or they could represent a buried ancestral channel of the Rio Grande (Wilson, op cit.). The most recent geologic map of the area acknowledges the work by JSAI, but does not represent these lineaments as graben bounding faults but rather as a series of segmented, north-striking faults that have experienced both west-down and east-down normal displacement (Koning et al. 2015). Data generated from the LRG-4652 drilling and testing program indicates that the lineaments bound a zone of higher permeability SFG sediments. This feature is represented in the MDCC model as a limited high transmissivity zone but without any bounding faults.

Perched shallow aquifer zone: Water level measurements taken in wells located along the axis of Las Animas Creek by MDCC in 2021-2022 (see Appendix A) and as previously reported by others (Davie and Spiegel 1967; JSAI 2014) show that groundwater levels in the alluvial aquifer underlying the Creek between the intersection of County Roads B050 and B026 to just below the Lower Las Animas Ditch diversion dam, are 50 to 70 feet higher than water levels in the underlying SFG sediments. Water-level and construction data from the Project's monitoring wells MW-9, MW-10 and MW-11 (provided in Appendix B) indicate that wells in this area that are screened to a depth of approximately 40 feet source their water from the shallow alluvial aquifer, while wells screened at a greater depth are likely to source their water from the deeper SFG aquifer.

Some of the wells completed into the SFG aquifer were likely drilled without proper annular seals that could prevent the flow of water between the SFG aquifer and the overlying alluvial aquifer and stream channel (JSAI 2014). Both the OSE and JSAI previously noted that the impacts of NMCC's pumping on stream discharge may be difficult to assess due to deterioration or lack of well seals, and to the limited information available regarding "the degree of hydraulic communication between each well and deep and shallow aquifers" (JSAI 2013). MDCC has identified a number of wells located in this reach that are completed to a depth equal to or greater than 70 feet that were likely completed without an annular seal. A well location map and well logs are provided in Appendix B.

To represent the potential movement of water via well boreholes between the two aquifers, layer 1 of the model (and the associated RIV cells – see below) remain active in this reach, albeit with the leakance factor between the alluvial and SFG aquifers reduced by three orders of magnitude.

Rio Grande: The shallow alluvial aquifer underlying Las Animas and Percha Creeks discharges directly to Caballo Reservoir and the Rio Grande through upward leakance (Davie and Spiegel 1967). The river and Caballo Reservoir are represented in the model using *constant head* (CH) cells. In addition, previously developed basin models in the Rio Grande basin suggest that groundwater pumping from the SFG aquifer by the mine's production wells would likely induce

inflow from the adjoining areas to the north that would have otherwise discharged to the Rio Grande above Caballo Reservoir; similarly, pumping would likely intercept groundwater that would have otherwise flowed out of the area to the south, discharging into the Rio Grande in the Rincon Basin (Weeden and Maddock 1999; McAda and Barroll 2002). To address these potential project-induced depletions on the Rio Grande, additional CH cells were added to the northeast and southeast corners model layer 1.

Las Animas Creek: The creek flows from west to east from its sources in the Black Range toward Caballo Reservoir, and has ephemeral, intermittent, and perennial reaches (BLM 2019). The lowermost, ephemeral reach of Las Animas Creek extends approximately 3 miles westward from its confluence with Caballo Reservoir (Intera 2011). Notwithstanding the lack of perennial flow to the Rio Grande, Las Animas Creek has been acknowledged as an important natural resource of the State (New Mexico Environment Department 2010). The nearest proposed Copper Flat mine production well is located within approximately 3500 feet of the creek.

The middle, intermittent reach extends approximately an additional 3.5 miles upstream. Streamflow in this reach is variable and is controlled in part by changes in groundwater levels, which are typically within 5 to 10 feet of the land surface, spring runoff conditions, upstream surface irrigation diversions and groundwater pumping (Davie and Spiegel 1967). Irrigation return flows from irrigated agriculture supplied by groundwater well pumping also contributes to surface water in Las Animas Creek (Intera 2011).

The intermittent reach experiences extended periods of continuous surface flow. For example, the Lower Animas Ditch which diverts from the south bank of Las Animas Creek at the downstream end of the intermittent reach, was reported by the OSE to have diverted an average of 1.32 cfs over 112 days between May 12 and October 31, 2020.[3] Las Animas Creek upstream of the intermittent reach has been classified as perennial by the New Mexico Environment Department Surface Water Quality Bureau (2009). On a December 1-3, 2021 field visit by MDCC personnel, excepting an 800-foot reach on the Ladder Ranch, Las Animas Creek was found to be flowing at multiple locations between its confluence with Cave Creek and the Lower Las Animas Ditch diversion, a distance of approximately 13 miles. The ditch was observed to be diverting the entire flow in the Creek of approximately 4.7 cfs as reported by the OSE (Ibid.). Within 1800 feet of the diversion the creek was observed to flow again, and continued to do so for an additional 2,200 feet.

The presence of significant stands of obligate riparian vegetation such as the Arizona sycamore, a species that depends completely on perennial flow and a high water table along extensive reaches of Las Animas Creek attests to the presence of significant surface and groundwater resources (Stromberg 2001a; Intera 2012). Therefore, Las Animas Creek upstream of Section 28, Township 28 South, Range 5 West is represented in the MDCC model as a perennial watercourse that contributes water to the model in proportion to the change in head

[3] http://meas.ose.state.nm.us/site.jsp?id=240&status=Y&type=S&dist=4&basin=Las%20Animas%20Creek.

(drawdown) in model layer 1 resulting from pumping the application wells in layer 2. The MODFLOW *River* (RIV) package is used to represent the hydrologic connection between surface water flow in the perennial reach of Las Animas Creek and the underlying shallow aquifer. The stream characteristics specified in the model are provided in Table 1. The high conductivity of the alluvial sediments overlying the SFG on the Ladder Ranch (RIV zone 2) is supported by results of an exploratory well drilling and testing program (Minton 1961). Similar values are used for Percha Creek.

Table 1. Las Animas Creek Model (RIV) specifications

Stream width		8 ft
Reach length		variable (330 ft to 1320 ft)
Hydraulic conductivity	Overlying limestone (RIV zone 1)[4]	0.1 ft/day
	Overlying alluvium (RIV zones 2,3,4)	24 ft/day

Pumping Schedule: The water budget for the mine project as specified by the BLM was presented in Figure 2-7 of the Final Environmental Impact Statement for the Copper Flat mine project, indicating that 6,105 acre-feet of fresh water will be produced annually from the well field (BLM 2019a). The final Copper Mine Record of Decision (BLM 2019b) states that this rate of annual production will extend for a period of 12 years. Water production in the twelfth year will include 2,200 acre-feet for the rapid-fill of the open-pit mine (JSAI 2018). Construction and reclamation activities prior to, and post mining, respectively, will also be supported by production from the well field.

It is my opinion that it's in the interest of protecting the protestants' water rights, and water rights of others to perform an impact analysis that incorporates the project's actual water demand as approved by the BLM. This approach is consistent with the OSE's guidelines for the assessment of drawdown which indicate that it would be "inappropriate" to grant a succession of permits to the same project without taking into consideration the whole (OSE 2017).

A pumping schedule for the four proposed production wells, with a maximum annual diversion of 2,400 acre-feet was submitted with the Application. This pumping schedule will also be examined by MDCC. However, it does not indicate how water production will be distributed between the four wells. Pumping test results indicate that the entire project budget could be supplied by any two of the wells (Water Development Corporation 1976 and 1977). To ensure a reasonably conservative analysis of both scenarios, all of the pumping will be assigned equally to PW-1 and PW-3, the two wells located closest to Las Animas Creek and nearby wells. The projected annual pumping rates under the two pumping schedules are presented in Table 2 [see following page].

[4] Source: JSAI 2014, Table 6.3.

Table 2. Water-supply pumping

Year	Annual Well-field Production (Ac-Ft)	
	Application Scenario	Full-Project Scenario
1	132	132
2	673	673
3 – 14	2400	6105
15	321	321
16	97	97
17	97	97
18	50	50
19	24	24
20	15	15
21	10	10
22	6	6
23	5	5
24 - 100	0	0

III. Nature and extent of hydrologic impacts

A. Previous Findings

The potentially adverse hydrologic impacts of the Copper Flat mine project were described in detail by the BLM (2019a), and at least in part quantified, by John Shomaker and Associates, Inc. (JSAI), the Applicants' hydrology consultants (2017a, 2017b, 2018 and 2019). The identified impacts described by the BLM include:

- Removal of water from storage and the resulting drawdown at wells, including community supply wells (e.g., Hillsboro), stock and domestic wells (e.g., Ladder Ranch, Pitchfork Ranch), artesian irrigation wells (e.g., along lower Las Animas and Percha creeks);
- Reductions in groundwater discharge to surface water supplies, including tributary streams such as Las Animas Creek, the Rio Grande, and Caballo Reservoir; and
- Other potential water table effects, such as reductions in discharge of individual springs and lowering of water levels in riparian corridors, especially in locations that provide important wildlife habitat.

The BLM concluded that these impacts to the regional water budget, including flows of the Rio Grande, "would be long-term, major, of large extent, probable, and adverse.…[I]mpacts to water levels caused by the supply well field would be long-term, moderate, of medium extent, probable, and adverse….[I]mpacts to water levels caused by the pit would be long-term, major, of small extent, probable, and adverse" (Ibid.).

B. Current Analysis

The present analysis will utilize the MDCC model to quantify impacts resulting from the NMCC production wells including; drawdown at nearby wells, depletion of flow to the Rio Grande and impacts to downstream appropriators, and depletion of flow in Las Animas Creek and the resultant impacts to irrigators. Hydrologic impacts resulting from excavation of the mine pit on wells and springs located on the Hillsboro Pitchfork Ranch and Ladder Ranch properties will be evaluated using drawdown data calculated by JSAI (JSAI 2018; BLM 2019).

a. Impacts from the NMCC production wells

The 40-year drawdown resulting from Copper Flat mine project pumping was evaluated for both the Application and Full-project scenarios. Model results demonstrate that pumping by NMCC from its production wells will impact an extensive area. Figures 10 and 11 [following pages] show the extent of drawdown at the end of mining (year 14) that would occur in the SFG aquifer (layer 2). The elongated shape of the drawdown reflects contrast between the higher permeability zone styled by JSAI as the Palomas Graben and the bounding lower permeability sediments within the SFG. The influence of the higher permeability alluvial sediments underlying Las Animas Creek (layer 1) can also be seen.

Wells impacted by NMCC's pumping ("wells of other ownership") were assigned to either the shallow aquifer (model layer 1) or the deeper SFG aquifer (model layer 2) based on the well's depth as reported on its driller's record or owner's declaration, depth to water as reported on the well's record, data from nearby wells with similar completions or from MDCC field measurement. Aquifer assignment also relied in part on data derived from NMCC's construction and testing of wells MW-9, MW-10 and MW-11 which were constructed in the Las Animas Creek valley in the general vicinity of private wells.

The criteria set out by the OSE for evaluating impacts to wells of ownership (OSE 2017) is a two-step process that first requires making a determination as to whether or not any of these wells are Critical Wells. Critical Wells are those in which either the well's economic or physical constraints are exceeded due to existing uses or existing uses in combination with the proposed project. According to the OSE's guidelines at Figure 4, NMCC's proposed appropriation may only induce a drawdown of 2.6 in wells determined to be critical when considering the 10-year term of the Application. Alternatively the limit would be 3.5 feet when considering the mine's 23-year proposed project life. For the purposes of MDCC's analysis, only impacts to the wells' physical constraint will be taken into account.

The physical drawdown constraint (PDC) is intended to preserve well yield, typically by reserving either the bottom 20 feet of the water column (WC) in livestock and domestic wells or the bottom 60 feet in unconfined wells used for irrigation purposes. Any domestic well with a water column of 20-feet or less, or an irrigation well with a water column of less than 60 feet is by definition a Critical Well. Alternatively, in artesian aquifers, the OSE guidelines state that the lowest practical pumping level could be set to the bottom of the confining unit.

Figure 10. Drawdown in the SFG aquifer at the end of mining--Full-Project Scenario

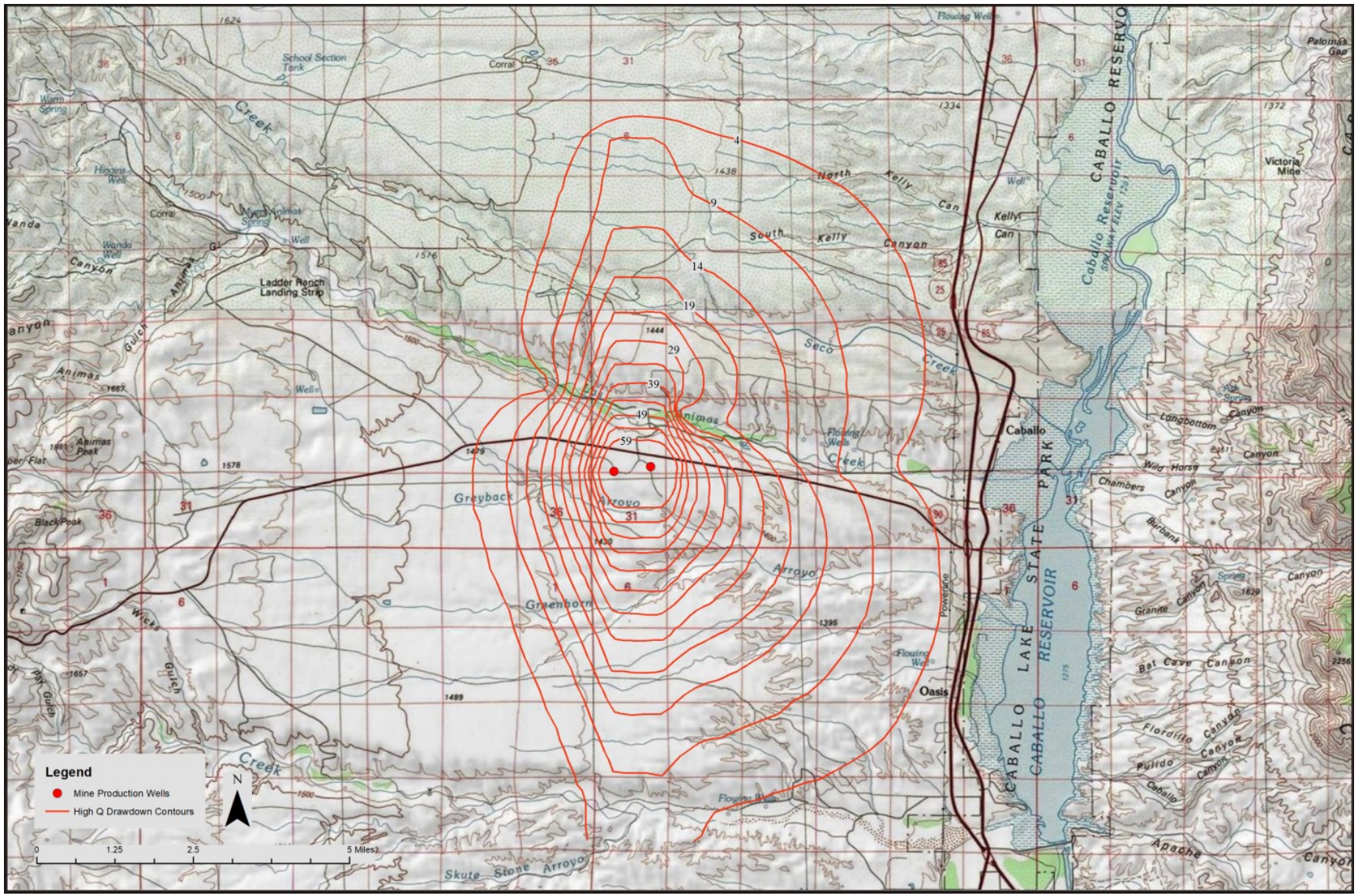
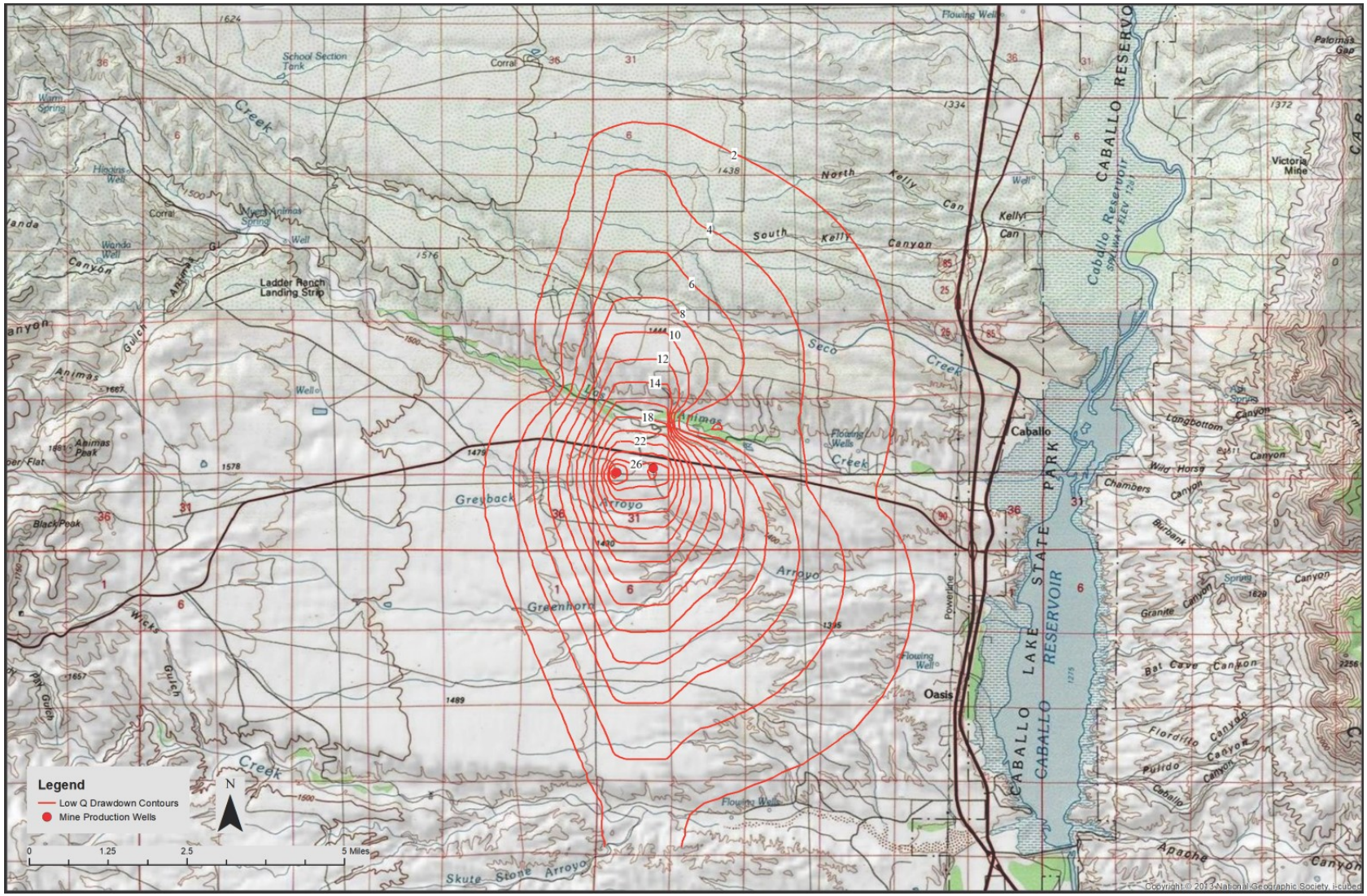


Figure 11. Drawdown in the SFG aquifer at the end of mining--Application Scenario



Impacts to PAWA member wells and wells of other ownership: The results of the 40-year drawdown impact analysis in selected wells are summarized in Tables 3 and 4. This analysis does not include the impacts to wells on the Hillsboro Pitchfork Ranch or the Ladder Ranch which are examined separately. These results demonstrate that the Applicant's proposed appropriation will adversely impact multiple wells, thereby impairing their ability to fully utilize the water rights associated with them. The contrast between the drawdown resulting from the proposed Application and the drawdown resulting from the implementation of the BLM Approved Alternative is significant and highlights the importance of not allowing a piecemeal analysis of the project's impacts.

The results are preliminary as the actual drawdown within these wells will be greater if drawdown from existing uses (DE) were to be included. The mutual effects between existing wells in the valley can be significant (Lee Newman personal communication). MDCC will incorporate values for DE as they become available through the exchange of exhibits. If the sum of the DD and DE in additional wells were determined to exceed those wells' physical constraint, those wells would also be classified as Critical and the Applicant's induced drawdown would have to be limited to only 2.6 or 3.5 feet.

Table 3. Summary of impacts to selected irrigation wells

OSE POD	Right (af/yr)	PAWA Member	Total Depth (ft)	Depth to Water (ft)	Water Column (ft)	Critical Status	NMCC Project DD (ft)	
							Low	High
LA-0051	20.4	N	22	13.8	8.2	Y	5.6	20.4
LA-0045	20.74	N	26	13.79	12.2	Y	5.6	20.4
LA-0053	20.4	N	30	13.8	16.2	Y	5.6	20.4
LA-0027	3.74	Y	70	9.38	60.6	Y	4.6	16
LA-0012	9.18	N	110	48	62.0	Y	16	46
LA-0025	14.28	Y	85	12.76	72.2	Y	4.5	17
LA-0048	4.42	N	90	14	76.0	Y	9.4	27.6
LA-0028	2.04	N	20	NA	<20	Y	1.6	0.1
LA-0058	1.36	N	15	NA	<15	Y	4	13.7
LA-0011	5.78	N	19	NA	<19	Y	5.6	19
LA-0064	10.2	N	25	NA	<25	Y	4.5	18

Table 4. Summary of impacts to selected domestic wells

OSE POD	Protestant	Total Depth (ft)	Depth to Water (ft)	Water Column (ft)	Critical Status	NMCC Project DD (ft)	
						Low	High
LA-0138	N	25	8	17	Y	4.9	18.2
LA-0147	Y	120	97	23	Y	19.8	51.3
LA-0087	N	44	18	26	Y		17
LA-0150	N	74	42	32	Y(?)	2	5.5
LA-0184	N	70	36	34	Y	4.2	42
LA-0150	N	74	42	32	N	2	6
LA-0184	N	70	36	34	Y	4.2	44

OSE POD	Protestant	Total Depth (ft)	Depth to Water (ft)	Water Column (ft)	Critical Status	NMCC Project DD (ft)	
						Low	High
LA-0123	N	50	12	38	Y(?)		11
LA-0232	N	340	300	40	Y(?)	5	12
LA-0093	N	60	12	48	Y(?)	12.2	34
LA-0177	Y	60	10.4	49.6	Y(?)	12	34
LA-0154	Y	70	19.38	50.6	Y(?)	7.5	23
LA-0149	Y	67	9.38	57.6	Y	20	52.6
LA-0173	Y	65	7.32	57.7	Y	16.9	45.7

Y(?) designated well could be Critical if "DE" were to be factored in.

Reduction in artesian flow: There are numerous flowing and non-flowing artesian wells located along the eastern ends of Las Animas and Percha valleys, within a zone extending approximately five miles upward from Caballo Reservoir (Murray 1959; Davie and Spiegel 1967). Any reduction in head in the confined SFG aquifer which supplies these wells will reduce the amount of water flowing at the land surface thereby potentially impairing their associated water rights (JSAI 2018, page iii). JSAI estimates that "a peak reduction in discharge to flowing wells of 1,054 ac-ft/yr, out of a pre-mining discharge of 2,030 ac-ft/yr" would occur (Ibid., page 17).

As shown in Figure 10, the proposed project would induce a drawdown of approximately 10 to 20 feet at the location of these wells by the end of mining. An additional 8 feet of drawdown would result from "compensatory" pumping efforts by well owners' to offset the loss in artesian flow (JSAI 2018). JSAI's analysis did not include a detailed investigation into whether or not all of the impacted flowing wells could in fact be equipped with an adequate pumping system.

Depletion to the Rio Grande: The flows of the lower Rio Grande and water stored in Elephant Butte and Caballo Reservoirs supply New Mexico irrigators both within and outside the Elephant Butte Irrigation District (EBID), and are also used to meet New Mexico's water delivery obligations to Texas. A full, annual surface water supply delivery is 3.024 acre-feet/acre.[5] According to EBID records, as shown in Table 5 [on following page], there has not been a full allocation in the past 17 years, suggesting that the water right owners served by the EBID experience chronic shortages in supply and must rely to a greater extent on groundwater.[6] The OSE has estimated that approximately 10% of EBID irrigators do not have supplemental groundwater.[7]

[5] Final Judgment in Stream System Issue No. 101, SS-97-101, filed August 22,2011, in State of New Mexico ex rel. Office of the State Engineer v. Elephant Butte Irrigation District, et al., Case No. D-307-CV-96-888.

[6] Leah Diaz, EBID Tax Office, personal communication.

[7] Erek Fuchs cited by Skaggs et al.

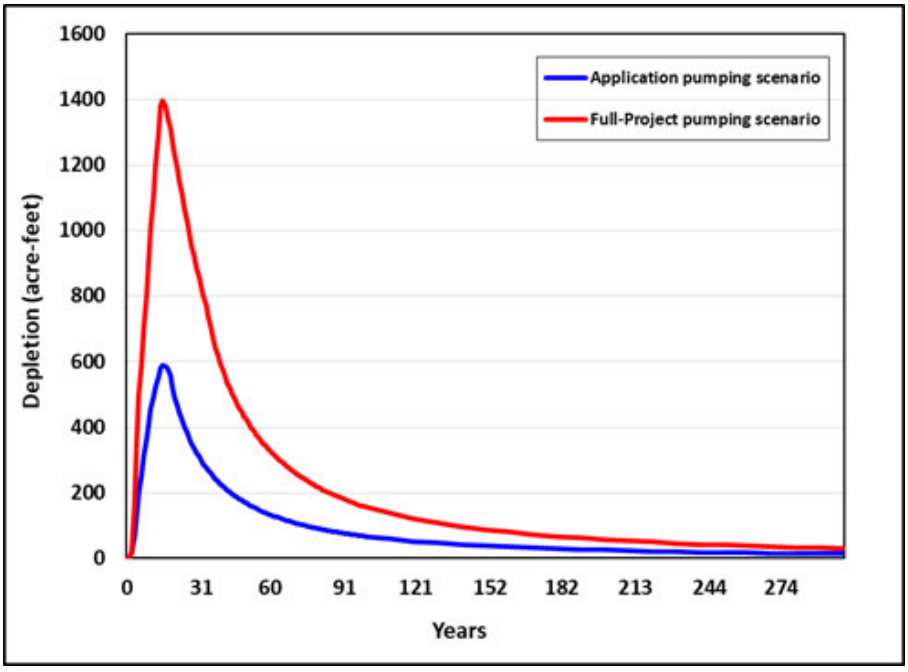
Table 5. EBID annual deliveries

Year	Allocation		Year	Allocation
2005	2 ac-ft		2014	0.63 ac-ft
2006	1 ac-ft		2015	0.92 ac-ft
2007	2 ac-ft		2016	1.1 ac-ft
2008	3 ac-ft		2017	2 ac-ft
2009	2.5 ac-ft		2018	0.83 ac-ft
2010	2 ac-ft		2019	1.2 ac-ft
2011	0.33 ac-ft		2020	1.2 ac-ft
2012	0.83 ac-ft		2021	0.33 ac-ft
2013	0.29 ac-ft			

The Copper Flat mine water supply wells will deplete the Rio Grande by intercepting groundwater that would have discharged to the river above Caballo Reservoir (i.e. Elephant Butte Reservoir), water that is stored in Caballo Reservoir, or groundwater discharged to the Rio Grande below Caballo Reservoir in the Rincon Valley.

The annual rate of depletion of the Rio Grande stream system surface water supply, inclusive of depletions to Las Animas Creek (but excluding depletions from the open pit), under the low and high pumping scenarios is shown in Figure 12. The figure demonstrates that the proposed diversions by the Copper Flat mine project will have an immediate and adverse impact to the interests of EBID farmers and an immediate and effectively permanent, adverse impact to the State's interest in its ability to meet its delivery obligations to Texas. Some of these impacts will dissipate within a few years beyond the end of mining. However, significant effects will last beyond 100 years.

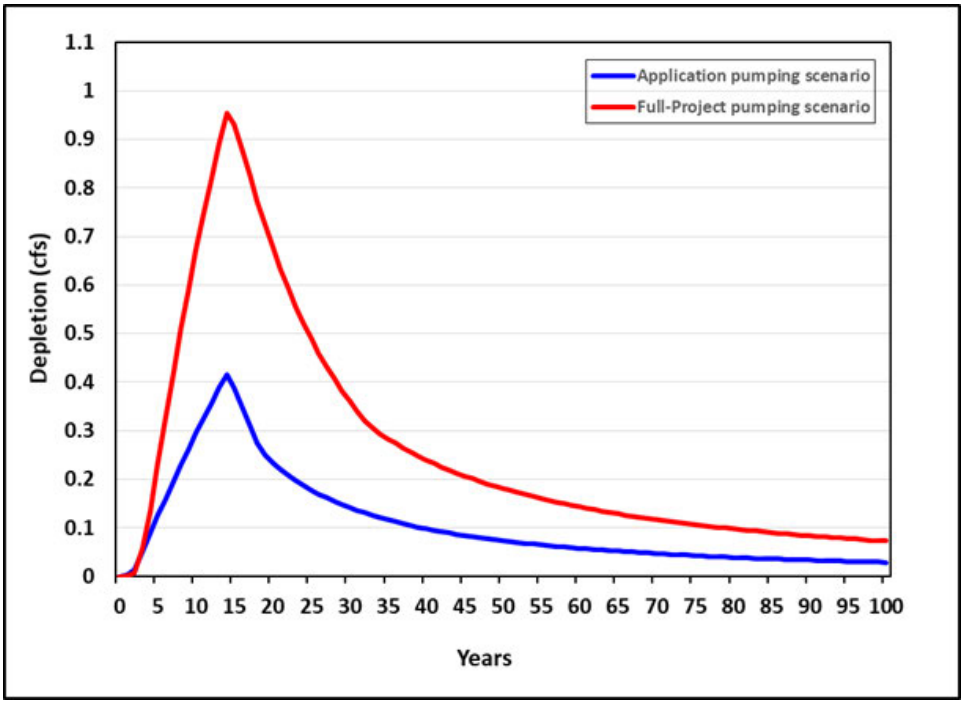
Figure 12. Rio Grande annual depletion



Impacts to Las Animas Creek and surface irrigation supply: The Lower Las Animas Ditch is an active community ditch diverting from Las Animas Creek approximately 3250 feet north of the NMCC production wells. According to the Las Animas Creek Hydrographic Report (OSE 1967) the maximum diversion amount of water that is needed to irrigate all of the acreage served by the ditch is 1 cfs for each 55 acres.[8] The hydrographic survey identified 123.2 irrigated acres served by the ditch. Therefore the diversion requirement of the Lower Las Animas Ditch can be calculated as: (123.2 acres ÷ 55 ac/cfs) = 2.24 cfs. The available diversion records reflect that between May 12 and October 31, 2020, water was diverted through the ditch on 112 days at the average rate of 1.32 cfs, with diversions ranging from 0.01 cfs to as much as 4.05 cfs.[9] On the December 1, 2021 site visit, MDCC observed the creek's entire flow of approximately 4.7 cfs diverted into the ditch (Ibid.).

NMCC's induced depletion of the divertible flows at the Lower Las Animas Ditch headworks is shown in Figure 13. It demonstrates that the proposed diversions by NMCC would have an immediate and adverse impact to the owners of water rights on the Lower Las Animas Ditch, some of whom are protestants in this proceeding. The appropriation of groundwater by NMCC will reduce the available water supply by as much as 0.42 to 0.95 cfs by the end of mining, or 19 to 42 percent of the irrigation demand of 2.24 cfs.

Figure 13. Depletions on the Lower Las Animas Ditch



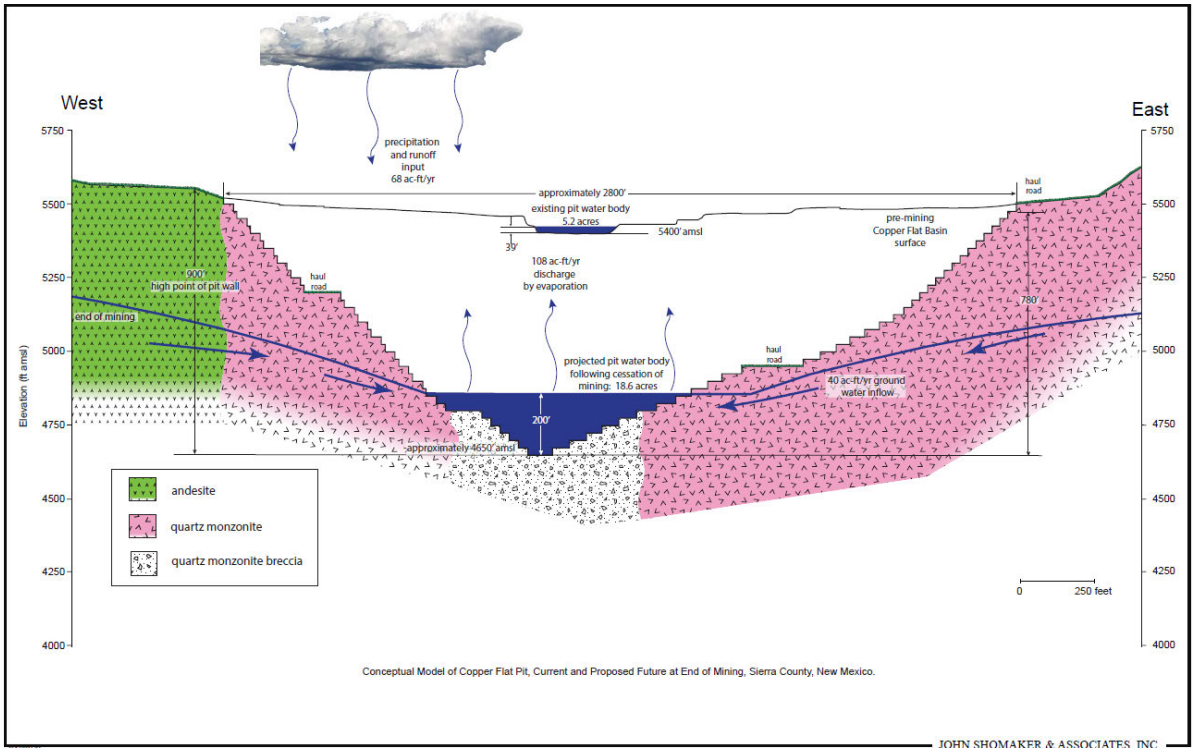
[8] The allowance for conveyance losses is not applied because the open ditch has been replaced with a pipeline.

[9] http://meas.ose.state.nm.us/site.jsp?id=240&status=Y&type=S&dist=4&basin=Las%20Animas%20Creek.

b. Impacts from the open pit

The mining of new ore by NMCC will entail the expansion of the existing open pit to a diameter of approximately 2,800 feet with an ultimate depth of approximately 780 vertical feet below the pre-mining ground surface (BLM 2019a). The schematic of the expanded pit prepared for NMCC shows that the pit will be excavated into the regional aquifer to a depth of approximately 700 feet thereby intercepting and depleting approximately 40-acre feet/year of groundwater that would have ultimately discharged to the Rio Grande system Figure 14. The pit will continue to intercept groundwater indefinitely after the mine ceases operation and post-reclamation.

Figure 14. Conceptual model of the Copper-Flat open pit mine



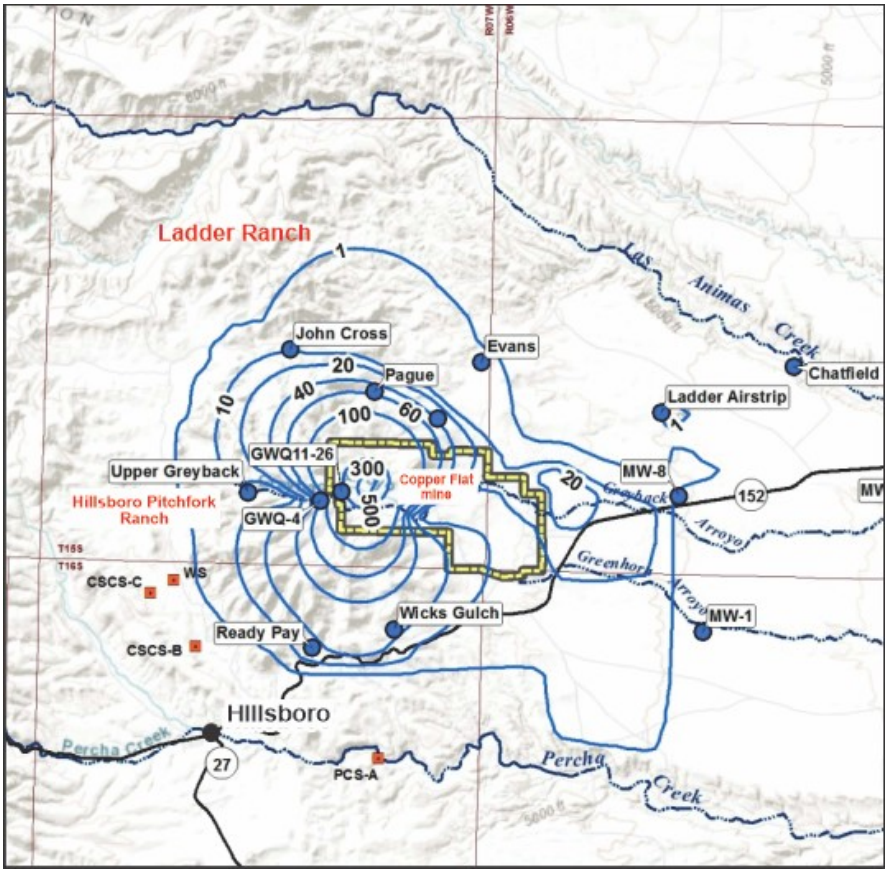
It has been an established practice of the OSE to require parties responsible for excavating a pit into an aquifer to offset any associated evaporative losses or depletions on nearby surface waters. In our experience, in calculating the annual rate of depletion, the OSE does not credit offsetting precipitation and incidental run-on inflow. To date NMCC has not filed an application with the OSE for the purposes of offsetting the depletions to the Rio Grande system resulting from the mine pit. Such an application would require designating the open pit as both the point of diversion and place of use.

Further, the development of the pit could reduce flow in Las Animas Creek and Percha Creek by intercepting groundwater that would otherwise discharge into those creeks. The regional potentiometric surface map produced by JSAI (2014 Figure 5.1) shows a groundwater high around the pit area, with steep contours both north and south. These contours reflect a flow

gradient away from the general area and towards these streams. That groundwater flow currently supports springs which feed the two creeks, including springs in the Las Animas Creek canyon and its perennial tributary Cave Creek. The development of the mine pit will also affect groundwater flow that supplies wells and springs on both the Hillsboro Pitchfork Ranch and Ladder Ranch properties.

The decline in groundwater levels at selected wells and springs located on the Ranch resulting from the Copper Flat mine project was previously calculated by JSAI (2014) and reported by the BLM (BLM 2019, Appendix H). If the andesite/monzonite near the pit has a higher conductivity than that assumed by JSAI (2014), these impact would extend even farther and affect the flows in the springs even more. Figure 15 demonstrates that the mine's open pit will induce a significant water-level decline in the aquifer underlying the Ladder Ranch and Hillsboro Pitchfork Ranch properties. Impacts to specific wells and springs will be addressed in the following pages.

Figure 15. Drawdown in wells on the Pitchfork and Ladder ranches

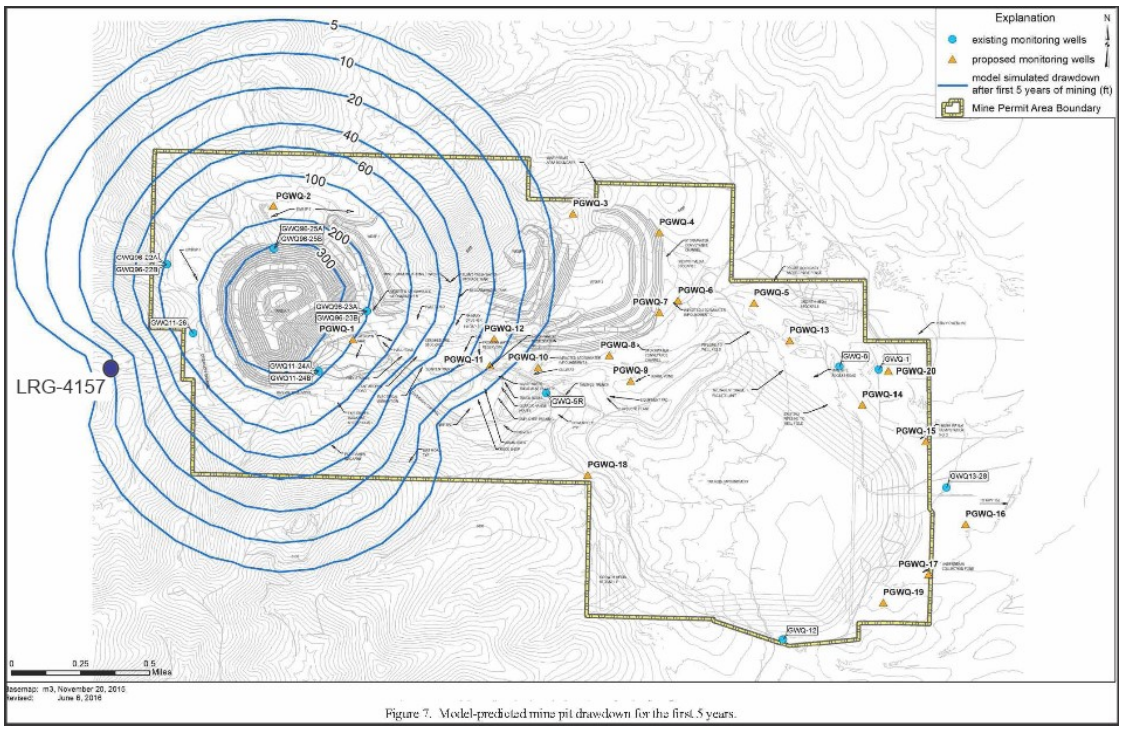


Source: BLM 2019a

Well LRG-4157 (Hillsboro Pitchfork Ranch): Identified in Figure 15 as "GWQ-4". It is located on the edge of Greyback Arroyo, less than 2000 feet west of the proposed open-pit. In January, 2022 the well's depth was measured by MDCC at 60 feet, and the static water level was

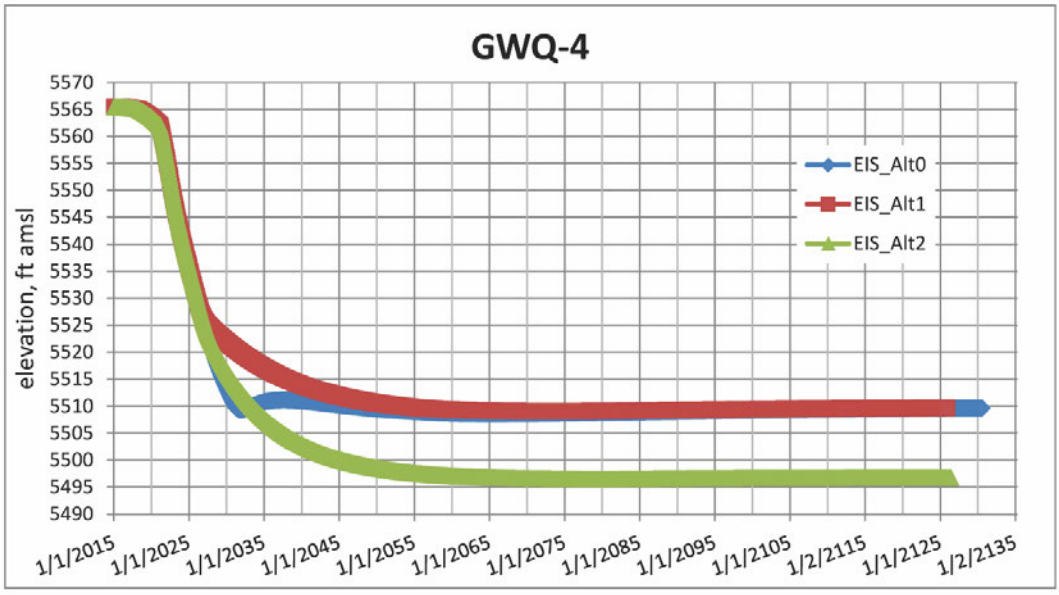
measured at 36.48 feet. Figure 16 demonstrates that within 5 years after mining commences, the open-pit will have reduced the available water column to 23.5 feet which is within 3.5 feet of the 20-foot reserve recommended in the OSE guidelines for domestic and livestock wells. Figure 17 demonstrates that the open pit will dewater the well within 10 years.

Figure 16. Projected drawdown induced by NMCC pit after 5 years of mining



Source; JSAI 2016

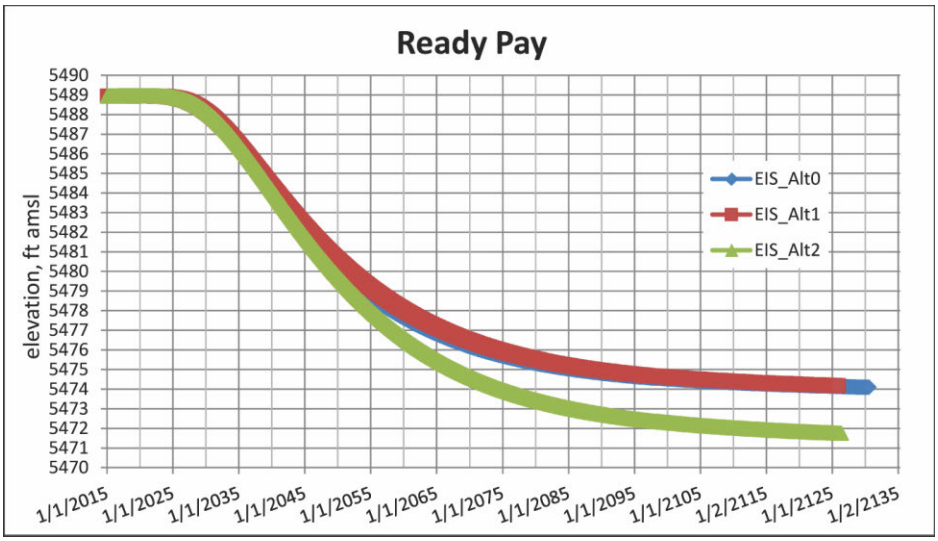
Figure 17. NMCC induced drawdown on LRG-4157



Source: BLM 2019a, Volume 2 Appendix H.

Well LRG-4158 (Hillsboro Pitchfork Ranch): Identified as "Ready Pay" in Figure 15. It is located approximately 2.3 miles south of the proposed mine pit. A depth to water of 45.98 feet and a well depth of 114 feet were measured by MDCC in January 2022. As shown in Figure 18, JSAI has calculated that the project-induced water level decline in this well would be 17 feet or 25% of the well's total water column.

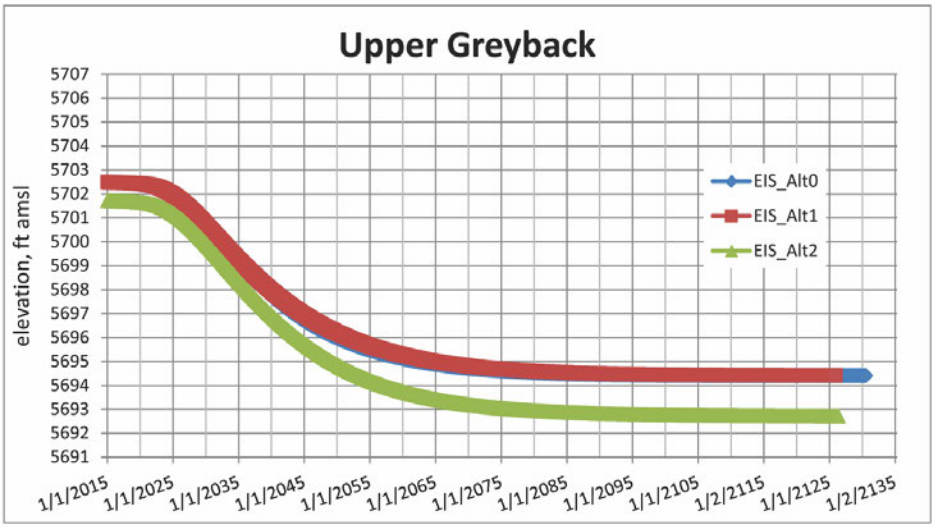
Figure 18. NMCC induced drawdown on LRG-4158



Source: BLM 2019a, Volume 2 Appendix H.

Well LRG-4159 (Hillsboro Pitchfork Ranch): Identified as "Upper Greyback" in Figure 15. It is located along Greyback Arroyo 1.5 miles west of the proposed open-pit. The well was drilled in 2002 to a depth of 200 feet. Depth to water of 46.14 feet was measured by MDCC in December 2021. The project induced drawdown of 8.5 feet as shown in Figure 19, represents approximately 6% of the well's water column.

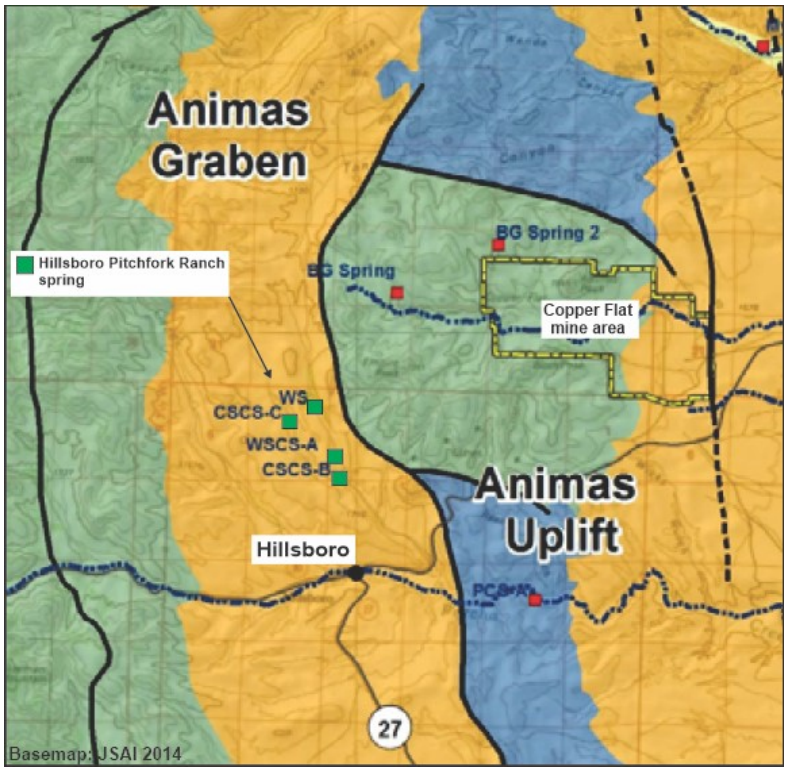
Figure 19. NMCC induced drawdown on LRG-4159



Source: BLM 2019a, Volume 2 Appendix H.

Warm Spring and Cold Spring (Hillsboro Pitchfork Ranch): These are a series of springs located in relative close proximity to each other, discharging from the SFG aquifer adjacent to the southwest margin of the crystalline bedrock uplift that encompasses the proposed mine site (Figure 20). Two of these springs, WS (SD-03099) and CSCS-B (SD-03100), have been improved with concrete spring boxes and piping.

Figure 20. Location of springs on the Hillsboro Pitchfork Ranch



The springs are located approximately 2.8 to 3 miles southwest of the proposed center of open-pit. Regarding these springs JSAI states that they "could be indirectly affected by the project if groundwater levels were lowered through indirect connection to the Animas Uplift" (BLM, 2019, Appendix C). JSAI calculated a 100-year post mining water level decline ranging from 0.12 to 0.19 feet at the springs (Ibid., Table 3.5). JSAI goes on to assert that the water-level decline will not result in a decrease in spring discharge "because the source of water for these springs is west of the Animas Uplift (Ibid.). Nevertheless, JSAI concedes that "discharge locations could move a short distance due to a change in water level".

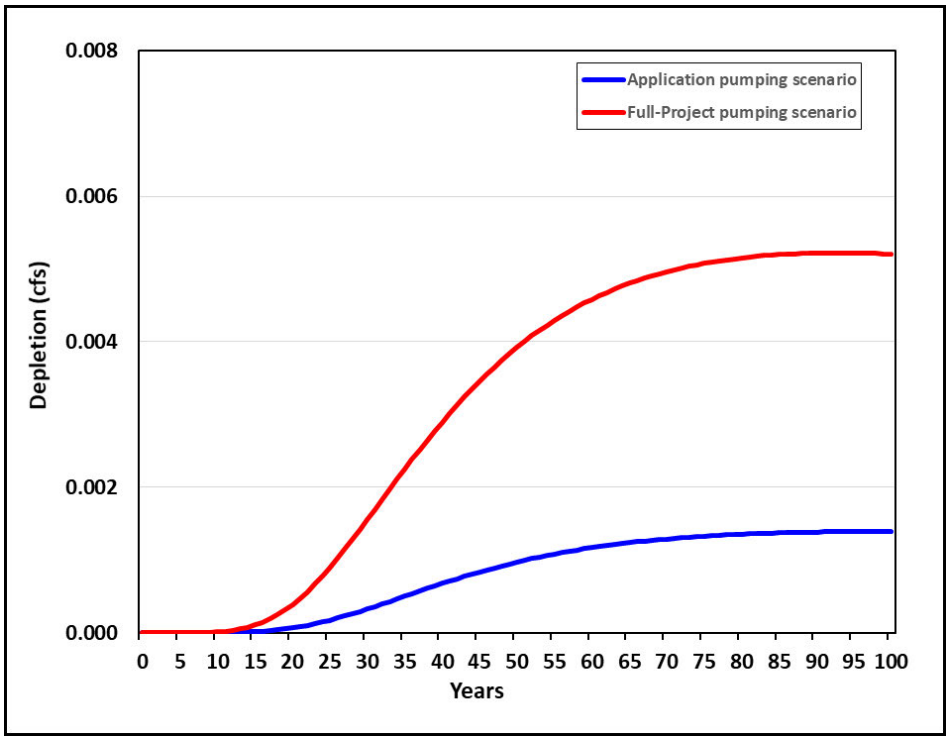
The geology in this area is complex. The close proximity of "warm" and "cold" springs suggests intermixing of source waters. The JSAI model clearly shows a continuous groundwater flow system between the aquifer in the crystalline uplift and the adjacent SFG sediments. A conservative impact analysis that is protective of the Hillsboro Pitchfork Ranch water resources is required. MDCC, through an iterative process, used the OSE's Theis and Glover-Balmer analytic solutions to estimate the 100-year depletion on the springs using an average distance of

2.9 miles, a drawdown of 0.17 feet and aquifer T and S values of 2 ft^2/day and 0.001, respectively. The results show that the proposed mine project could reduce the annual discharge of each of the four springs by an average 0.12 acre-feet (0.072 gpm) within 100 years. The preceding analysis relied on drawdown derived from the JSAI model using aquifer parameter values for transmissivity that are on the low-side for quartz monzonite and andesite (Kilmer 2008). If the higher value suggested by Kilmer were to be used, the induced drawdown and depletion impacts to these springs would be greater.

John Cross well (Ladder Ranch): This well, which at a distance of approximately 2 miles, is the Ladder Ranch well located closest to the NMCC open-pit. As shown previously in Figure 16, the NMCC project will induce a drawdown of 10 feet in this well at the conclusion of mining and prior to rapid-fill of the pit. The ranch manager, Dustin Long, reports that the well was drilled to a depth of 170 feet. The well has been equipped with a transducer. The generated data show that on numerous occasions the pumping depth dropped to within 30 feet of the well's bottom. Therefore, the additional drawdown induced by NMCC's pumping would adversely impact the operability of the well. If the OSE were to find that the John Cross well is "critical" then the NMCC induced drawdown of 10 feet would exceed the maximum allowable drawdown of 2.6 to 3.5 feet, thereby creating a presumption of impairment (OSE 2017).

Las Animas Creek (Ladder Ranch reach): The MDCC model was used to calculate depletions on Las Animas Creek from its confluence with Cave Creek to its downstream exit from the ranch property. As shown in Figure 21, the effect is relatively small. However, under drought conditions this impact may be significant.

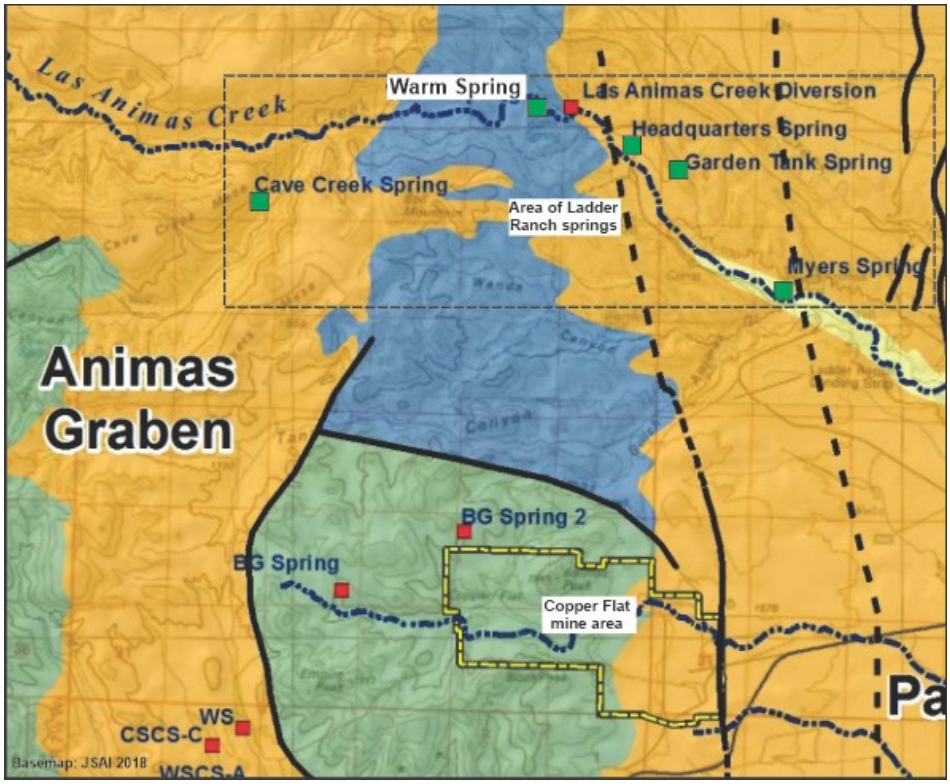
Figure 21. Depletion on Las Animas Creek on the Ladder Ranch



In an internal agency memorandum senior NMED staff from multiple bureaus noted that "any reduction or drawdown in the shallow groundwater that feeds them [i.e. Las Animas and Percha Creeks] would likely reduce surface flows and potentially eliminate surface waters and aquatic habitat in certain reaches that are currently wet, which would cause additional stress and impairment to the aquatic community" (NMED 2008).

Warm Spring (Ladder Ranch): Warm Spring is one of a number of springs which are a significant source of water supporting perennial flow in Las Animas Creek. These are a series of springs located in relative close proximity to each other, discharging into Las Animas Creek from the SFG and Paleozoic aquifer system located north of the bedrock uplift that encompasses the proposed mine site (Figure 22).

Figure 22. Location of selected springs on the Ladder Ranch



Referencing these springs JSAI states that they "could be indirectly affected by the project if groundwater levels were lowered through indirect connection to the Animas Uplift" (BLM 2019, Appendix C). JSAI calculated a 100-year post mining water level decline ranging from 0.01 to 0.05 feet at these springs (Ibid., Table 3.5). The previously described iterative process using the OSE's Theis and Glover-Balmer analytic solutions was applied to estimate the 100-year depletion on Warm Spring using a distance of 5 miles, a drawdown of 0.05 feet and aquifer T and S values of 80 ft^2/day and 0.005, respectively. The results show that the proposed mine project could reduce the annual discharge of Warm Spring by 0.46 acre-feet (<0.001 cfs) within 100 years. The discharge of the other springs would be reduced by a lesser amount.

Davie and Spiegel measured Warm Spring to have a flow rate of 0.81 cfs in 1967 (Davie and Spiegel 1967). Citing Intera (2012) and others, the BLM reported measured spring discharge varying from 0.007 cfs (5 ac-ft/yr) to 1.1 cfs (BLM 2019). It is possible, therefore, that under certain low flow and drought conditions the relatively small depletions resulting from the mine project would have a significant impact on an already diminished water supply.

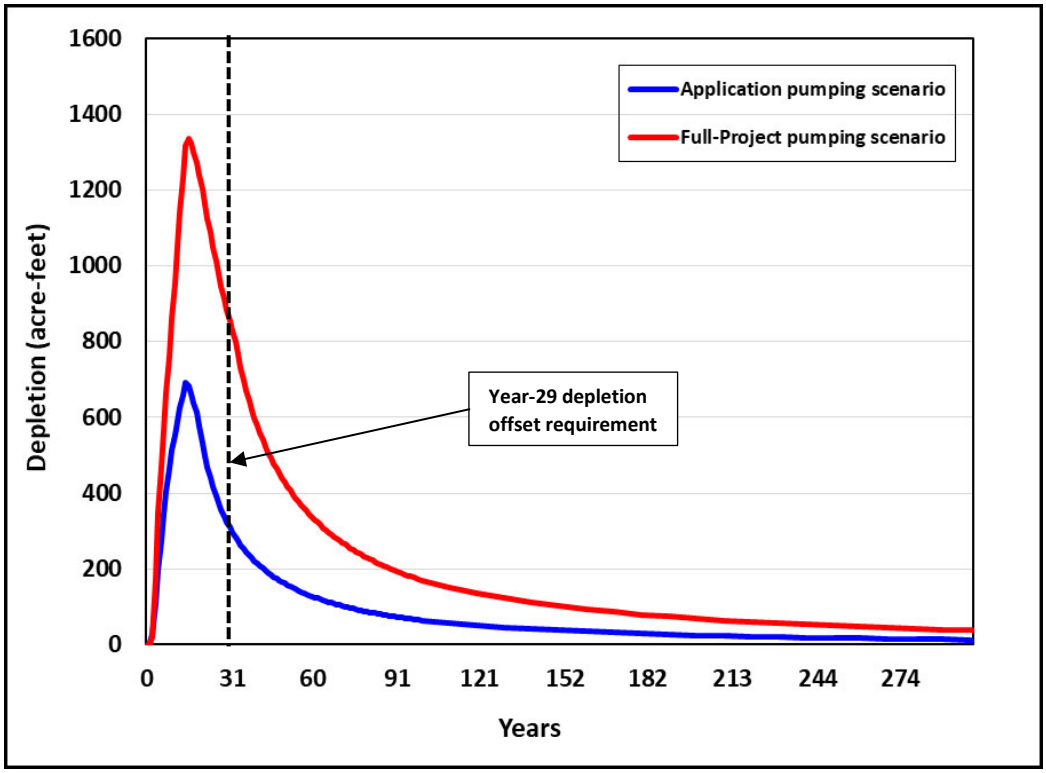
IV. Other Issues

In considering whether an application is detrimental to the public welfare of the state, the State Engineer can consider both statewide and local issues of concern (OSE 1999). These issues of concern include; the availability of surface water for depletion offsets, conservation of water, reduction in artesian pressure in wells of other ownership and impacts to a riparian ecosystem.

A. Availability of surface water depletion offsets

"The Rio Grande stream system is fully allocated and existing rights may not be impaired by proposed appropriations" (OSE 1999). Offsetting the effects of groundwater diversions is critical to the conjunctive management of the water resources within the Rio Grande stream system (OSE 2000). A surface water depletion greater than 0.10 acre-foot in any year due to a proposed appropriation should not be acceptable. If the depletion impact is large and immediate, an offset of this impact should be required **during that year** (Ibid., emphasis added). As shown in Figure 23, NMCC's depletion impact on the Rio Grande stream system will be large, immediate and persistent.

Figure 23. Rio Grande depletion offset requirement



Any existing permittee requiring surface water rights for offset purposes is confronted with finding valid surface water rights and obtaining a permit from the OSE to transfer the surface water rights. The transfer of surface water rights within the Rio Grande stream system is a complicated and often lengthy process. Because a transfer application can be denied or approved and the decision appealed, the final decision may be far removed from the time the application was filed (Ibid). The public welfare of the state is promoted only if there is certainty that NMCC will be able to obtain and transfer all necessary valid surface water rights to prevent adverse effects upon the flow of the Rio Grande (Ibid.).

NMCC has not submitted a plan to offset its depletions on either the Rio Grande or Las Animas Creek. In the absence of NMCC's ability to demonstrate its control of sufficient depletion offsets prior to the issuance of a groundwater permit, the State Engineer should find that there is insufficient water available to satisfy the project's water requirements. Accordingly, the public interest is best served by denying Application LRG-3150-E.

NMCC has recently made commitments to the BLM to fully offset depletions to the Rio Grande resulting from its mining operations (BLM 2019b). NMCC has advised the BLM that the offset was to be provided with water obtained from a lease of San Juan-Chama Project (SJCP) water executed with the Jicarilla Apache Nation for a period of 15 years from when ore crushing would begin; and after that, the lease would be extended or another water source secured that would provide offsets to year 29 (Ibid.).

The lease agreement with the Jicarilla Apache Nation does not guarantee the actual amount of SJCP water that will be available for offsets every year. Article 9 of this agreement states that water deliveries to NMCC will be curtailed in the event that the Secretary of the United States Department of Interior determines "for any reason" that there is a shortage in the amount of the San Juan-Chama Project supply that can be delivered to the contractors.[10] A number of project delivery shortfalls have occurred in recent years.

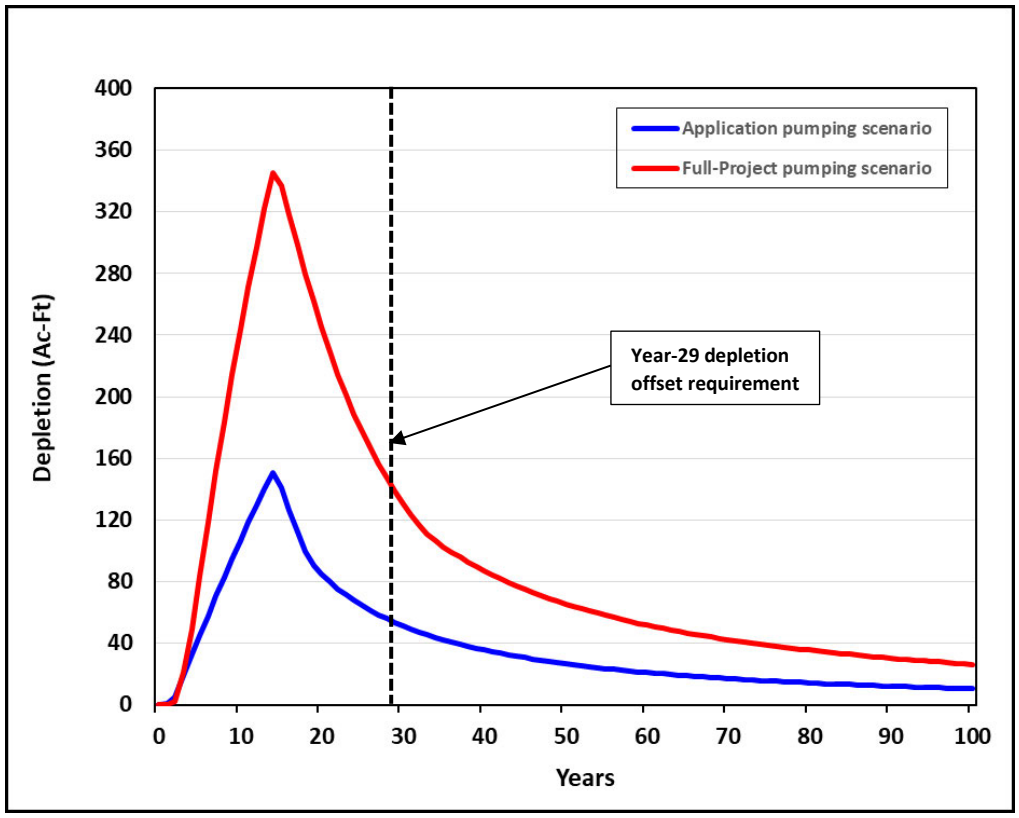
NMCC has also committed to the BLM that once its lease with the Jicarilla Apache Nation ends, it would retire an existing water right "that holds a legal entitlement to deplete water from the river" in an amount equal to NMCC's effects on the Rio Grande at the time of retirement (Ibid). At a minimum, NMCC should be required to permanently retire sufficient water rights to offset an annual depletion of at least 320 to 880 ac-ft to meet its commitment to the BLM to permanently retire sufficient water rights to address post-mine year-29 closure depletions as shown in the Figure 23.

Similarly, NMCC should also be required to offset its depletions on Las Animas Creek of 53 to 138 acre-feet at the Lower Las Animas Ditch diversion as shown in Figure 24 [see following page]. Assuming a consumptive use of 1.89 ac-ft/ac (OSE 1967) and a 100% historical

[10] Water Supply Agreement between the Jicarilla Apache Nation and New Mexico Copper Corporation, Inc.

supply (not a given), the Applicants would have to permanently retire approximately 28 to 73 acres of adjudicated irrigated land on the Lower Las Animas Ditch.

Figure 24. Las Animas Creek depletion offset requirement



At present, NMCC is asserting that any river depletions associated with the move-from water rights under File LRG-3150-E will not be used as an off-set credit during the term of its groundwater lease.[11] However, in the event that the matter is raised at a future date, it should be kept in mind that the move-from wells are located relatively close to the reach of the Rio Grande that is either located wholly within Texas or that forms the international boundary between the United States (Texas) and Mexico. Assuming radial flow in the aquifer, a reasonable assumption, the majority of the depletions resulting from historic pumping by the move-from wells would not be on the waters of the State as was shown earlier in Figure 2. If these depletions were to be credited to the NMCC wells, a new, net depletion on the surface waters of the State would result.

B. Impacts to Las Animas Creek riparian ecosystem

The riparian habitat along Las Animas Creek is extensive alongside the upper and middle reaches of the creek, including an ecologically important stand of Arizona sycamores (*Plantanus wrightii*) with cottonwoods, netleaf hackberry, velvet ash, Gooding's willow, and coyote willow

[11] Applicants' answers and responses to Protestant Percha-Animas Watershed Association's first combined interrogatories, requests for production of documents, and requests for admission to Tulla Resources Group and Santa Teresa Capital, LLC.

(BLM 2019). The Arizona sycamore is a relatively unique tree in New Mexico (Intera 2012). East of the Continental Divide, it can only be found growing in New Mexico along Las Animas Creek. The Arizona sycamore is an important bird tree. A preliminary list of seasonal bird presence for Las Animas Creek includes listed (i.e., endangered) species such as the spotted owl and candidate species such as the yellow-billed cuckoo (Ibid.).

Stands of Arizona sycamore extend westward from approximately 3 miles west of the confluence of Las Animas Creek and Caballo Reservoir through the Ladder Ranch property (Ibid.). The tree is an obligate riparian tree, a species that depends completely upon habitat along a body of water whose roots generally extend downward into the water table (Ibid.). Seedling growth is also more rapid in sites with perennial stream flow and shallower groundwater than at sites with ephemeral stream flow and groundwater deeper below the surface (Stromberg, 2001a). The detailed vegetation survey undertaken by Parametrix, Inc. on behalf of NMCC (Intera 2012, Appendix 4-E) mapped extensive, healthy stands of Arizona sycamore growing as much as 500 feet out from the stream banks, indicating that the presence of shallow groundwater is probably more critical to the health of this woodland than the presence of perennial flow in Las Animas Creek.

The NMCC-Parametrix, Inc. survey identified the presence of a significant gallery forest containing large numbers of Arizona sycamore and cottonwood along the reach of Las Animas Creek below the Lower Las Animas Ditch diversion (Ibid.). Groundwater levels in this area were measured in December 2021 by MDCC at depths ranging from approximately 7 to 20 feet. In Arizona, these trees had highest productivity, and the forests had greatest compositional diversity, where ground water averaged less than 2 m (~6.6 ft) below the tree base during the growing season, and where ground water fluctuated annually by less than a meter (<3 ft). Where ground water was at a depth of 3 to 5 m (9.8 to 16.4 ft), trees had low growth rates (Stromberg 2001a). Citing others, Stromberg (Ibid.) further states that cottonwood riparian forests "are best developed where water tables are less than 3 m (<10 ft) below the flood plain surface during the growing season, and that ground water declines of 1 m can kill both mature trees and saplings.

Locally, ground waters in the SFG and alluvium are hydraulically connected to each other and to the surface flow of Las Animas Creek (Davie and Spiegel 1967), and under natural conditions water is discharged by upward leakage into the alluvium of Las Animas Creek (Ibid.). A decrease in upward leakage resulting from a decline in head in the SFG aquifer would cause declines of water levels in the alluvium of Las Animas Creek, thereby impacting the riparian habitat that supports wildlife along Las Animas Creek.

The model projected drawdown resulting from groundwater pumping by NMCC indicates that the water level in the shallow aquifer that sustains the Las Animas riparian ecosystem would decline by as much as 15 feet while mining is ongoing. By reducing the depth to groundwater to more than 20 feet over a large area, significantly in excess of the 3-meter best-conditions threshold identified by Stromberg, NMCC's new appropriation of groundwater would

be detrimental to the interests of the local community and State in maintaining the viability of this unique resource.

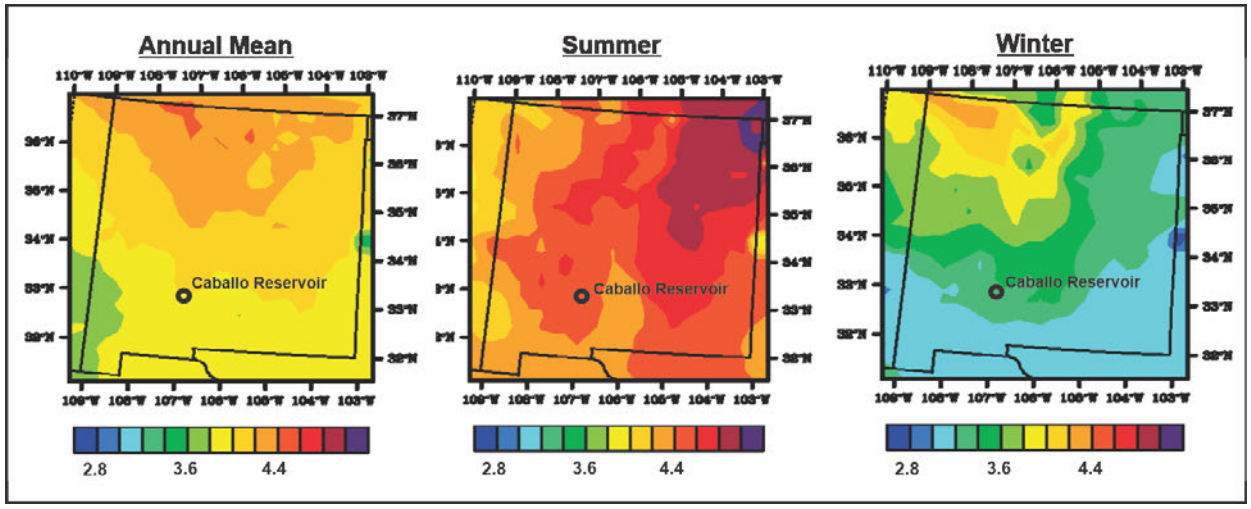
In an internal agency memorandum senior NMED staff from multiple bureaus noted that any reduction or drawdown in the shallow groundwater that feeds Las Animas Creek "would likely reduce surface flows and potentially eliminate surface waters and aquatic habitat in certain reaches that are currently wet, which would cause additional stress and impairment to the aquatic community" (NMED 2008). Similarly, the New Mexico Department of Game & Fish "remains dubious" that NMCC has provided "sufficient security and mitigation to preclude adverse impacts to perennial flow and riparian habitat along lower Las Animas Creek (NMG&F 2018).

C. Implications of Climate Change on Future Supply

In reviewing water right applications, the OSE should consider long-term trends in climate that go beyond the most recent historic record. Climate change data indicate a long-term trend on a time scale of 100 years, with significant impacts in the next few decades, the time scale within which most water right transfers are considered.

The OSE has produced a report compiling and synthesizing existing data and scientific opinion on the issue of climate change and the impact on New Mexico's water resources that can be expected (OSE 2006). The report's principal finding is that temperatures have already risen in New Mexico and are predicted to continue to increase during the next century. While the observed temperature change across the state since the 1960s has been somewhat less than 1°C the global and regional scale climate change models cited in the OSE report consistently show that the warming trend will continue at a greatly accelerated rate. The projected average temperature increase along the Las Animas Creek watershed by the end of the 21st century would be approximately 4°C as shown below in Figure 25.

Figure 25. Simulated change in temperature (°C) from 1961-1985 to 2071-2095



While researchers have a high level of confidence in predicted changes in temperature, the precipitation (runoff potential) predictions cited by the OSE are less certain. However there is a consensus that climate change will likely have a significant impact on the availability and demand for water in the Rio Grande Basin, including Las Animas Creek (Llewellyn and Vaddey 2013). These effects include:

- Supplies of native sources to the Rio Grande, inclusive of Caballo Reservoir are projected to decrease.

- The seasonality of flows is projected to change. Anticipated changes include earlier snowmelt runoffs as well as increased variability in the magnitude, timing, and spatial distribution of streamflow and other hydrologic variables.

- The frequency, intensity, and duration of both droughts and floods are projected to increase.

- The reduced surface-water inflows, coupled with increases in the demand for irrigated agricultural and riparian vegetation, are projected to result in decreased reservoir storage in Caballo Reservoir. Reduction in water is expected to reduce surface water flows, and reduce the shallow groundwater available to riparian vegetation.

- New Mexico would be required to take additional management actions to meet its obligations under the Rio Grande Compact.

The OSE's analysis of the LRG-3150-E water right transfer should therefore incorporate climate impacts before they occur. Doing so will ensure that water right owners and the public interest are protected and otherwise would not be impaired by the proposed action.

V. Summary of Opinions and Conclusions

Based on the information and analysis presented in this report, the following opinions are offered:

Public Welfare and Conservation of Water of the State

1. Only the historical consumptive use component of LRG-3150-E should be considered for transfer. The amount of transferable consumptive use should be limited to that amount historically depleted within New Mexico. The Applicant has failed to quantify historical consumptive use, which makes it impossible to analyze the Application.

2. Moving the LRG-3150-E right 87 miles to the north of its current points of diversion and place of use has the effect of a new appropriation in a fully appropriated basin, which is not in the public interest.

3. The OSE needs to review and analyze the Copper Flat Mine project as a whole, not in a fragmented, piecemeal fashion. The review needs to take into consideration, among other things, all the water rights that will be used for mining, milling, and reclamation purposes during the life of the mine and closure; the hydrological effects in the move-from locations of the water rights; the cumulative hydrological effects of moving the water rights to the production wells (or other move-to location); all the necessary offsets; and the hydrological effects of excavating the open pit. Otherwise, the OSE cannot fully evaluate whether the project will impair the water rights of other users, whether the project will be contrary to the conservation of water, or whether the project will be detrimental to the public welfare.

4. NMCC cannot demonstrate that it can place the pending 2,400 acre-feet to beneficial use within a reasonable period of time. As of January 2022, NMCC has not filed any application with the OSE to develop the additional 2,843.16 acre-feet required for a viable project pursuant to its commitments to the BLM.

5. NMCC cannot demonstrate that it has sufficient water rights to properly close the mine after the twelve-year life of the mine. The term of the lease is only ten years.

6. The State Engineer should consider together the hydrologic and water rights consequences of the proposed temporary transfer of the water rights under OSE File LRG-3150-E and the hydrologic impacts resulting from the excavation of the mine pit.

7. It is in the interest of the State, and in the interest of users of nearby water rights, to perform an impact analysis that incorporates the project's actual annual water demand of 6,105 acre-feet as approved by the BLM.

8. The proposed diversions by NMCC will have an immediate and adverse impact to the interests of EBID farmers already experience shortages, with 10% of the farms having no supplemental wells.

9. There will be an immediate and effectively permanent, adverse impact to the State's interest in its ability to meet its delivery obligations to Texas under the Rio Grande Compact.

Impacts to protestant Hillsboro Pitchfork Ranch water rights

1. Hillsboro Pitchfork Ranch well LRG-4157 will go dry as a consequence of the NMCC mine project.

2. The NMCC project will reduce the annual discharge of each of the four springs located on the Hillsboro Pitchfork Ranch by an average 0.12 acre-feet (0.072 gpm) within 100 years.

Impacts to protestant Ladder Ranch water rights

1. Groundwater diversions by NMCC will reduce the annual discharge of Warm Spring by 0.46 acre-feet within 100 years. The discharge of other tributary springs would be reduced by a lesser amount. Under low flow and drought conditions the depletions resulting from the mine project would have a significant impact on an already diminished water supply.

Impacts to protestant PAWA water rights and water rights of others

1. NMCC's proposed groundwater diversions would reduce the available water supply to the Lower Las Animas Ditch by 0.42 to 0.95 cfs by the end of mining, or 19 to 42 percent of the irrigation demand of 2.24 cfs.

2. The Applicant's proposed appropriation will adversely impact 24 wells, thereby impairing their ability to fully utilize their associated water rights.

Lack of depletion offsets

1. The Rio Grande stream system is fully appropriated. Offsetting the effects of groundwater diversions is critical to the conjunctive management of the water resources within the Rio Grande stream system. A surface water depletion greater than 0.10 acre-foot in any year due to a water right transfer is not acceptable.

2. Groundwater diversions from the NMCC water supply wells will have a large and immediate impact to the Rio Grande and Las Animas Creek.

3. NMCC's proposed diversions will result in significant impacts greater than 0.1 acre-feet, extending beyond 300 years.

4. A lease of San Juan-Chama Project water for surface water depletion offsets is not a substitute for the permanent retirement and transfer of existing valid water rights.

5. NMCC has not submitted a plan to offset its depletions on either the Rio Grande or Las Animas Creek. Unless NMCC can demonstrate its control of sufficient depletion offsets, there is insufficient water available to satisfy the project's water requirements.

6. At a minimum, NMCC should be required to permanently retire sufficient water rights to offset an annual depletion of at least 320 to 880 ac-ft per year. This offset is necessary for NMCC to meet its commitment to the BLM to permanently retire sufficient water rights to address long-term depletions 30 years after mining and beyond.

7. To offset its depletions on the Lower Las Animas Ditch NMCC would have to permanently retire approximately 28 to 73 acres of adjudicated irrigated land. This is likely to be impractical and it would have a detrimental impact to the local community..

8. NMCC must demonstrate that it will be able to obtain and transfer all necessary valid surface water rights to prevent adverse effects upon the flow of the Rio Grande.

9. To date NMCC has not filed an application with the OSE for the purposes of offsetting depletions to the Rio Grande system resulting from the mine pit.

Impacts to a sensitive riparian ecosystem

1. The extensive riparian habitat along Las Animas Creek includes an ecologically important stand of Arizona sycamores which is a unique tree in New Mexico. East of the Continental Divide, the Arizona sycamore can be found growing in New Mexico only along Las Animas Creek.

2. Groundwater diversions by NMCC will reduce the depth to groundwater by more than 20 feet over a large area within the Las Animas Creek riparian zone. Therefore, NMCC's new appropriation of groundwater will be detrimental to the interests of the local community and State in maintaining the viability of this unique resource.

3. Any reduction or drawdown in the shallow groundwater that supplies Las Animas and Percha Creeks would likely reduce surface flows and potentially eliminate surface waters and aquatic habitat in certain reaches that are currently wet, which would cause stress and impairment to their associated aquatic community.

4. NMCC has not provided "sufficient security and mitigation" to prevent adverse impacts to perennial flow and riparian habitat along lower Las Animas Creek.

5. Climate change will likely have a significant impact on the availability and demand for water in the Rio Grande Basin, including Las Animas Creek. The anticipated reduction in surface water flows will reduce the shallow groundwater available to riparian vegetation further exacerbating depletions induced by NMCC's groundwater diversions.

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APPENDIX A
WELL FIELD-INSPECTIONS

Memorandum

Date:	January 30, 2022
Subject:	Copper Flat Field Work
From:	Sara Chudnoff, PG
To:	Mustafa Chudnoff
Company:	Mustafa Chudnoff Consulting

Introduction

The purpose of this memo is to summarize field work completed on 11/30/2021, 12/1-3/2021 and 1/21-22/2022 in the vicinity of the Copper Flat Mine and Las Animas Creek. The field work focused on three areas; protestants' and other wells located along Las Animas Creek and Hwy 152, Hillsboro Pitchfork Ranch and Ladder Ranch.

Max Yeh president of the Percha Animas Watershed Association (PAWA) coordinated wells to be inventoried and measured along Las Animas Creek and Hwy 152. Mr. Yeh accompanied me to all sites he coordinated, in addition Mustafa Chudnoff assisted in work at these sites on 12/1-2/2021. Mr. Chudnoff coordinated field work at the Pitchfork and Ladder Ranch. Work on the Pitchfork Ranch was completed by myself and Mr. Chudnoff on 12/2/2021 while accompanied by co-owner Robert Cunningham. Work on the Ladder Ranch was completed on 12/3/2021 by myself and Mr. Chudnoff while accompanied by the ranch manager, Dustin Long. A follow up trip was completed on 1/21/2022 with Mr. Yeh for additional water level measurements and on 1/22/2022 with Mr. Cunningham to measure water levels and well depths. During the 1/22/2022 field work with Mr. Cunningham the well cap for LRG-04156 broke while trying to remove it to measure the total depth. Subsequently Mr.

Cunningham took a total depth measurement in this well following the below methodology on 1/24/2022 and provided it to me.

Methodology

Prior to field work Mr. Yeh contacted well owners to ask them to reduce or cease water usage 24-hours prior to measurements to ensure as close to static water level would be obtained. During field work if a pump turned on, the time it turned on was noted as well as the duration of pumping. The well then would be allowed to rest prior to obtaining a measurement or continuing monitoring. Water levels were not taken at wells that had been actively pumping upon arrival. A steel tape or e-line was used for obtaining water levels. Per standards established by the USGS, measurements taken with the steel tape were repeated until two measurements were within 0.02-feet of one another.

Well depths were obtained by lowering a weighted string into a well until the string lost tension. Once the string lost tension that point was marked (from top of casing) with electrical tape and the entire line was pulled from the well and measured to the nearest foot. The measurement was repeated to ensure accuracy. The total depth was adjusted by subtracting the casing to represent a total depth from ground surface.

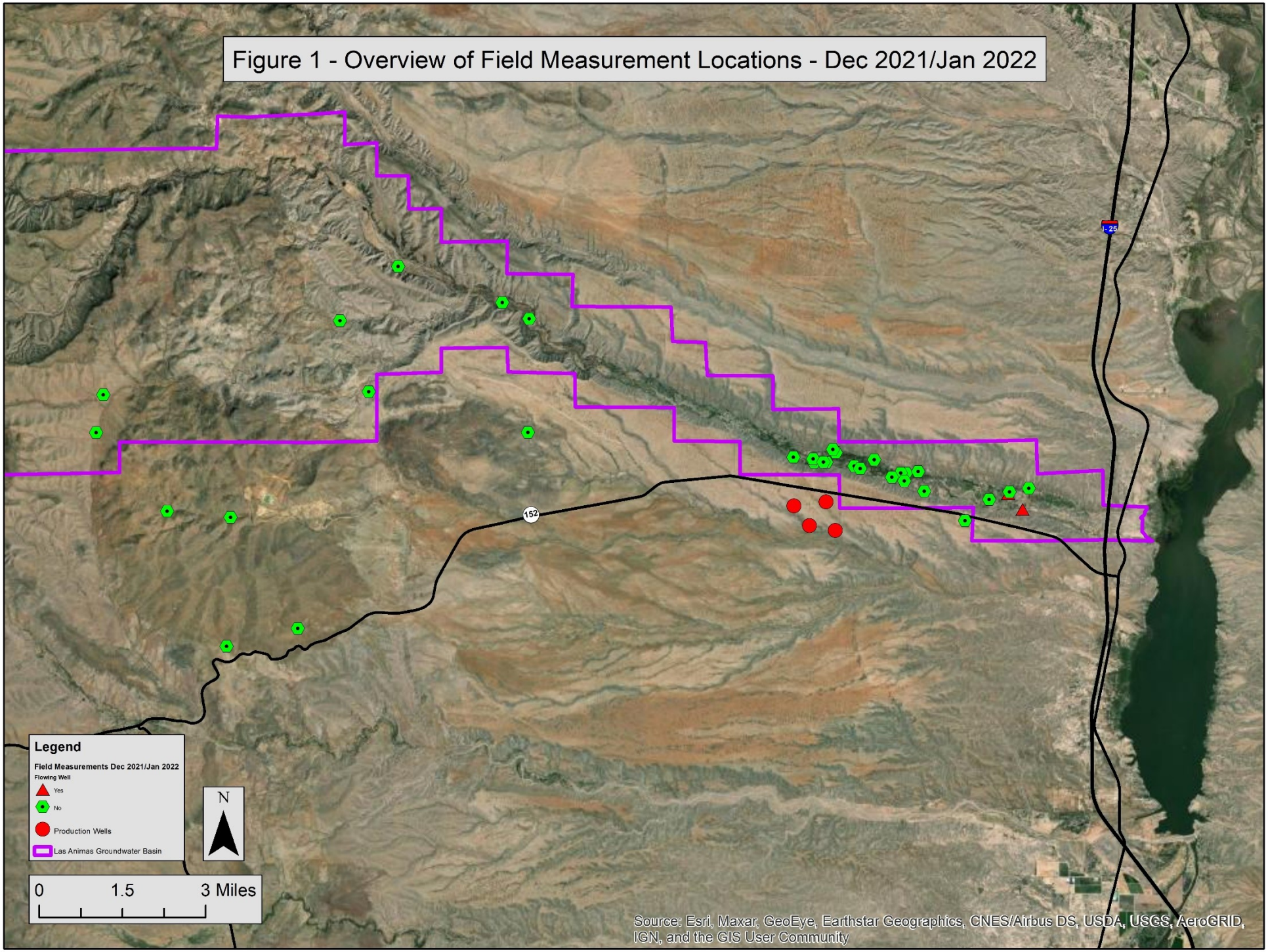
Field Work/Data Compilation/Mapping

Upon arrival of a field site the following was recorded, obtained and measured: owner/site name, date, well coordinates (WGS-84), well stick-up (measuring point correction), description of measurment point, photos, water level(s) and any other pertinent data. Upon completion of field work all data and measurements obtained were compiled in a spreadsheet file. In addition the spreadsheet file was also populated with applicable OSE well record information.

Once the file was complete the data was imported into ArcMap and plotted using the coordinates taken in the field. Elevations were obtained for each well from the USGS 3D Bare Earth DEM contour map

shapefile. The elevations were converted from meters to feet and then utilized to calculate the water level elevations.

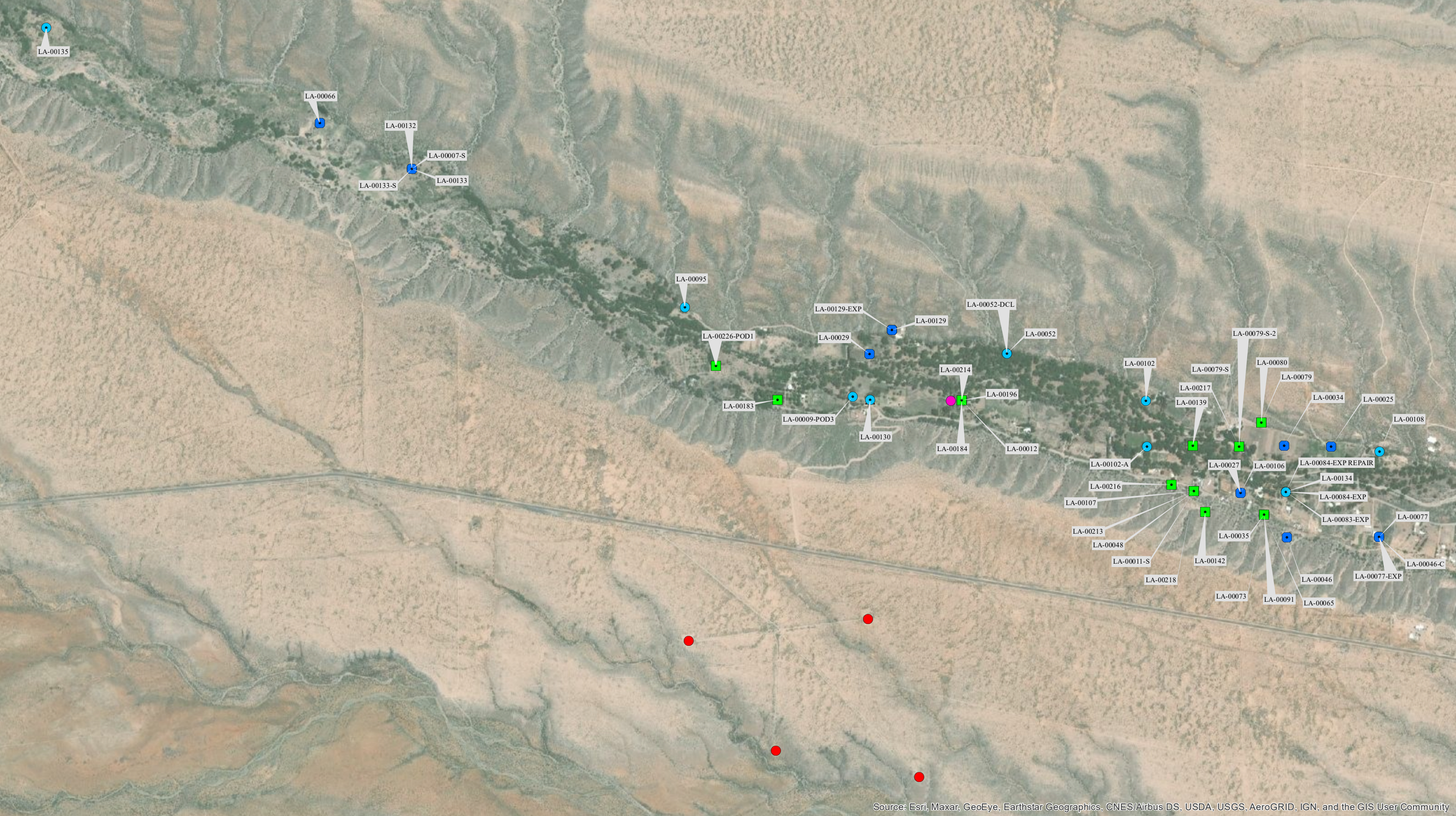
Figure 1 is a map of field locations, Table 1 is a summary of the wells measured including; OSE water right number, OSE POD number, well completion information, field measurements (Latitude and Longitude, total depth, water level), general field comments and model cell information (row and column).


Figure 1 - Overview of Field Measurement Locations - Dec 2021/Jan 2022
I- 25
152
Legend
Field Measurements Dec 2021/Jan 2022
Flowing Well
Yes
No
Production Wells
Las Animas Groundwater Basin
N
0
1.5
3 Miles
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Owner Name	OSE Water Right Number	OSE POD Number	Use	Longitude	Latitude	Elevation (m) USGS 3-D Bare Earth DEM Contour	Elevation (ft)	Date Drilling Completed	Total Depth	Screened Interval	Depth to Water Upon Completion of Drilling or reported on Declaration	Stickup	Field Measurement Date	Depth to Water (from TOC)	Depth to Water (bgs)	Water Level Elevation (ft)	Well Flowing (Yes or No)?	Comments	Model Row	Model Column
Van Den Brink			Domestic	-107.3917	32.979	1361.54	4466.99					2.58	12/1/2021	15.67	13.09	4453.90	No		R102	C90
Savage				-107.3457	32.970	1315.7	4316.60					1.06	12/2/2021	20.33	19.27	4297.33	No	May be expired permit LA-185 or LA-179	R105	C107
Ladder Ranch				-107.5150	33.009	1566.01	5137.83					2.32	12/3/2021	132.95	130.63	5007.20	No		R61	C19
Ladder Ranch				-107.5076	32.994	1580.51	5185.40					0.83	12/3/2021	170.82	169.99	5015.41	No	Possibly LA-162	R83	C25
Ladder Ranch			Livestock	-107.5768	32.993	1731.35	5680.21					0.7	12/31/2021	251.36	250.66	5429.55	No			
Ladder Ranch	LA-00001 5	LA-00002	Irrigation	-107.4727	33.013	1452.45	4765.26	12/31/1952	70			0.97	12/3/2021	6.34	5.37	4759.89	No		R56	C49
Ladder Ranch	LA-00001/LA-00001-4	LA-00003		-107.4999	33.021	1481.53	4860.66					0.24	12/3/2021	15.95	15.71	4844.95	No		R45	C32
Ladder Ranch	LA-00001/LA-00001-4	LA-00003 (replacement)		-107.4999	33.021	1481.53	4860.66	1955	42		10"6" on 3/25/1961 Murry Report	0.25	12/3/2021	15.91	15.66	4845.00	No	Used e-line, tagged bottom of well at 38.5	R45	C32
Ladder Ranch	LA-00005	LA-00005	Irrigation	-107.4657	33.010	1445.58	4742.72	1961	50			1.69	12/3/2021	3.37	1.68	4741.04	No	DTW 3.0 feet bgs on 3/4/1961	R60	C53
Vanlandingham	LA-00009	LA-00009 POD3	Irrigation	-107.3889	32.978	1358.34	4456.50					3.7	12/1/2021	13.55	9.85	4446.65	No	confirmed POD No. with meter SN	R103	C92
Vanlandingham	LA-00009	LA-00009 S	Irrigation	-107.3881	32.978	1358.34	4456.50	5/27/1973	28		8	2.39	12/1/2021	12.73	10.34	4446.16	No		R103	C93
Van Den Brink	LA-00013	LA-00013-B	Irrigation	-107.3916	32.979	1361.54	4466.99		16			-4.6	1/21/2022	6.64	11.24	4455.75	No		R102	C90
Newman	LA-00019	LA-00019 S-2	Irrigation	-107.3407	32.971	1312.65	4306.59	9/18/2002	300	273-300		1.9	11/30/2021	3.10	5.00	4311.59	Yes		R105	C108
Delbert	LA-00025	LA-00025	Irrigation	-107.3674	32.976	1334.67	4378.84	6/30/1952	85			1.56	11/30/2021	14.32	12.76	4366.08	No		R103	C102
Grandjean	LA-00027	LA-00027	Irrigation	-107.3710	32.975	1339.56	4394.88	7/18/1958	70			2.23	12/1/2021	11.61	9.38	4385.50	No		R104	C101
Moss	LA-00032	LA-00032	Irrigation & Domestic	-107.3370	32.968	1310.6	4299.87	12/7/1960	400			0	11/30/2021	9.30	9.30	4309.17	Yes	measured from ground surface to where water first started to flow from hose to get artesian head	R106	C109
Cardell		LA-00035	Domestic	-107.3688	32.976	1336.5	4384.84	1938	120			2.36	12/2/2021	22.90	20.54	4364.30	No		R103	C101
Hobbs	LA-00045	LA-00045	Irrigation	-107.3793	32.977	1351.32	4433.46	1946	26"4"			-8.08	12/2/2021	5.71	13.79	4419.67	No		R103	C99
Moya	LA-00102	LA-00102	Irrigation	-107.3757	32.979	1345.64	4414.83					1.97	12/1/2021	39.49	37.52	4377.31	No	difficult to feed steel tape	R102	C100
Dutton	LA-00108	LA-00108	Irrigation	-107.3642	32.976	1334.24	4377.43					0.9	11/30/2021	14.00	13.10	4364.33	No	Pump had kicked on for ~30-seconds at 435, let well rest 15 minutes before resuming measurements	R103	C102

Bussman		LA-00115	Domestic	-107.3968	32.979	1364.65	4477.20	11/11/1980	35		11	1.61	12/1/2021	15.68	14.07	4463.13	No		R102	C85
Johnson		LA-00146	Domestic	-107.3865	32.981	1363.84	4474.54	3/6/1997	165	34-154	65	0.75	12/1/2021	90.38	89.63	4384.91	No		R100	C95
Hayward/Lawrence		LA-00149	Domestic	-107.3914	32.978	1362.64	4470.60	2/17/1990	67	20-40	5	1.1	12/1/2021	10.48	9.38	4461.22	No		R103	C90
Edwards		LA-00154	Domestic	-107.3678	32.974	1335.51	4381.54	2/15/1991	70	50-62	14	0.71	1/21/2022	20.09	19.38	4299.77	No		R104	C101
Harthun		LA-00158	Domestic	-107.3626	32.972	1334.42	4378.02	1/15/1992	96	80-95	15	1.39	11/30/2021	4.39	3.00	4375.02	No		R105	C103
Newman		LA-00170	Domestic	-107.3404	32.972	1312.65	4306.59	7/22/1995	103	89-102	25	1.12	12/2/2021	24.09	22.97	4283.62	No		R105	C108
Ficklin		LA-00173	Domestic	-107.3857	32.980	1358.58	4457.28	2/24/1997	65	16-56	2	2.1	12/1/2021	9.42	7.32	4449.96	No		R101	C95
McDonald		LA-00177	Domestic	-107.3808	32.977	1351.49	4434.02	10/28/1997	60	20-40	12	1.75	12/1/2021	12.15	10.40	4423.62	No		R103	C98
Gott		LA-00233	Domestic	-107.3353	32.972	1310.52	4299.61	5/10/2017	80	40-80	22	2.42	12/2/2021	30.02	27.60	4272.01	No	Used e-line	R105	C109
Pitchfork Ranch		LRG-04153	Livestock	-107.5787	32.985	1733.3	5686.61	4/30/1905	285		60	1	1/22/2022	116.96	115.96	5570.65	No		Outside model boundary	
Pitchfork Ranch		LRG-04156	STK	-107.5261	32.942	1657.08	5436.61	1956	102			0.65	12/2/2022	31.73	31.08	5436.61	No	Bob Cunningham measured TD from TOC on 1/24/2022 per method utilized by SMC on 1/22/2022	R115	C13
Pitchfork Ranch		LRG-04158	Livestock	-107.5447	32.938	1685.48	5529.72	5/8/1905	114		60	2.6	1/22/2022	48.58	45.98	5483.74	No	TD measured by SMC on 1/22/2022	R118	C7
Kittel		LRG-08800	Domestic	-107.3520	32.965	1399.62	4591.93	4/5/1995	365	325-365	260	2.13	1/21/2022	239.50	237.37	4354.56	No		R107	C105
Ladder Ranch		LRG-16319		-107.4660	32.985	1524.55	5001.80					1.79	12/3/2021	286.78	284.99	4716.81	No		R95	C52
Pitchfork Ranch		LRG-4157	STK	-107.5436	32.966	1696.57	5566.17	1948	63		30	1.78	12/2/2021	38.79	37.01	5529.16	No	TD measured by SMC on 1/22/2022	R107	C7
Pitchfork Ranch		LRG-4159	STK	-107.5602	32.967	1743.37	5719.72	2002	200		70	0.7	12/2/2021	46.84	46.14	5673.58	No		R106	C32

APPENDIX B
SELECTED WELL LOGS


LA-00135
LA-00066
LA-00132
LA-00007-S
LA-00133
LA-00133-S
LA-00095
LA-00226-POD1
LA-00129-EXP
LA-00129
LA-00029
LA-00052-DCL
LA-00052
LA-00214
LA-00196
LA-00183
LA-00009-POD3
LA-00130
LA-00184
LA-00012
LA-00102
LA-00079-S-2
LA-00080
LA-00079-S
LA-00079
LA-00217
LA-00139
LA-00034
LA-00025
LA-00108
LA-00102-A
LA-00027
LA-00106
LA-00084-EXP REPAIR
LA-00134
LA-00216
LA-00084-EXP
LA-00107
LA-00083-EXP
LA-00213
LA-00035
LA-00077
LA-00048
LA-00011-S
LA-00142
LA-00046-C
LA-00218
LA-00046
LA-00077-EXP
LA-00073
LA-00091
LA-00065
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

August 5, 1975

COPY

FILE: LA-79

Mr. K. W. Lanford
P. O. Box 23
Caballo, New Mexico 87931

Dear Sir:

Enclosed are your copies of the Well Record and Proof of Completion of Well under your permit to change location of well No. LA-79, which have been accepted for filing.

These are the final filings under Permit to Change Location of Well No. LA-79.

Yours truly,

L. T. Putnam
Supervisor, District III

By:
R. E. Babcock
Engineering Technician

REB:jl
Encls: Proof of Completion
Well Record
cc: State Engineer

Form WR-23 STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well H.W. Langford

Street and Number Box 231 87931

City Caballo State New Mexico

Well was drilled under Permit No. LA-79 and is located in the SW ¼ SE ¼ NE ¼ of Section 29 Twp. 15S. Rge. 3W

(B) Drilling Contractor John A. Tipton License No. WD74

Street and Number Box-8-

City Derry 87933 State New Mexico

Drilling was commenced 12/22 19 72

Drilling was completed 11/9 19 73

Elevation at top of casing in feet above sea level _____ Total depth of well 209 ft.

State whether well is shallow or artesian Shallow Depth to water upon completion 12'

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	0	31	31	Rock & Gravel
	31	41	10	Sandy Clay
2	41	74	33	Gravel & Sand
	74	77	3	Light Clay
3	81	116	35	Sand Gravel
	116	161	43	Caving Conglomerate & Clay Average 3' thick
4	178	171	13	Red Clay
	171	200	29	Gravel
5	200	209	9	Red Clay

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
6 5/8	18		0	204	feet	pipe	126	136
							184	204

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor _____ License No. _____

Street and Number _____ City _____ State _____

Tons of Clay used _____ Tons of Roughage used _____ Type of roughage _____

Plugging method used _____ Date Plugged _____ 19 ____

Plugging approved by:

_____ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received January 26, 1973

File No. LA-79 Use Irrigation Location No. 15.3.29.243

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	31	31	stone	Rock & Gravel
31	41	10	Light Brown	Sandy Clay
41	76	35	Stone	Gravel & Sand
76	81	5	Light Brown	Flint Clay
81	116	35	stone	Sand gravel
116	161	45	Reddish-	Layers Conglomerate & Clay Layers
156	171	15	red	red clay
171	200	29	stone	Gravel
200	209	9	red	Clay
		209		

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

John A. Lipton
Well Driller

March 14, 1974

FILE: LA-80

Mr. K. W. Lanford
P. O. Box 23
Caballo, New Mexico 87931

Dear Sir:

Enclosed is your copy of the Well Record for your domestic No. LA-80, which has been accepted for filing.

This is the final filing under Domestic Well Permit No. LA-80.

Yours truly,

L. T. Putnam
Supervisor, District III

LTP:jl
Encl: Well Record
cc: State Engineer

Form WR-23 STATE ENGINEER OFFICE

TRN 174734

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well K. W. Lanford - 87931
Street and Number Box 23
City Caballo ~~LA-80~~ State New Mexico
Well was drilled under Permit No. L.A-80 and is located in the
¼ ¼ ¼ of Section Twp. Rge.
(B) Drilling Contractor John A. Tipton License No. WD74
Street and Number Box-8
City Derry 87933 State New Mexico
Drilling was commenced 12/22 19 72
Drilling was completed 1/9 19 73

Elevation at top of casing in feet above sea level Total depth of well 204'
State whether well is shallow or artesian Shallow Depth to water upon completion 8'

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	41'	76'	35'	Sand & Gravel
2	81	116	35'	Sand & Gravel
3	171	200	29'	Gravel -
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
6"	19	none	0	204	204	pipe -	183	204
6"	19	none	0	204	204	pipe -		
			0	183	Blank	Pipe -		

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.
Street and Number City State
Tons of Clay used Tons of Roughage used Type of roughage
Plugging method used Date Plugged 19
Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received January 8, 1974

File No. LA-80 Use Domestic Location No. 15.5.29.24

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	31	31	Gray	Rock & Gravel fill-
31	40	9	Sandy	Sandy Clay
40	41	1	Sandy	Sandy Clay -
41	76	35'	Gray	Gravel & Sand -
76	81	5'	Light red	Clay
81	116	35'	Gray	Sand & Gravel
116	161	45'	red & Gray	Layers of Conglomerate & Stone
161	171	10'	red Clay	Clay -
171	200	29'	Gray	Gravel -
200	204	4'	red Clay	red Clay -

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

John A. Tipton
Well Driller

1974 MAR 15 PM 12 14
STATE ENGINEER OFFICE
SANTA FE, N.M.

STATE OF NEW MEXICO

STATE ENGINEER OFFICE

DEMING

S. E. REYNOLDS
STATE ENGINEER

November 1, 1978

ADDRESS CORRESPONDENCE TO:
P. O. BOX 844
DEMING, N. M. 88030

FILE: LA-91

Mr. James A. Robertson
886 West Brownlee
Las Cruces, New Mexico 88001

Dear Sir:

Enclosed is your copy of the well record for your domestic and stock well No. LA-91, which has been accepted for filing.

This is the final filing under Domestic and Stock Well Permit No. LA-91.

Yours truly,

L. T. Putnam
Supervisor, District III

LTP:sfs
Encl: Well Record
cc: State Engineer

Revised June 1972

TRN 174816

STATE ENGINEER OFFICE
WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well James A Robertson Owner's Well No. _____
Street or Post Office Address 886 West Brownlee
City and State Las Cruces, N.M. 88001

Well was drilled under Permit No. LA 91 and is located in the:

a. _____ ¼ _____ ¼ NE ¼ SE ¼ of Section 29 Township 15S Range 5W N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

'78 NOV 3 AM 11 43

c. Lot No. _____ of Block No. _____ of the _____
Subdivision, recorded in _____ County.

STATE ENGINEER OFFICE
SANTA FE, N.M. 87503

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

(B) Drilling Contractor Johnson Drilling Co. License No. WD 23

Address Box 89, T or C, N.M. 87901

Drilling Began Oct.6, 1978 Completed Oct.12, 1978 Type tools Cable Size of hole 6 5/8 in.

Elevation of land surface or _____ at well is _____ ft. Total depth of well 100 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 15 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
42	48	6	Gravel and sand	10
95	100	5	Sand and gravel	30

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6 5/8	13	None	+1'	100'	101'	None	40	100

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

STATE ENGINEER FIELD OFFICE
Deming, N. M.
FILED
OCT 24 1978

Section 5. PLUGGING RECORD

Plugging Contractor _____
Address _____
Plugging Method _____
Date Well Plugged _____
Plugging approved by:
_____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received October 24, 1978

Quad _____ FWL _____ FSL _____

File No. LA-91 Use Domestic & Stock Location No. 15.5.29.42

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	26	26	Pink gravel and boulders (seep at 15')
26	42	16	Pink clay
42	48	6	Gravel and sand
48	76	28	Pink clay
76	86	10	White sand and gravel
86	95	9	Pink clay
95	100	5	Red sand and gravel

Section 7: REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

William J. Brown
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, ex[illegible] Section 5, shall be answered as completely [illegible] accurately as possible when any well is drilled, repaired or deepened. When this [illegible]n is used as a plugging record, only Section 1(a, [illegible]nd Section 5 need be completed.

Phone:(505) 524-6161

STATE OF NEW MEXICO
STATE ENGINEER OFFICE
LAS CRUCES

S. E. REYNOLDS
STATE ENGINEER

530 SO. MELENDRES ST.
LAS CRUCES, NEW MEXICO 88005

May 22, 1986

86 MAY 27 AM 10:18
STATE ENGINEER OFFICE
SANTA FE, NEW MEXICO

FILE: LA-139

Mr. A. D. Wright
c/o J. Rutledge
P. O. Box 64
Caballo, NM 87931

Dear Mr. Wright:

Enclosed is your copy of the Well Record for your Domestic Well No. LA-139, which has been accepted for filing subject to the conditions as noted on your Permit.

Your attention is called to the reverse side of your Permit to all General Conditions, but special attention is directed to Specific Condition No. 4, which states:

4. Use shall be limited to household, non-commercial trees, lawn and garden not to exceed one acre and/or stock use.

This is the final filing under Domestic Well Permit No. LA-139.

Sincerely,

Ted R. Reyes

T. R. Reyes
Water Resource Specialist
District III

TRR:DN
Encl: Well Record
pc: State Engineer

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

TRN 174907

Section 1. GENERAL INFORMATION

(A) Owner of well A D Wright Owner's Well No. LA-139

Street or Post Office Address Po Box 64

City and State Caballo NM 87931

Well was drilled under Permit No. 14150 LC and is located in the:

a. SE ¼ SW ¼ NE ¼ — ¼ of Section 29 Township 15S Range 5 W N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

c. Lot No. _____ of Block No. _____ of the _____ Subdivision, recorded in _____ County.

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

STATE ENGINEER OFFICE SANTA FE, NEW MEXICO 86 MAY 27 AM 8:11

(B) Drilling Contractor Billy Joe Clark License No. WD 827

Address Box 338 Caballo NM 87931

Drilling Began 5 MAY 86 Completed 12 MAY Type tools Cable Size of hole 6" in.

Elevation of land surface or Approx at well is 4200 ft. Total depth of well 62 ft.

Completed well is ☑ shallow ☐ artesian. Depth to water upon completion of well 14 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
15	22	7	Gravel and Boulders	25
22	55	33	Conglomerate	
55	62	7	Sand And Gravel	25

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6 5/8 OD	.188 WALL				62	HOME MADE	14	20
	welded						57	62

STATE ENGINEER OFFICE 1986 MAY 22 PM 1 09

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
			NA		

Section 5. PLUGGING RECORD

Plugging Contractor _____

Address _____

Plugging Method _____ Date Well Plugged _____

Plugging approved by: _____ State Engineer Representative _____

	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received May 22, 1986

Quad _____ FWL _____ FSL _____

File No. LA-139 Use Domestic Location No. 15.5W.29.234

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	14	14	Boulders and Soil
14	20	6	Boulders and Gravel
20	57	37	Conglomerate
57	62	5	Sand and Gravel

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

BILLY JOE CLARK

Driller

Billy Joe Clark

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

Phone: (505) 524-6161

88 SEP 16 P12 : 03

STATE OF NEW MEXICO

STATE ENGINEER OFFICE

LAS CRUCES

SANTA FE, NEW MEXICO

S. E. REYNOLDS
STATE ENGINEER

530 SO. MELENDRES ST.
LAS CRUCES, NEW MEXICO 88005

September 14, 1988

FILE: LA-142

Wendell Price
Star Rt. Box 64
Caballo, NM 87931

Dear Mr. Price:

Enclosed is your copy of Well Record for Domestic Well Permit No. LA-142, which has been accepted for filing subject to the conditions as noted on your permit.

Your attention is called to the reverse side of your permit to all General Conditions, but special attention is directed to Specific Condition No. 4, which states:

4. Use shall be limited to one household, non-commercial trees, lawn and garden not to exceed one acre and/or stock use.

This is the final filing under Domestic Well Permit No. LA-142.

Sincerely,

J. B. Nixon
Engineer, District 3

JBN:mm
Encl: Well Record
cc: State Engineer

Revised June 1972

TRN 174982

STATE ENGINEER OFFICE
WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well ~~XXXXXXXXX~~ Wendell Price Owner's Well No. _____
Street or Post Office Address Star Rt. Box 64
City and State Caballo, N.M. 87931

Well was drilled under Permit No. L. A. 142 and is located in the:

a. E½ ~~XX~~ NW ¼ SE ¼ _____ ¼ of Section 29 Township 15 S. Range 5W N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

c. Lot No. _____ of Block No. _____ of the _____
Subdivision, recorded in _____ County.

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

(B) Drilling Contractor ~~Johnson Drilling Company~~ License No. WD 23

Address PO Box 89 T. or C., N.M. 87901

Drilling Began 8/23/88 Completed 9/9/88 Type tools cable tool Size of hole 6 5/8 in.

Elevation of land surface or _____ at well is _____ ft. Total depth of well 102 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 8 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
61	70	9	white sand and gravel	60

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6 5/8	13	none	+18"	98	101	none	60	100 ~~XXX~~

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

Section 5. PLUGGING RECORD

Plugging Contractor _____
Address _____
Plugging Method _____
Date Well Plugged _____
Plugging approved by:

_____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received September 14, 1988

Quad _____ FWL _____ FSL _____

File No. LA-142 Use Domestic Location No. 15S.5W.29.410

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	4	4	light red top soil
4	16	12	white gravel and boulders
16	20	4	boulders (white)
20	21	1	clay and gravel
21	29	8	light red loose gravel and boulders
29	33	4	light red clay and gravel
33	35	2	white loose gravel
35	61	26	light red clay and gravel
61	70	9	white sand and gravel
70	76	6	light red clay and gravel
76	82	6	white sand and gravel
82	88	6	red clay
88	102	14	light red clay with strata of sand

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Bill Johnson
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this f used as a plugging record, only Section 1(a. ection 5 need be completed.

Thomas C. Turney
State Engineer

Las Cruces Office
133 WYATT DRIVE, SUITE 3
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 161138
File Nbr: LA 00183
Well File Nbr: LA 00183

Apr. 09, 1999

GLEN THAMERT
1712 VALENCIA DR. NE
ALBUQUERQUE, NM 87110-6521

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Calvin Chavez
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

Revised June 1972

TRN 161138

STATE ENGINEER OFFICE
WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Glen Thamert Owner's Well No. _____

Street or Post Office Address 1712 Valencia Dr. N. E.

City and State Albuquerque, NM 87110-6521

Well was drilled under Permit No. LA-183 and is located in the:

a. NW ¼ SW ¼ NE ¼ ____ ¼ of Section 30 Township 15 S Range 5 W N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

c. Lot No. _____ of Block No. _____ of the _____
Subdivision, recorded in _____ County.

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

(B) Drilling Contractor Mauldin Drilling License No. WD-578

Address P.O. Box 131, Williamsburg, NM 87942

Drilling Began 02/25/99 Completed 02/27/99 Type tools Rotary Size of hole 6 in.

Elevation of land surface or _____ at well is _____ ft. Total depth of well 95 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 15 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
76	88	12	Gravel	15

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6			+18"	95	96.5	None	75	95

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

RECEIVED
99 APR -8 AM 11:18
STATE ENGINEER OFFICE
LAS CRUCES, NEW MEXICO

Section 5. PLUGGING RECORD

Plugging Contractor _____

Address _____

Plugging Method _____

Date Well Plugged _____

Plugging approved by:

_____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received April 8, 1999

Quad _____ FWL _____ FSL _____

File No. LA-183 Use ~~Domestic~~ Location No. ~~15S.5W.30.231~~

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	6	6	Top soil
6	39	33	Gravel
39	42	3	Clay
42	53	11	Gravel with clay
53	76	23	Clay with some gravel
76	88	12	Gravel
88	95	7	Clay

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this . is used as a plugging record, only Section 1(. d Section 5 need be completed.

Thomas C. Turney
State Engineer

Las Cruces Office
133 WYATT DRIVE, SUITE 3
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 161138
File Nbr: LA 00183
Well File Nbr: LA 00183

Apr. 09, 1999

GLEN THAMERT
1712 VALENCIA DR. NE
ALBUQUERQUE, NM 87110-6521

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Calvin Chavez
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

Revised June 1972

TRN 161138

STATE ENGINEER OFFICE
WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Glen Thamert Owner's Well No. _____

Street or Post Office Address 1712 Valencia Dr. N. E.

City and State Albuquerque, NM 87110-6521

Well was drilled under Permit No. LA-183 and is located in the:

a. NW ¼ SW ¼ NE ¼ ____ ¼ of Section 30 Township 15 S Range 5 W N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

c. Lot No. _____ of Block No. _____ of the _____
Subdivision, recorded in _____ County.

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

(B) Drilling Contractor Mauldin Drilling License No. WD-578

Address P.O. Box 131, Williamsburg, NM 87942

Drilling Began 02/25/99 Completed 02/27/99 Type tools Rotary Size of hole 6 in.

Elevation of land surface or _____ at well is _____ ft. Total depth of well 95 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 15 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
76	88	12	Gravel	15

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6			+18"	95	96.5	None	75	95

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

RECEIVED
99 APR -8 AM 11:18
STATE ENGINEER OFFICE
LAS CRUCES, NEW MEXICO

Section 5. PLUGGING RECORD

Plugging Contractor _____

Address _____

Plugging Method _____

Date Well Plugged _____

Plugging approved by:

_____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received April 8, 1999

Quad _____ FWL _____ FSL _____

File No. LA-183 Use ~~Domestic~~ Location No. ~~15S.5W.30.231~~

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	6	6	Top soil
6	39	33	Gravel
39	42	3	Clay
42	53	11	Gravel with clay
53	76	23	Clay with some gravel
76	88	12	Gravel
88	95	7	Clay

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this . is used as a plugging record, only Section 1(. d Section 5 need be completed.

Thomas C. Turney
State Engineer

Las Cruces Office
133 WYATT DRIVE, SUITE 3
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 163498
File Nbr: LA 00184
Well File Nbr: LA 00184

Jan. 27, 2000

HOYT & KAREN MEYER
HCR 31 BOX 76
CABALLO, NM 87931

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Erek Fuchs
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

TRN 163498

Section 1. GENERAL INFORMATION

(A) Owner of well Hoyt & Karen Meyer Owner's Well No. 011299

Street or Post Office Address HCR 31 Box 76

City and State Caballo N.M. 87931

Well was drilled under Permit No. LA 00184 and is located in the:

a. NW ¼ SW ¼ NW ¼ ¼ of Section 29 Township 15S Range 05W N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

c. Lot No. _____ of Block No. _____ of the _____ Subdivision, recorded in Sierra County.

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

(B) Drilling Contractor JOHNSON DRILLING COMPANY License No. WD-23

Address P.O.BOX 89 T.OR C. N.M. 87901

Drilling Began 11/30/99 Completed 12/1/99 Type tools Rotary Size of hole 6.5 in.

Elevation of land surface or _____ at well is _____ ft. Total depth of well 70 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 36 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
40	70	30	sand & gravel	20

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
4.5	3	none	+1	70	71	cap	30	70
pvc								

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

RECEIVED
99 DEC -8 PM 2:01
STATE ENGINEER OFFICE
LAS CRUCES, NEW MEXICO

Section 5. PLUGGING RECORD

Plugging Contractor _____

Address _____

Plugging Method _____

Date Well Plugged _____

Plugging approved by:

_____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received December 3, 1999

Quad _____ FWL _____ FSL _____

File No. LA-00184 Use Domestic Location No. 15S.5W.29.131

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	25	25	boulders & gravel
25	38	13	Clay with streaks of gravel
38	40	2	conglomorante
40	70	10	clay with streaks of gravel & hard cong. (red)

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

John C. Johnson
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

John R. D Antonio, Jr., P.E.
State Engineer

Las Cruces Office
1680 HICKORY LOOP, SUITE J
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 330705
File Nbr: LA 00213
Well File Nbr: LA 00213

Dec. 22, 2005

WEBB R. JOHNSON
HCR 31 BOX 66
CABALLO, NM 87931

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Debbie Heredia
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

LA 213
Rev 11-80 TRN 339705

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Webb Johnson Owner's Well No. 2
Street or Post Office Address HCR 31, Box 66
City and State Caballo NM

Well was drilled under Permit No. LA-213 #412929 and is located in the:

a. ____ ¼ NE ¼ NW ¼ SE ¼ of Section 29 Township 15S Range 05W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Apache Well Service License No. 1585

Address Engle Star Route, HC 32, Box 82 T or C NM 87901

Drilling Began 12-2-05 Completed 12-17-05 Type tools Cable Size of hole 6 in.

Elevation of land surface or 4200 at well is 4200 ft. Total depth of well 93½ ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 14 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
14	49	35	Lt Brown Sand w/ Boulders	156PM
76	93½	17½	Lt Brown Sand w/ Boulders	150PM

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6"	288		1½	93½	95'	Steel	65	93

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
					Owner to furnish

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:
____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

RECEIVED
JAN 3 2006
WATER RIGHTS DIVISION

FOR USE OF STATE ENGINEER ONLY

Date Received
January 3, 2006
Quad ____ FWL ____ FSL ____
File No. ____ Use ____ Location No. LA 213 15S.05W.29

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	8		Lt Brown Overburden
8	15		Black Sand & Small Gravel
15	31		Lt Brown Sand & Gravel
31	38		Lt Brown Fine Sand
38	49		Lt Brown Sand & Large Gravel
48	76		Lt Brown Clay
76	80		Black Fine Sand
80	93½		Lt Brown Sand & Small Gravel

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Ed Schum
Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

John R. D Antonio, Jr., P.E.
State Engineer

Las Cruces Office
1680 HICKORY LOOP, SUITE J
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 302554
File Nbr: LA 00214
Well File Nbr: LA 00214

Dec. 07, 2004

GAYLE SHEPPARD
P.O. BOX 74
CABALLO, NM 87931

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Susan Benoit

Susan Benoit
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

File Number: LA-214 LA-00214 TRN302554

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Gayle Shepperd Work Phone:
Contact: Home Phone: 743-2847
Address: P.O. Box 74
City: Caballo State: NM Zip: 87931

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 SW 1/4 NW 1/4 Section: 29 Township: 15 S Range: 5W N.M.P.M. in Sierra County.

B. X = _____ feet, Y = _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant. U.S.G.S. Quad Map _____

C. Latitude: ____d ____m ____s Longitude: ____d ____m ____s

D. East _____ (m), North _____ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the _____ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract _____ of the _____ Subdivision recorded in _____ County.

G. Other: _____

H. Give State Engineer File Number if existing well: _____

I. On land owned by (required): Gayle Shepperd & Thema Wynne

3. DRILLING CONTRACTOR

License Number: WD-578
Name: Mauldin Drilling Work Phone: 894-3192
Agent: David Mauldin Home Phone: 894-3192
Mailing Address: P.O. Box 131
City: Williamsburg State: NM Zip: 87942

4. DRILLING RECORD

Drilling began: 05/02/04; Completed: 05/03/04; Type tools: rotary;
Size of hole: 5 in.; Total depth of well: 79 ft.;
Completed well is: shallow (shallow, artesian);
Depth to water upon completion of well: 9 ft.

DECEMBER 07, 2004 DOMESTIC 15S.05W.29.131
TRN302554

File Number: _____ Trn Number: _____

Form: wr-20 page 1 of 4

File Number: LA-214

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
9	79	70	SAnd, gravel with boulders	20

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
5			+2	79	81	none	59	79

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement

8. PLUGGING RECORD

Plugging Contractor: _____

Address: _____

Plugging Method: _____

Date Well Plugged: _____

Plugging approved by: _____

State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

File Number: _____ Trn Number: _____

Form: wr-20

File Number: LA-214

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9.LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	6	6	Top soil with gravel
6	17	11	Sand and gravel
17	30	13	Sand and gravel with boulders
30	79	49	Sand and gravel

File Number: LA-214

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

Sept. 16, 2004
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad ____; FWL ____; FSL ____; Use _____; Location No. _____

File Number: _____ Trn Number: _____

Form: wr-20 page 4 of 4

John R. D Antonio, Jr., P.E.
State Engineer

Las Cruces Office
1680 HICKORY LOOP, SUITE J
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 317748
File Nbr: LA 00216
Well File Nbr: LA 00216

Sep. 08, 2005

JOHN LANFORD
15 MISSION PARK LOOP
LOS LUNAS, NM 87031

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Debbie Heredia
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

LA 216

File Number: LA-216

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: John Lanford — Work Phone: 894-6661
Contact: — Home Phone: 480-9701
Address: 15 Mission Park Loop
City: Los Lunas — State: NM Zip: 87031

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. N 1/2 NW 1/4 SE 1/4 Section: 29 Township: 15 S Range: 5 W N.M.P.M.
in Sierra County.

B. X = _____ feet, Y = _____ feet, N.M. Coordinate System
_____ Zone in the _____ Grant.
U.S.G.S. Quad Map _____

C. Latitude: _____ d _____ m _____ s Longitude: _____ d _____ m _____ s

D. East _____ (m), North _____ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the _____ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract _____ of the
_____ Subdivision recorded in _____ County.

G. Other: _____

H. Give State Engineer File Number if existing well: _____

I. On land owned by (required): Steven Lanford

STATE ENGINEER OFFICE
LAS CRUCES, NEW MEXICO
05 AUG 31 PM 2:44

3. DRILLING CONTRACTOR

License Number: WD-578
Name: Mauldin Drilling — Work Phone: 894-3192
Agent: David Mauldin — Home Phone: 894-3192
Mailing Address: P.O. Box 131
City: Williamsburg — State: NM Zip: 87942

4. DRILLING RECORD

Drilling began: 12/06/04 Completed: 12/07/04 Type tools: rotary ;
Size of hole: 6 in.; Total depth of well: 102 ft.;
Completed well is: shallow (shallow, artesian);
Depth to water upon completion of well: 10 ft.

File Number: _____ Trn Number: _____
Form: wr-20 page 1 of 4

15S.05W.29
TRN 317748

File Number: LA-216

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
51	60	9	Sand and gravel	
65	77	12	Sand and gravel	60 total

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
6			+2	102	104	none	82	102

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement

8. PLUGGING RECORD

Plugging Contractor: _____
Address: _____
Plugging Method: _____
Date Well Plugged: _____

Plugging approved by: _____
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

File Number: _____ Trn Number: _____

File Number: LA-216

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	4	4	Top soil
4	24	20	Sand and gravel
24	28	4	Clay
28	33	5	Sand and gravel
33	51	18	Clay
51	60	9	Sand and gravel
60	65	5	Clay
65	77	12	Sand and gravel
77	102	25	Clay with layers of sand and gravel

15S.05W.29
TRN 317748

File Number: LA-216

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

August 25, 2005
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad ____; FWL ____; FSL ____; Use _____; Location No. _____

John R. D Antonio, Jr., P.E.
State Engineer

Las Cruces Office
1680 HICKORY LOOP, SUITE J
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 323104
File Nbr: LA 00217
Well File Nbr: LA 00217

Oct. 12, 2005

GERALD SMITH
HC 31, BOX 58
CABALLO, NM 87931

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Debbie Heredia
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

File Number: LA-217

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Gerald Smith
Contact:
Address: HC-31-58
City: Caballo
Work Phone:
Home Phone: 505-743-0149
State: NM Zip: 87931

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SW 1/4 SE 1/4 NE 1/4 Section: 29 Township: 15 S Range: 4 W N.M.P.M. in Sierra County.

B. X = _____ feet, Y = _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.
U.S.G.S. Quad Map _____

C. Latitude: _____d ____m _____s Longitude: _____d ____m _____s

D. East _____ (m), North _____ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the _____ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract _____ of the _____ Subdivision recorded in _____ County.

G. Other: _____

H. Give State Engineer File Number if existing well: _____

I. On land owned by (required): Gerald Smith

3. DRILLING CONTRACTOR

License Number: WD-578
Name: Mauldin Drilling
Agent: David Mauldin
Mailing Address: P.O. Box 131
City: Williamsburg
Work Phone: 505-894-3192
Home Phone: same
State: NM Zip: 87942

4. DRILLING RECORD

Drilling began: 02/10/05 Completed: 02/10/05 Type tools: rotary;
Size of hole: 5 in.; Total depth of well: 85 ft.;
Completed well is: shallow (shallow, artesian);
Depth to water upon completion of well: 9 ft.

05 SEP 29 AM 9:18
STATE ENGINEER OFFICE
LAS CRUCES, NEW MEXICO

File Number: _____
Form: wr-20

Trn Number: _____

15S.04W.29
TRN 323104

File Number: LA-217

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
26	35	9	Sand and gravel	
48	68	20	Sand and gravel	
69	71	2	Sand and gravel	35 Total
78	85	7	Sand and gravel	

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
5			+18"	85	86.5	none	55	85

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement

8. PLUGGING RECORD

Plugging Contractor: _____
Address: _____
Plugging Method: _____
Date Well Plugged: _____

Plugging approved by: _____
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

File Number: _____ Trn Number: _____
Form: wr-20

File Number: LA-217

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	3	3	Top soil
3	18	15	Sand and gravel
18	26	8	Clay
26	35	9	Sand and gravel
35	48	13	Clay
48	68	20	Sand and gravel
68	69	1	Clay
69	71	2	Sand and gravel
71	78	7	Clay
78	85	7	Sand and gravel

File Number: _____ Trn Number: _____

15S.04W.29
TRN 323104

File Number: LA-217

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

Sept. 19, 2005
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad ____; FWL ____; FSL ____; Use _____; Location No. _____

File Number: _____ Trn Number: _____

Form: wr-20 page 4 of 4

John R. D Antonio, Jr., P.E.
State Engineer

Las Cruces Office
1680 HICKORY LOOP, SUITE J
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 343712
File Nbr: LA 00218
Well File Nbr: LA 00218

Aug. 25, 2006

RAYMOND T. HIGGINS
HCR 31 BOX 65
CABALLO, NM 87931

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Linda Filosa
(505)524-6161

Enclosure
cc: Santa Fe Office

wellrrcv

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well R.T. Higgins Owner's Well No. 1
Street or Post Office Address H C R 31 Box 65A
City and State Caballo, New Mexico 87931

Well was drilled under Permit No. LA-218 TRN343712 and is located in the:

a. ____ ¼ NE ¼ NW ¼ SE ¼ of Section 29 Township 15 S Range 5W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Apache Well Service License No. 1585

Address Engle Rt. 32 Box 82 Truth or Consequences, New Mexico

Drilling Began 06-26-06 Completed 07-14-06 Type tools Cable/Rotory Size of hole 6 in.

Elevation of land surface or 4000' at well is 4000' ft. Total depth of well 100 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 20 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
20	28	8	Lt. Brown Sand	5
29	39	10	Lt. Brown Sand & Gravel	10
39	74	35	Lt. Brown Sand & Gravel	10
74	88	14	Reddish Clay W/ Sand	0
88	100	12	Black Coarse Sand	20

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
6	188	NO	1 1/2"	98 1/2	100	Steel	68	100

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
0	20				Gravel Pack
					Higgins to Cement

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:
____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

2006 JUL 28 PM 4:01

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ RECEIVED

LA-218
TRN-365483

File No. ____ Use ____ Location No. ____

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	9	9	Lt. Brown Overburden
9	28	18	Lt. Brown Fine Sand
29	39	10	Lt. Brown Coarse Sand & Gravel
39	74	35	Lt. Brown Coarse Gravel
74	88	14	Lt. Brown Clay & Sand
88	100	12	Black Coarse Sand & Gravel

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Ed Johnson

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except [redacted]ion 5, shall be answered as completely and [redacted]urately as possible when any well is drilled, repaired or deepened. When this form [redacted]sed as a plugging record, only Section 1(a) and [redacted]ection 5 need be completed.

John R. D Antonio, Jr., P.E.
State Engineer

Las Cruces Office
1680 HICKORY LOOP, SUITE J
LAS CRUCES, NM 88005

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 427095
File Nbr: LA 00226
Well File Nbr: LA 00226 POD1

Jun. 08, 2010

JAMES H JACOBS
P O BOX 1522
ELEPHANT BUTTE, NM 87935

Greetings:

Enclosed is your copy of the well record for the above numbered permit, which has been accepted for filing.

Sincerely,

Linda Filosa
(575)524-6161

Enclosure

wellrrcv

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

RECEIVED
2010 JUN -8 AM 11:15
STATE ENGINEER OFFICE
LAS CRUCES, NEW MEXICO

1. GENERAL AND WELL LOCATION

POD NUMBER (WELL NUMBER)	OSE FILE NUMBER(S)
LA-226	
WELL OWNER NAME(S)	**PHONE (OPTIONAL)**
James H. Jacobs	575-740-0566
WELL OWNER MAILING ADDRESS	**CITY** / **STATE** / **ZIP**
PO Box 1522	Elephant Butte / NM / 87935

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	32	58	46.10	N
	LONGITUDE	107	23	43.30	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND
* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS

2. OPTIONAL

(2.5 ACRE)	(10 ACRE)	(40 ACRE)	(160 ACRE)	SECTION	TOWNSHIP	RANGE
¼	¼	¼	¼		☐ NORTH ☑ SOUTH	☐ EAST ☑ WEST

SUBDIVISION NAME	LOT NUMBER	BLOCK NUMBER	UNIT/TRACT

HYDROGRAPHIC SURVEY	MAP NUMBER	TRACT NUMBER

3. DRILLING INFORMATION

LICENSE NUMBER	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
WD-578	David Mauldin	Mauldin Drilling LLC

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
06/23/2009	06/25/2009	108	108	35

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☑ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT): 35

DRILLING FLUID: ☐ AIR ☑ MUD ☐ ADDITIVES – SPECIFY:

DRILLING METHOD: ☑ ROTARY ☐ HAMMER ☐ CABLE TOOL ☐ OTHER – SPECIFY:

DEPTH (FT) FROM	DEPTH (FT) TO	BORE HOLE DIA. (IN)	CASING MATERIAL	CONNECTION TYPE (CASING)	INSIDE DIA. CASING (IN)	CASING WALL THICKNESS (IN)	SLOT SIZE (IN)
0	108	8.5	PVC	eagle lock	5	sch 40	.032

4. WATER BEARING STRATA

DEPTH (FT) FROM	DEPTH (FT) TO	THICKNESS (FT)	FORMATION DESCRIPTION OF PRINCIPAL WATER-BEARING STRATA (INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES)	YIELD (GPM)
35	108	73	Sand and gravel	50

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA	TOTAL ESTIMATED WELL YIELD (GPM)
air lift	50

FOR OSE INTERNAL USE — WELL RECORD & LOG (Version 6/9/08)

FILE NUMBER	POD NUMBER	TRN NUMBER
LOCATION		PAGE 1 OF 2

TRN-427095

File No. LA-226
Permit No. LA-226 POD1

5. SEAL AND PUMP

TYPE OF PUMP: ☐ SUBMERSIBLE ☐ JET ☑ NO PUMP – WELL NOT EQUIPPED ☐ TURBINE ☐ CYLINDER ☐ OTHER – SPECIFY:

ANNULAR SEAL AND GRAVEL PACK	DEPTH (FT) FROM	DEPTH (FT) TO	BORE HOLE DIA. (IN)	MATERIAL TYPE AND SIZE	AMOUNT (CUBIC FT)	METHOD OF PLACEMENT
	0	20	8.5	bentonite chips	8	
	20	108	8.5	pea gravel		

6. GEOLOGIC LOG OF WELL

DEPTH (FT) FROM	DEPTH (FT) TO	THICKNESS (FT)	COLOR AND TYPE OF MATERIAL ENCOUNTERED (INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES)	WATER BEARING?
0	3	3	Silt	☐ YES ☑ NO
3	35	32	Sand and gravel	☐ YES ☑ NO
35	108	73	Sand and gravel	☑ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO
				☐ YES ☐ NO

ATTACH ADDITIONAL PAGES AS NEEDED TO FULLY DESCRIBE THE GEOLOGIC LOG OF THE WELL

7. TEST & ADDITIONAL INFO

WELL TEST — METHOD: ☐ BAILER ☐ PUMP ☑ AIR LIFT ☐ OTHER – SPECIFY:

TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

ADDITIONAL STATEMENTS OR EXPLANATIONS:

8. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 20 DAYS AFTER COMPLETION OF WELL DRILLING:

SIGNATURE OF DRILLER — June 8, 2010 — DATE

FOR OSE INTERNAL USE — WELL RECORD & LOG (Version 6/9/08)

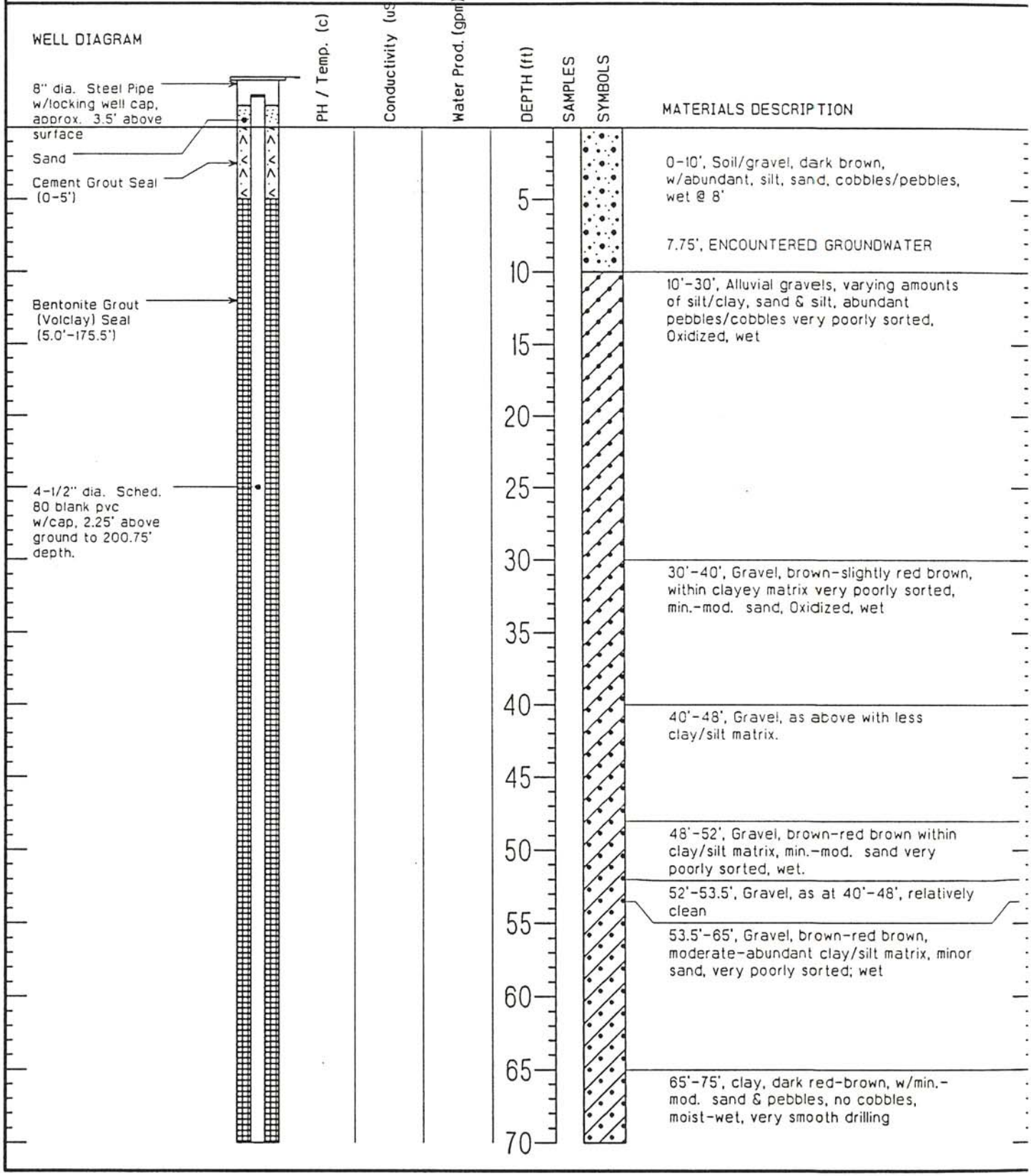
FILE NUMBER	POD NUMBER	TRN NUMBER
LOCATION		PAGE 2 OF 2

TRN-427095

File No. LA-226
Permit No. LA-226 POD1

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

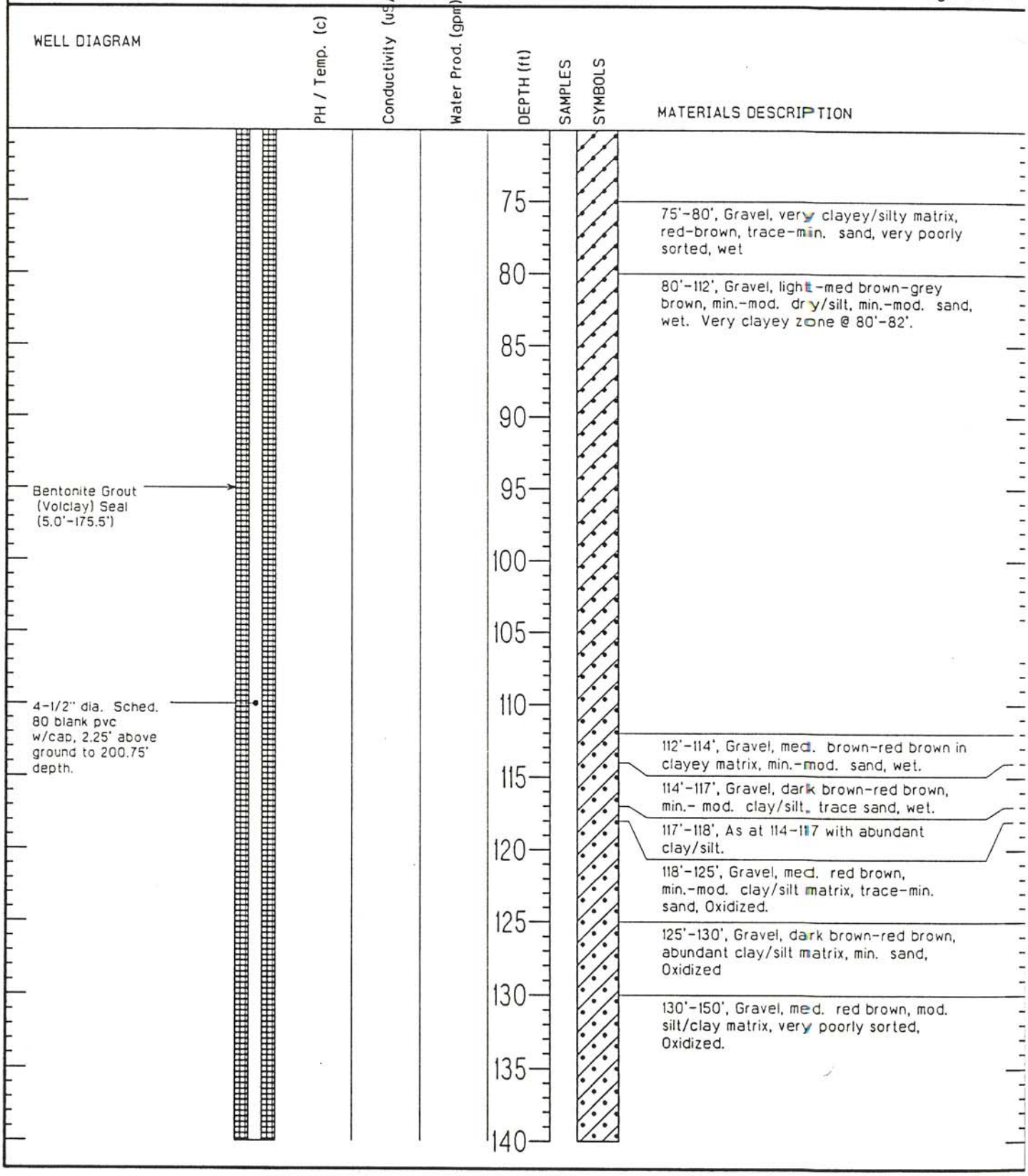
LOG OF MONITORING WELL MW-9



PROJECT Copper Flat - Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N713191.10, E603249.22 N.M. S.P.C.	DATE DRILLED 09/20/94 - 09/26/94
JOB NUMBER 68607 (ref: 68607M9)	SURFACE ELEVATION 4440.14
GEOLOGIST C.W.	TOTAL DEPTH OF HOLE 252.50 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 71.05 Feet

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

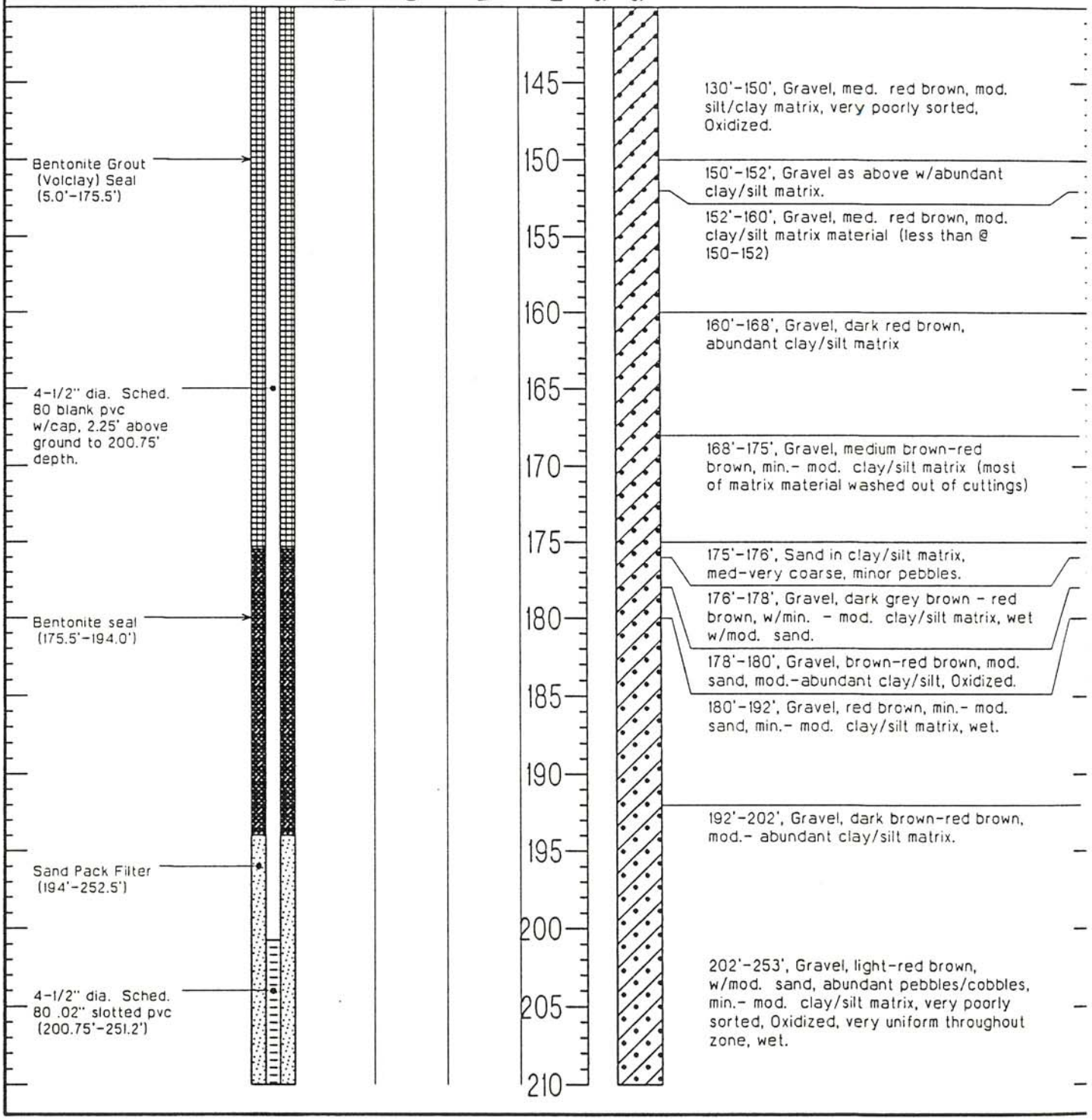
LOG OF MONITORING WELL MW-9



PROJECT Copper Flat – Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N713191.10, E603249.22 N.M. S.P.C.	DATE DRILLED 09/20/94 - 09/26/94
JOB NUMBER 68607 (ref: 68607M9)	SURFACE ELEVATION 4440.14
GEOLOGIST C.W.	TOTAL DEPTH OF HOLE 252.50 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 71.05 Feet

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

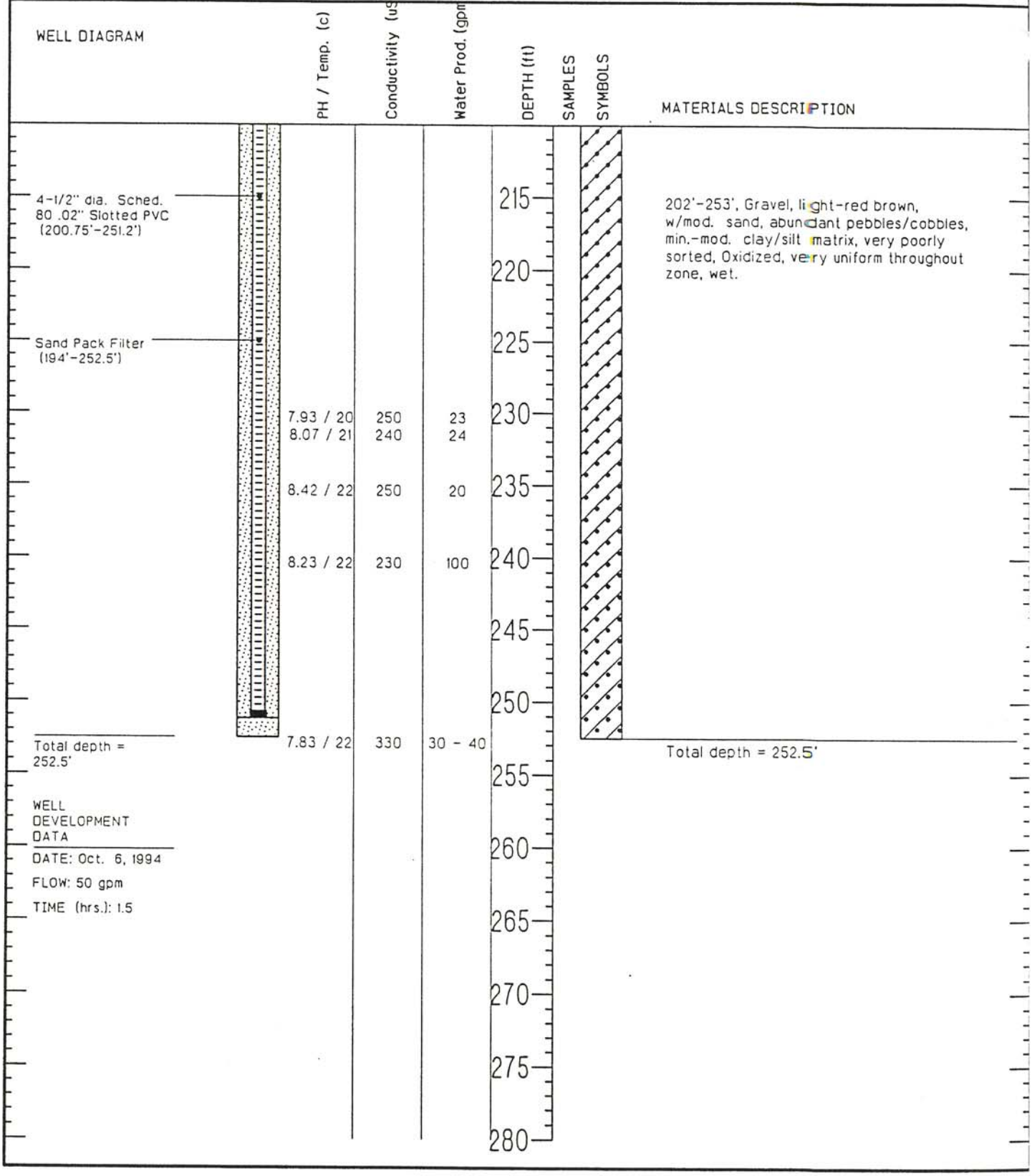
LOG OF MONITORING WELL MW-9



PROJECT Copper Flat - Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N713191.10, E603249.22 N.M. S.P.C.	DATE DRILLED 09/20/94 - 09/26/94
JOB NUMBER 68607 (ref: 68607M9)	SURFACE ELEVATION 4440.14
GEOLOGIST C.W.	TOTAL DEPTH OF HOLE 252.50 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 71.05 Feet

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

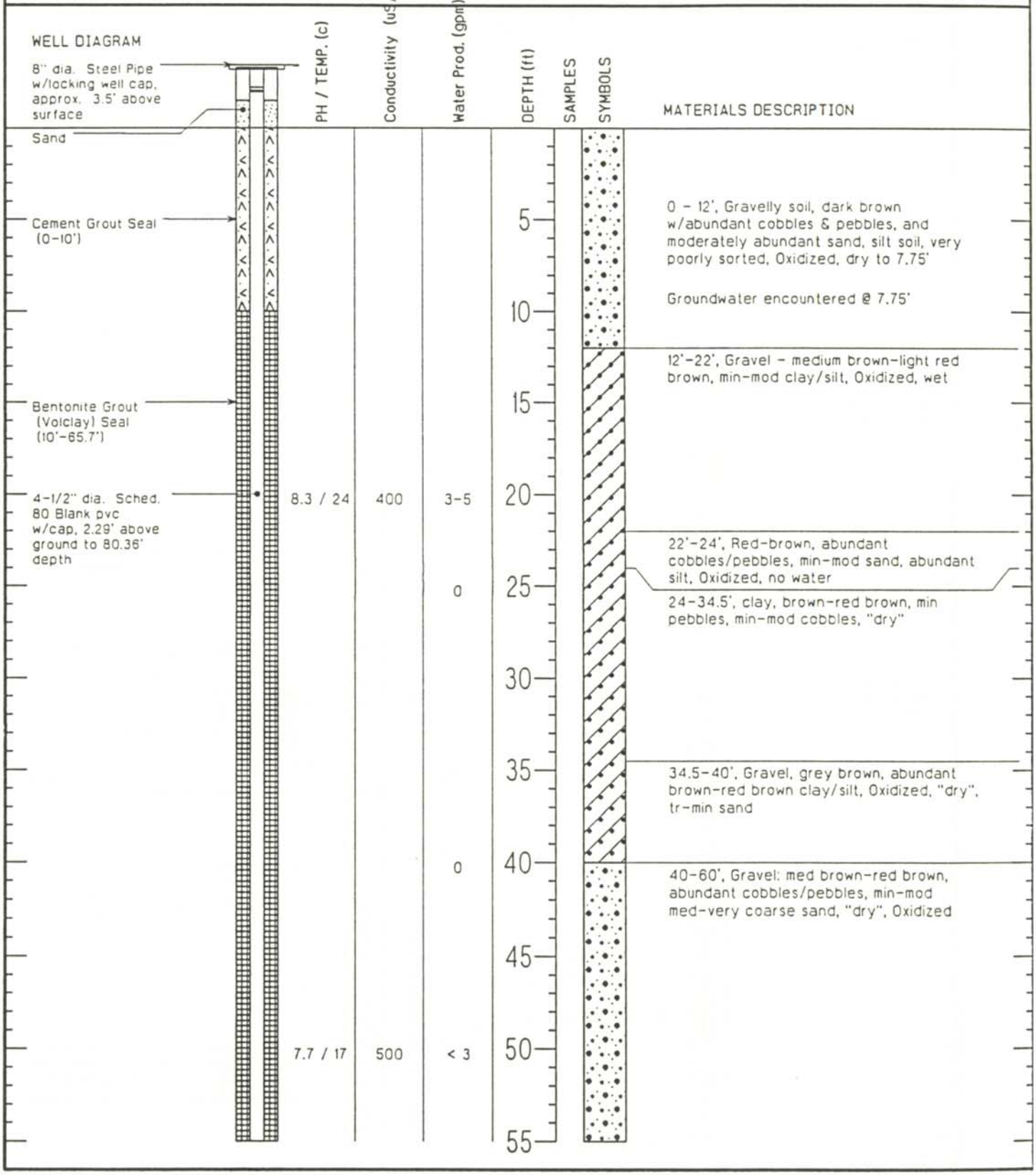
LOG OF MONITORING WELL MW-9



PROJECT Cooper Flat - Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N713191.10, E603249.22 N.M. S.P.C.	DATE DRILLED 09/20/94 - 09/26/94
JOB NUMBER 68607 (ref: 68607M9)	SURFACE ELEVATION 4440.14
GEOLOGIST C.W.	TOTAL DEPTH OF HOLE 252.50 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 71.05 Feet

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

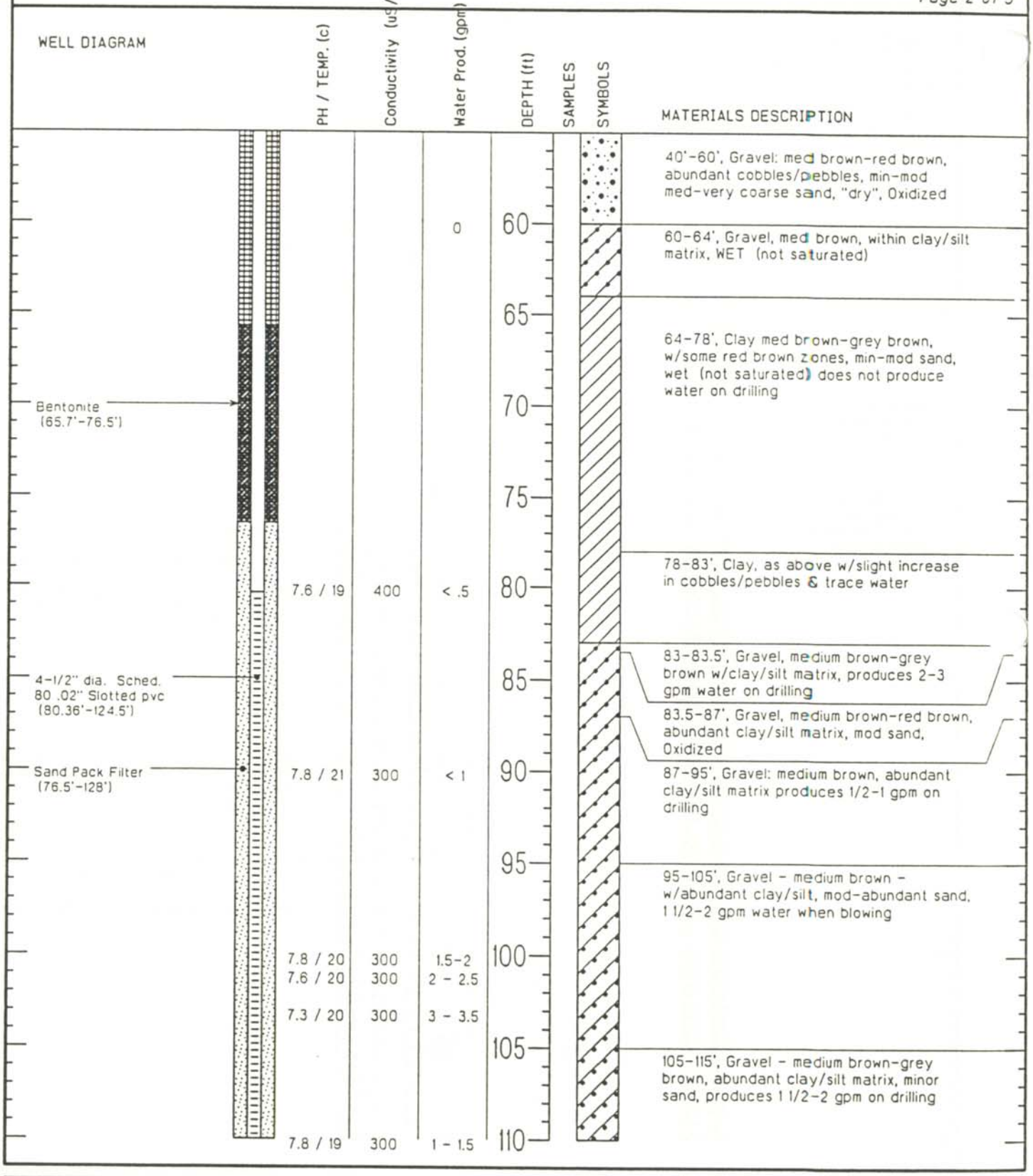
LOG OF MONITORING WELL MW-10



PROJECT Copper Flat - Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N719968.25, E636740.99 N.M. S.P.C.	DATE DRILLED 10/94
JOB NUMBER 68607 (ref: 68607M10)	SURFACE ELEVATION 4439.27
GEOLOGIST CW	TOTAL DEPTH OF HOLE 128.0 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 70.625 Feet

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

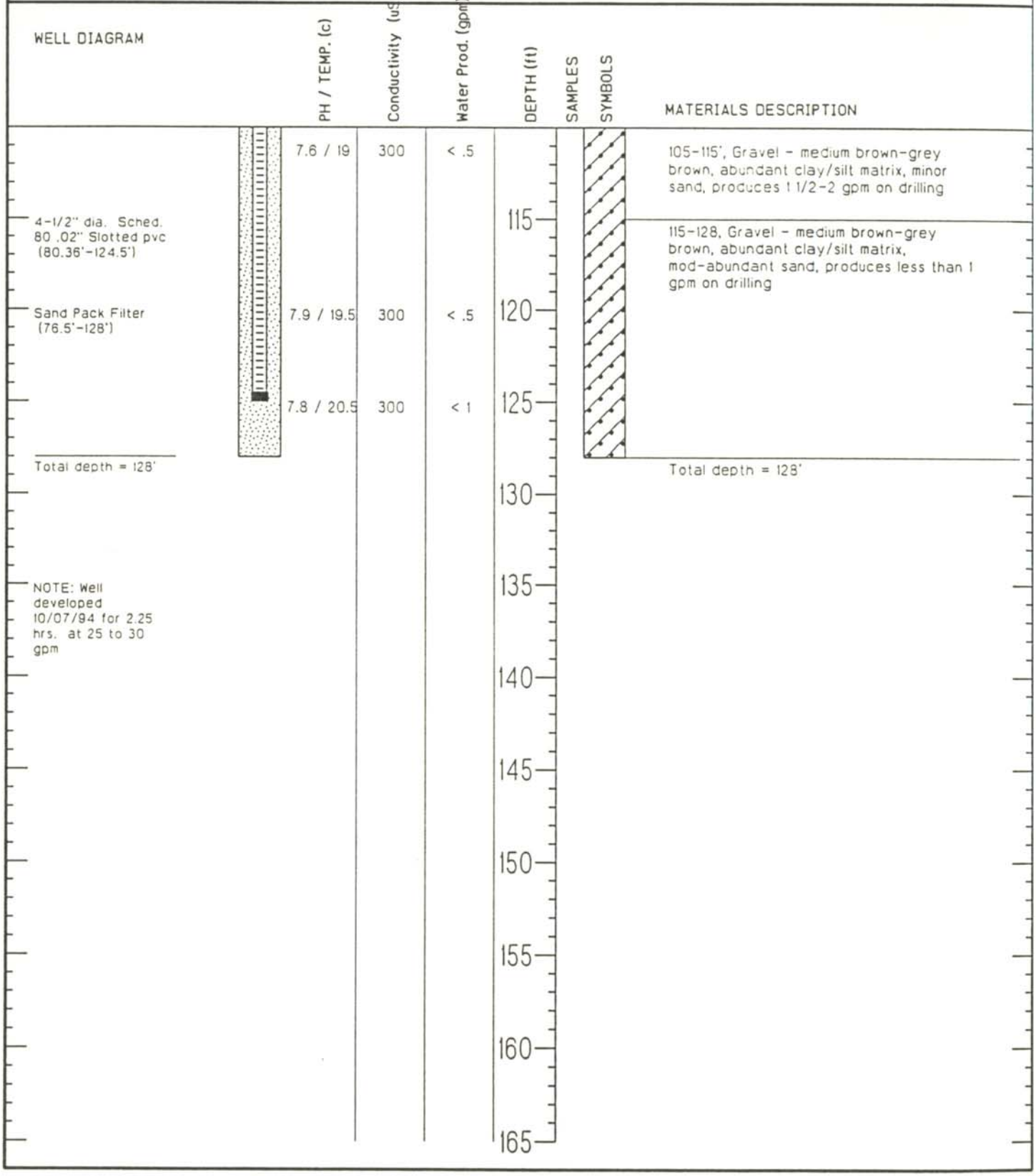
LOG OF MONITORING WELL MW-10



PROJECT Copper Flat - Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N719968.25, E636740.99 N.M. S.P.C.	DATE DRILLED 10/94
JOB NUMBER 68607 (ref: 68607M10)	SURFACE ELEVATION 4439.27
GEOLOGIST CW	TOTAL DEPTH OF HOLE 128.0 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 70.625 Feet

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

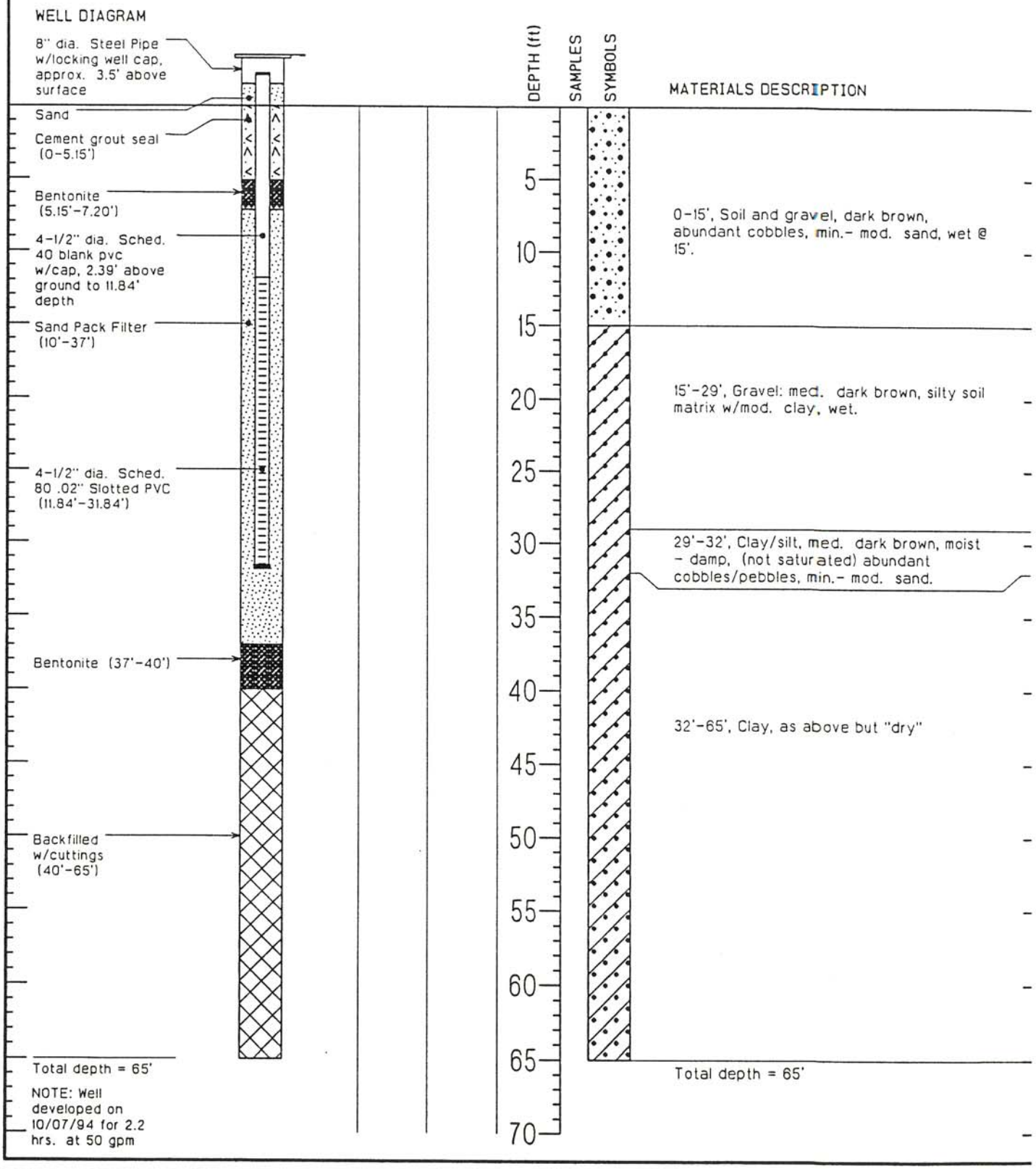
LOG OF MONITORING WELL MW-10



PROJECT Copper Flat - Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N719968.25, E636740.99 N.M. S.P.C.	DATE DRILLED 10/94
JOB NUMBER 68607 (ref: 68607M10)	SURFACE ELEVATION 4439.27
GEOLOGIST CW	TOTAL DEPTH OF HOLE 128.0 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 70.625 Feet

Steffen Robertson and Kirsten
Engineering and Environmental Consultants

LOG OF MONITORING WELL MW-11



PROJECT Copper Flat - Hillsboro, N.M.	DRILLING COMPANY Beylik Drilling
LOCATION N713751.31, E603378.24 N.M. S.P.C.	DATE DRILLED 10/11/94
JOB NUMBER 68607 (ref: 68607M11)	SURFACE ELEVATION 4439.48
GEOLOGIST CW	TOTAL DEPTH OF HOLE 65 Feet
DRILL RIG Air Rotary	WATER LEVEL Static, from TOC on 11/7/94: 10.65 Feet

SIERRA VISTA HOSPITAL
AND CLINICS

SIERRA VISTA HOSPITAL
Truth or Consequences, New Mexico

October 13, 2026

RE: Letter of Support for the Copper Flat Mine Project.

To Whom It May Concern:

On behalf of Sierra Vista Hospital, I am pleased to express our support for the Copper Flat Mine project and the significant economic opportunities it represents for Sierra County and the surrounding communities.

As the community's Critical Access Hospital, we understand that **the health of our community is directly connected to the strength of our local economy.** Sierra County needs a stronger private-sector economy, more employment opportunities, a growing population, and an expanded tax base to sustain the essential services upon which our residents depend. The Copper Flat Mine project represents an important opportunity to help achieve these goals.

In a rural community such as ours, everything is interconnected. Residents need good-paying jobs to support their families. Local businesses need customers to remain viable and create additional employment opportunities. Schools need students and resources, and local governments need a strong tax base to maintain essential infrastructure and services. Our hospital needs a stable and growing population, a strong workforce, and sufficient patient volumes to sustain and expand access to quality healthcare.

The economic benefits of Copper Flat would extend well beyond the mine itself. The project is expected to create hundreds of long-term employment opportunities, in addition to substantial construction-related jobs. Construction activity would generate demand for local lodging, restaurants, fuel, supplies, contractors, and other services. Long-term employees and their families would need housing, groceries, childcare, education, healthcare, and other essential services. This increased economic activity would benefit existing businesses, encourage new investment, and create additional employment opportunities throughout Sierra County.

For Sierra Vista Hospital, the potential benefits are particularly meaningful. Like many rural hospitals, we face ongoing challenges in recruiting and retaining healthcare professionals, maintaining essential services, and ensuring long-term financial sustainability. **An expanding local economy and growing population would create opportunities to increase hospital patient volumes and revenues, recruit additional physicians, nurses, and other healthcare professionals, create new healthcare jobs, and expand the services we provide to our community.** Increased employment and access to employer-sponsored health insurance could also improve residents' ability to obtain timely healthcare services.

Additionally, increased commercial activity and an expanded tax base, including potential growth in gross receipts tax (GRT) revenues, could strengthen the financial resources available to support our hospital and other essential community services. A stronger local economy would allow us to reinvest in healthcare facilities,

medical equipment, technology, and clinical programs, while improving our ability to provide high-quality care close to home.

We also recognize the critical importance of economic development to the future of our schools and families. Communities cannot grow and prosper without quality healthcare, strong educational systems, and meaningful employment opportunities. These elements are mutually dependent. When families have stable employment and opportunities for advancement, they are more likely to establish roots, purchase homes, support local businesses, and contribute to the long-term vitality of the community. This is especially important in rural areas where retaining young families and attracting skilled professionals are essential to sustaining our future.

We recognize that responsible economic development must also protect the natural resources and quality of life that make Sierra County a desirable place to live. Water availability and environmental stewardship are important considerations for our community. We understand that the Copper Flat project has incorporated a dry-stack design intended to substantially reduce water requirements and that the company reports holding existing water rights sufficient for its projected needs. We expect the project to meet all applicable environmental, water, safety, and regulatory requirements established by the State of New Mexico and other governing authorities.

Our vision for Sierra County is a growing, economically vibrant community with a thriving hospital, strong schools, successful local businesses, and opportunities that encourage our young people and families to build their futures here rather than seek opportunities elsewhere. Achieving that vision requires private-sector investment, job creation, and sustainable economic growth.

Sierra Vista Hospital supports the responsible development of the Copper Flat Mine project because we believe it has the potential to be an important economic catalyst for Sierra County. Its benefits could extend across generations, helping create the population, workforce, and financial foundation necessary to sustain our hospital, strengthen our schools, and build a healthier, more prosperous community.

We encourage the continued advancement of this project, subject to the applicable regulatory and environmental requirements, and look forward to the opportunities it may bring to Sierra County and the residents we serve.

Sincerely,

Shauna Cameron

Shauna Cameron, MS, RN, FACHE
Chief Executive Officer
Sierra Vista Hospital
Truth or Consequences, New Mexico

Outlook

[EXTERNAL] Please don't re-open the copper Flat Mine

From Margaret Hadderman <haddermanm@gmail.com>
Date Wed 10/14/2026 9:57 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from haddermanm@gmail.com. Learn why this is important

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Dear EMNRD Engineers:
There are way too many technical deficiencies to proceed safely and responsibly! Regulators haven't solved the water usage problem by switching from conventional wet tailings to filtered tailings. Also, the filtered tailings storage facility design sounds shaky, and could fail catastrophically.
Re-opening the Copper Flat mine would be completely out of sync with New Mexico's new water reality, which is looking GRIM. We're in a 25 -year drought with no end in sight! Increased evaporation, hotter summers, dried-out forests, wildfires too intense to extinguish...we're all wondering what next with the Super El Nino, etc.? It doesn't look good!
In fact, I consider this mine re-opening idea ALMOST as unfeasible (crazy?) as recent proposals to build massive, perpetually operating, water-sucking data centers in Hachita and Santa Teresa. The time has come to find out how much ground water remains, CONSERVE as much water as possible, and make sure it gets shared as equitably as possible--despite all the designated senior/junior rights.
We're all depending on State Engineers to make the right decision. This Copper Flat re-opening is too risky!
Thanks for reading my comments.
Sincerely,
Margaret Hadderman
[redacted]

Outlook

[EXTERNAL] Public comment in support of Copper Flat Mine - Peter Meiusi, Marina Vista (Elephant Butte)

From Peter M <peter@marinavistanm.com>
Date Wed 10/14/2026 11:58 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

1 attachment (29 KB)
Copper_Flat_Support_Letter_Meiusi.pdf;

You don't often get email from peter@marinavistanm.com. Learn why this is important

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

To the New Mexico Mining and Minerals Division:

Please accept the attached letter as my public comment in support of the Copper Flat Mine.

My family and I own and operate Marina Vista at Elephant Butte Lake, which includes Dam Site Marina, Marina Del Sur, Dam Site Lodging and the Rock Canyon Service Center. As the letter explains, Sierra County's economy leans too heavily on the lake and the summer season, and Copper Flat would bring the year-round, good-paying jobs the county needs. The redesigned project's reduced water use, water recycling and existing water rights are what make me comfortable supporting it, and I expect it to meet every environmental and regulatory requirement the State sets.

Thank you for considering my comments. I am happy to answer any questions.

Respectfully,

Peter Meiusi
Owner, NM Marina Management LLC (Marina Vista)
Elephant Butte, New Mexico
peter@marinavistanm.com

Peter Meiusi
NM Marina Management LLC (Marina Vista)
Elephant Butte, New Mexico

October 5, 2026

New Mexico Mining and Minerals Division
Energy, Minerals and Natural Resources Department
Via email: MMD.MARP@emnrd.nm.gov

Re: Copper Flat and the Elephant Butte Lake Economy

To the New Mexico Mining and Minerals Division:

My name is Peter Meiusi. My family and I own and operate Marina Vista at Elephant Butte Lake. That includes Dam Site Marina, Marina Del Sur, Dam Site Lodging and the Rock Canyon Service Center. I am writing to support the Copper Flat Mine.

Running a business in Sierra County teaches you quickly how connected everything is. Our visitors fill the lodging, restaurants and gas stations. Our employees live here, shop here and send their kids to school here. When one link in that chain weakens, everyone feels it.

Right now too much of Sierra County's economy rests on one thing: the lake. Our business rises and falls with the water level and the summer season. With Elephant Butte at historically low levels, we have seen firsthand how quickly visitors, revenue and jobs can disappear when one industry carries a county. Keeping good people employed year-round is a constant challenge. Too many capable young people leave because the steady careers are somewhere else.

Copper Flat would give Sierra County what it badly needs: year-round, good-paying jobs that don't depend on the weather or the reservoir. The benefit also goes well beyond the mine gates. Construction crews need places to stay and eat. Long-term employees need homes, groceries, vehicle repairs, healthcare and childcare, and they need somewhere to spend their weekends. Elephant Butte is right down the road. More working families means more customers for every business in the county, and a larger tax base for schools, roads, healthcare, law enforcement and fire protection.

Water is the first question I would ask too. Few people here watch water more closely than someone running marinas on a reservoir that keeps dropping. So it matters to me that the redesigned project uses a dry-stack design that substantially cuts water use, recycles most of its process water, and already holds water rights sufficient for its projected needs. Sierra County should not have to choose between protecting its water and building a stronger economy.

I expect Copper Flat to meet every environmental and regulatory requirement New Mexico sets. If it does, I support the project moving forward, and I hope the Division will too.

Respectfully,



Peter Meiusi
Owner, NM Marina Management LLC (Marina Vista)
Elephant Butte, New Mexico

New Mexico State Senate
State Capitol
Santa Fe

COMMITTEES:
RANKING MEMBER:
• Judiciary
MEMBER:
• Rules

SENATOR CRYSTAL BRANTLEY
R-Catron, Doña Ana, Grant, Hidalgo, Luna, Sierra & Socorro-35

P.O. Box 1947
Elephant Butte, NM 87935

Phone: (575) 740-1539
E-mail: crystal.brantley@nmlegis.gov

October 13, 2026

Mining and Minerals Division
Santa Fe, New Mexico

Re: Support for the Copper Flat Mine, Sierra County

To Whom It May Concern,

As the state senator for Senate District 35, which includes Sierra County, I write in support of the Copper Flat Mine and ask that the Division move the project through its review in a timely and thorough manner.

Sierra County faces an aging population, too few private-sector jobs and too many young people leaving to find work. Project estimates show Copper Flat would support about 1,156 construction-related jobs in New Mexico and roughly 300 full-time jobs in Sierra County, with about $200 million in federal, state and local taxes over the project's life, all privately funded.

I know water is the first question my constituents ask. The revised dry-stack tailings design eliminates the conventional wet-tailings pond and cuts projected annual water demand from about 4,626 acre-feet to about 1,050, which is within water rights the company already holds.

Support for this project does not mean setting the regulatory process aside. Copper Flat must continue to meet every state and federal permitting, monitoring and reclamation requirement, and the public deserves a full and transparent review.

Please feel free to contact my office with any questions.

Sincerely,



Crystal Brantley
District 35, Senate Republican Caucus Chair

Outlook

[EXTERNAL] Comment on Copper Flat Mine Revised Application, Permit No. SI027RN

From adamrhill@hushmail.com <adamrhill@hushmail.com>
Date Thu 10/15/2026 5:42 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

[You don't often get email from adamrhill@hushmail.com. Learn why this is important at https://aka.ms/LearnAboutSenderIdentification]

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Greetings Director Aguilera,

I would like to take this public comment opportunity to express my opposition to approving this application until such time that all substantial concerns regarding actual water consumption and slope stability have been thoroughly and properly analyzed.

I am a life long New Mexico resident and proud alumni of the New Mexico Institute of Mining and Technology.

Best regards,

Adam Hill
BS ChemE NMT, MBA UNM

Outlook

[EXTERNAL] Copper Flat Mine

From Carol Sassaman <carol.sassaman@gmail.com>
Date Thu 10/15/2026 12:28 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from carol.sassaman@gmail.com. Learn why this is important

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Dear Director Aguilera,

MMD should deny NMCC's application at this time given its technical deficiencies:

- The mine operator has overestimated the water savings from switching to filtered tailings from conventional wet tailings and therefore does not have sufficient water rights to operate the mine at 30,000 tons per day of production and reclaim it once the mine ceases operation.
- Due to several deficiencies in NMCC's slope stability analysis, we recommend that MMD require the company redesign its tailings storage facility to meet the Global Industry Standard on Tailings Management (GISTM standards) and revise the associated analyses to properly evaluate the probability of catastrophic failure of the filtered tailings storage facility.
- We recommend that the Office of the State Engineer (OSE) review the filtered tailings storage facility design given the potential risk of catastrophic failure and potential to pose a direct threat to life and property. The OSE has said that the tailings facility doesn't meet its definition of a "dam", but this is an abrogation of the agency's responsibility to regulate tailings storage facilities.

You don't need to be a mining expert, and I'm not, but I do understand that this isn't okay!

Thank you and Best Regards,
Carol Sassaman

Outlook

[EXTERNAL] Copper Flat

From Edwina Gardner <edwinagardner@icloud.com>
Date Thu 10/15/2026 9:07 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from edwinagardner@icloud.com. Learn why this is important

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I urge the New Mexico Mining and Minerals Division (MMD) not to approve New Mexico Copper Corporation's revised application for the Copper Flat Mine.
My reasons: A. Water
B. Water
C. Water

Not sure if enough studies have been conducted on the underground river of water that surfaces down the road from this mine. The wildlife that flourishes in the area around the spring (where it emerges), would not be sustained and effects of the project's water use beyond the mine boundary (pumping and other mine-related depletion) could affect nearby wells and springs, and ultimately the Rio Grande River. Ask the farmers down river if this is ok with them.

I am a descendent of the homesteaders who farmed that area near the spring. I am also a descendant of miners from the Grant County area.
Ask Fierro, New Mexico what happened to their well water?
Water is life for those who live, drink, and farm down from Copper Flat Mine. Please reconsider for further study.

Edwina S. Chavez-Gardner

Outlook

[EXTERNAL] Public Comment on Copper Flat Mine Revised Application, Permit No. S1027RN

From Emily Pollom <emily.pollom@gmail.com>
Date Thu 10/15/2026 12:34 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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Director Aguiera,

I am writing to express opposition to the reopening of Copper Flat Mine. The immediate community does not support it, as showcased by the 20+ oral comments at the public hearing on Sept 17.

Water savings from switching to filtered tailings have been overestimated and the area does not have sufficient water to operate the mine at 30,ooo tons per day of production and reclaim is when the mine closes.

MMD should require the company to redo it's tailings storage facility plan to fully meet the GISTM standards.

I also believe that the Office of the State Engineer deny the application and permit for the filtered tailing storage facility because there is rick of horrific failure, posing threat to life and property.

Emily Pollom
Silver City, NM

Outlook

[EXTERNAL] Copper Flat Mine Revised Application, Permit No. SI027RN

From John Masterson <magnafix@gmail.com>
Date Thu 10/15/2026 9:10 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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I oppose the copper flat mine because mines are ugly and industrial and this is a beautiful stretch of wild and natural land that I enjoy regularly.

Outlook

[EXTERNAL] Copper Flat Mine

From Mary Baxter <mary@baxtergallery.com>
Date Thu 10/15/2026 6:08 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from mary@baxtergallery.com. Learn why this is important

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Humans have a long history of polluting the planet in order to make more money. It's time to stop. It's time to start thinking of the Earth before profits.
We live downwards from the mine area, but so do the wildlife which are already stressed from habitat loss and the ongoing drought.
Please do not permit more mining.
Please consider the bigger and longer term decisions.

Thank you,

Mary Baxter
T or C, New Mexico

Outlook

[EXTERNAL] SI027RN and DP-1840

From Max Yeh <maxwyeh@gmail.com>
Date Thu 10/15/2026 4:16 PM
To Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>; Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>
Cc Bob Cunningham <bcunni4668@aol.com>; jsmith <jsmith@ebid-nm.org>; allysonsiwik <allysonsiwik@gmail.com>; Dustin Long (TEI-Ladder) <Dustin.Long@tedturner.com>; Greg Daviet <LegalReview@ebid-nm.org>; Carter Kruse (TEI - Montana) <Carter.Kruse@retranches.com>; Tessa Davidson <ttd@tessadavidson.com>; Tea Davidson <tea@tessadavidson.com>; David Salopek <dpsalo@zianet.com>; Kathy McKinney <kathymckinney@sbcglobal.net>; jpking <jpking@kingengr.com>

1 attachment (3 MB)
Failure of the Reclamation Plan-Winter on Lakes.pdf;

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Hello, Evan and Jordan,

Attached is my argument about the after mining water situation at the pitlake. It continues my demonstration that in spite of the high regional water table around the pit, it does not require a rise in the pitlake level to the level of the regional water table for water to flow from the pitlake into groundwater. Basically, the pressure head in groundwater at the edge of the pitlake is not the simple pressure caused by the height of the regional water table above the pitlake surface. It is drastically reduced by the low conductivity of the ground there. The pressure on the groundwater side of the divide between groundwater and pitwater is fairly constant (controlled mostly by the low conductivity). The pressure on the pitlake side varies quickly with the surface elevation. This is why I think the pitlake level is the key to inflow and outflow, i.e., key to the difference between an evaporative sink and a flow through situation.

In this comment, I present two pieces of evidence about pitwater outflow. One is an old but seminal study of the interactions between lakes and groundwater. You will see that there are several situations where lake water flows into groundwater irrespective of the high regional water table. You can also see what factors hydrologists who study this phenomenon consider, none of which have been considered in our case by the mine's rather flippant assumption that as long as the water table is above the pitlake water always flows into and not out of the pitlake. The second piece of evidence is my calculation of a year's runoff of 12 inches of precipitation into the future pitlake. The results show that perhaps half the time, the pit may be a flow-through pit. If that is even somewhat true, neither the pitlake nor the OPSDA can be permanently left the way the reclamation plan proposes.

--
Max

To: Anna Aguilera, Director
Mining and Minerals Division, EMNRD
James Kenney, Secretary
Environment Department
From: Max Yeh
Percha/Animas Watershed Association
Date: October 14, 2026
Re: SI027RN and DP-1840
Failure of the Reclamation Plan at Copper Flat Mine

In an earlier comment, "Copper Flat Mine Pit Reclamation" (September30, 2026), I tried to demonstrate that the future pitlake is not necessarily always a hydrological evaporative sink by the definition in the Copper Rule, and therefore, in accordance with the state's case law, the pitlake should not always be exempt from surface water pollution standards. However, the assumption that the future pitlake will be such a sink is basic to much of the Draft Permit for DP-1840, affecting the whole concept of an Open Pit Surface Drainage Area which is defined as an area where both surface water and underlying groundwater are "contained" by pumping or by evaporation from the pit, presumably functioning as an evaporative sink after mining. If the pit were not an evaporative sink, the OPSD area could not itself escape pollution standards nor could it be used as an overload impoundment for contaminated substances, nor could there be reduced coverage and slope requirements in reclamation.

Therefore, I want to question further this important assumption. In the Shomaker and Assoc. letter to NMCC explaining that assumption [DP-1840 Admin Record_Bates-13950-13952 JSAI letter.pdf], the future pitlake water level is given as fluctuating around 4,850 ft amsl with a maximum of 4,900 ft amsl. The letter goes on to demonstrate that "[n]o conceivable storm event, wet year or even wet decade could possibly add enough water to the pit to reach the water level (>5,100) required to achieve flow-through."

First, as I have pointed out, the pitlake level does not have to rise to the regional water table for pitlake solution to move into groundwater. By both dispersion and by bulk carry, solutes can enter groundwater when there is little or no gradient between pit water and groundwater.

Furthermore, if there is a groundwater flow at the pit – which NMCC diagrams affirm – the pitlake, because its water surface is flat, can act as a shunt so that water passes through the pitlake. The net effect may be as little as zero, but water can move into groundwater on the down-gradient side of the pit as water inflows from groundwater on the up-gradient side. This can happen even as the regional water table remains mounded above the pitlake surface. See the Thomas C. Winter, "Numerical Simulation Analysis of the Interaction of Lakes and Groundwater," Geological Survey Professional Paper 1001, US Department of Interior, 1976. Herein attached as "Attachment." See especially the discussion of the division between the local and regional water flow zones, whether that divide is continuous or not, and of the "stagnation point" on that divide (p. 9). Equally important are figures 13, 14, 17, and 18 diagramming conditions which allow water flow out of the lake into groundwater (while the regional water table remains high above the lake surface).

More important, the regional water table is not a stable, even surface as the Shomaker statement assumes and its accompanying diagram illustrates. Since we are dealing with an irregular aquifer of fractures, crevices, and pockets of breccia in hard rock, which may have perched sectors or confined aquifers, the water table around the pit and near the pit is highly irregular. Furthermore, the water table around the pit is constantly varying due to uncertain and irregular infiltration of storm waters and

seasonal changes. Thus, a long term drought, as we have been having, now lasting over 20 years, may easily reduce that ideal 5,100 ft amsl to a level within possibility given that irregularity in the water table. The Shomaker estimate of the phreatic surface levels near the pit dates from at least 15 years ago. In the Draft Permit for DP-1840, Figure 2 showing the water table elevations dates from 2011. The 5,100 ft amsl number simply cannot be counted on even if the aquifer were less variegated.

Finally, there is no evidence at all today for what the water table around the future pitlake will be like since the excavation of the pit will change that shape in unpredictable ways, and even the water levels in 2011 (Draft Permit, Figure 2) around the pitlake are entirely hypothetical since there were no wells inside the future pit to ascertain those water levels. The only certainty is that the phreatic surface will not be a nice even slope from the regional water level to the future pitlake surface as depicted in the Shomaker letter.

This doubt is made stronger by the information given by the applicant in a meeting with NMED and interested parties at the beginning of the renewal process, when NMCC stated that at that time the pitlake was dry. How does a pitlake into which the groundwater is presumed to flow continuously under a permanent head go dry if it is not losing water? And when the pitlake is dry, and a heavy storm event occurs, does the water not flow into groundwater carrying concentrated solute?

Another confusing consideration in this matter of water movement – remember that we are essentially speaking of solute transport rather than water *per se* – is presented by understanding that precipitation (including runoff) is, like drought, a major factor in determining pitlake water levels as well as the regional water table. This reality is shown by a calculation of the effect of the average annual rainfall of 12 inches on the pitlake level.

In a hydrological evaporative sink, Inflow = Outflow. Inflow is groundwater inflow plus precipitation and runoff. If outflow is only evaporation (and not pitwater moving into groundwater), then how much groundwater must flow into the pitlake from groundwater in a year to maintain hydrological balance?

Inflow is groundwater inflow (G) plus direct precipitation (P) plus runoff (Q). Outflow (O) is 50 inches a year, and average annual rainfall is 12 inches. Therefore,

$$G + 12 + Q = 50, \text{ or } G = 38 - Q \text{ (all in inches)}$$

To estimate a Q for any P around the pitlake, I use the Natural Resources Conservation Service (NRCS) Curve Number runoff equation. See “Appendix” for the calculation. Using NRCS estimates for arid rangeland, at Copper Flat

$$Q = (P - 0.272)^2 / (P + 1.09).$$

Note that the equation is valid only when P is greater than 0.272 inches, that is a fairly substantial rain. Since this relationship applies to individual storm events, we can hypothetically duplicate the average annual precipitation at Copper Flat of 12 inches a year by18 events of 0.5 inches per rain storm and 3 events of 1.0 inches precipitation. Each 0.5 inch event, then, would produce a runoff of

$$Q_{0.5} = (0.5 - 0.272)^2 / (0.5 + 1.09) = 0.0327 \text{ inches.}$$

That runoff over 306 acres funneled into the 21 acre pit would raise the pitlake 0.476 inches. Cumulatively, over the 18 events, those rises in the pitlake would amount to 8.57 inches.

Each 1.0 inch would produce a runoff of

$$Q_{1.0} = (1.0 - 0.27)^2 / (1.0 + 1.09) = 0.77 \text{ inches.}$$

That runoff would raise the pitlake 11.22 inches, and cumulative over the year would raise the pitlake by 33.66 inches. Therefore, in this modeling of an average rainfall year, total accumulated rise in the pitlake would be 42.23 inches, which makes groundwater inflow in the hydrological balance equation negative:

$$G = 38 - Q = -4.23$$

If we can assume that the mean precipitation at Copper Flat is close to the average precipitation, then about half the years will see a flow from groundwater into the pit and the other half of the time, it will not. The pitlake cannot be said to be continually an evaporative sink by the Copper Rule's definition, and movement of water out of the pit into groundwater must be considered significant depending on rainfall. Water pollution standards must apply to both the pitlake and the OPSDA. The reclamation plan fails.

This is only to say that runoff is the largest factor in hydrologic balance at Copper Flat. The hydrological rule of thumb applied to the evaporative sink idea is that evaporation is much greater than precipitation (here 50 inches of evaporation vs. 12 inches of precipitation), but this calculation of runoff shows that the rule of thumb should be abandoned because runoff overshadows that rule.

Given these doubts about the viability of the assumption that the future pitlake will always be a hydrological evaporative sink, it behooves NMED to monitor the situation in the pitlake. And given that we are speaking of pollution prevention and not just water movement, we need considerations of solute transport (both by dispersion and by bulk carry) under varying pressure differential situations. Primarily, we need better conditions of monitoring.

The numerous monitoring wells around the pit are specifically designed to monitor the OPSDA and not the pitlake itself. They are too far away from the pit to monitor what is happening there, being between 1,000 and 2,000 feet away when 20.6.7.28(B)(3) NMAC specifies a 75-foot distance of a monitoring well from the possible contamination source. Although I have not been able to find the depths of the OPSDA monitoring wells, they might not be deep enough to monitor the pit which is more than 800 feet lower in elevation. I assume these wells were designed to monitor the chemistry and phreatic surface (as indicated by the monitoring schedules in the Draft Permit) and thus need not be very deep.

NMED should include in its conditions for this permit the construction of monitoring wells **inside** the pit near the future pitlake in order to monitor both the chemical content of groundwater near the pit and to monitor the internal pressures at the interface between the pitlake and groundwater to determine the direction of flow. This means piezometric installations in these in-pit monitoring wells, in the saturated segments of the surrounding ground, and in the pitlake at the same amsl elevations. These pressure measuring devices in wells (open water) and in the surrounding areas (in saturated soil) should be able to detect pitwater solution movement into groundwater on the down-gradient side of the pit under a slow-flow condition.

The possibility that the future pit may be either a flow through pitlake or an evaporative sink depending on deviations of rainfall from the average should make MMD reconsider the mine's reclamation plans and bonding requirements. The present reclamation plan will result in the clear possibility of perpetual

monitoring of the pitlake and of the OPSDA and perpetual remediations of both. The Mining Act does not allow perpetual care.

Appendix

The NRCS runoff equation for storm events derives from a mass balance equation and is generally used in the form

$$Q = (P - Ia)^2 / (P - Ia) + S,$$

for P > Ia, where Ia is Initial Abstraction referring to the precipitation that is caught on vegetation or puddled on the ground surface or deeply infiltrated into the groundwater and thus taken out (abstracted) from the consideration of runoff. S is the maximum amount of water that the soil can absorb before runoff starts and is calculated by the equation

$$S = (1000 / CN) - 10,$$

where CN is an experimentally determine index of the terrain. NRCS gives the CN for arid desert shrub (mesquite, cactus, etc.) with less than 30% ground cover) and shallow soil underlain by impervious rock as 88 out of a range of CN values running from 30 to 100. See Table 2-2d, USDA NRCS TR-55, as referenced via the USACE HEC CN Tables. One can see that when CN is 100, S becomes 0, so that runoff is maximized.

Originally, the equation was solved with the assumption that the ratio Ia/S = 0.20, but more recently the rule of thumb is to use an Ia/S ratio of 0.05. I have used the 5% ratio in previous calculations, but for the present calculations I use the 20% ratio to give a more conservative estimate.

Thus, at Copper Flat,

$$S = 1.36, \text{ and } Ia = 0.2S = 0.272$$

Q, the runoff for any P, precipitation can be calculated:

$$Q = (P - 0.272)^2 / P - 0.272 + 1.36, \text{ or}$$

$$Q = (P - 0.272)^2 / (P + 1.09).$$

The impact of a runoff of Q over the 306 acre drainage area would be 306Q. That amount of water (in acre inches) would raise the 21 acre pitlake by 306Q/21, or 14.57Q.

ATTACHMENT

Numerical Simulation Analysis of the Interaction of Lakes and Ground Water

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1001



Numerical Simulation Analysis of the Interaction of Lakes and Ground Water

By THOMAS C. WINTER

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1001



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NUMERICAL SIMULATION ANALYSIS OF THE INTERACTION OF LAKES AND GROUND WATER

By THOMAS C. WINTER

ABSTRACT

Because the interrelationship of lakes and ground water is perhaps the least understood aspect of lake hydrology, vertical-section, steady-state, numerical-model simulations were run to evaluate the factors that control the interaction of lakes and ground water. The study is concerned only with lakes encircled by water-table mounds that are at a higher altitude than lake level. Simulations of one-lake and multiple-lake systems in vertical sections show that for many hydrogeologic settings, the line (divide) separating local from regional ground-water flow systems is continuous beneath individual lakes. If the divide is continuous, there exists a point along it at which the head is a minimum compared to all other points along the divide. This point of minimum head is always greater than the head represented by lake level, therefore in such a setting there can be no movement of lake water through the lake bed to the ground-water system. In a setting where the divide is not continuous, the lake loses water through part of its bed, but rarely in the littoral zone of the lake.

Factors that strongly influence the position, shape, and continuity of the flow-system divide beneath lakes are height of the water table on the downslope side of the lake relative to lake level, position and hydraulic conductivity of aquifers within the ground-water reservoir, ratio of horizontal to vertical hydraulic conductivity of the ground-water system, and lake depth.

INTRODUCTION

BACKGROUND OF THE STUDY, INCLUDING PREVIOUS INVESTIGATIONS

Lakes are a valuable natural resource in many areas of the United States. In addition to being sources of water supply for many communities, they are the focus of recreational activity and their aesthetic qualities are highly valued. That they are a desirable feature is evidenced by the large number of small reservoirs being constructed throughout much of the United States for a wide variety of purposes. Increasingly, lakes are being used as the focal point in planning urban developments.

Unfortunately, the popularity of lakes often leads to their deterioration. The increased input of nutrients through the activities of man causes the organisms in lakes to flourish at rates far in excess of natural conditions. This increased productivity in turn causes chemical changes in lakes that result in obnoxious odors, fish kills, and unsightly conditions in the lakes and along their shorelines.

The number of problem lakes is sharply increasing. In order to evaluate lake problems and the effect of management projects, nutrient budgets and water budgets of lakes are needed. Only by thorough understanding of the interrelationships of lake hydrology, chemistry, and biology can progress be made in alleviating present lake problems and preventing more problems from arising.

In recent years, much money and research effort have been expended to understand the principles of lake chemistry, biology, and the nutrient balance of lakes. At the same time, comparatively little money and effort have been devoted to understanding the principles of lake hydrology or the water balance of lakes. With few exceptions, the relationship of ground water to lakes has been a minor part of the hydrologic studies, and it remains the least studied and least understood aspect of lake hydrology.

In most studies of lake hydrology, atmospheric water (precipitation and evaporation) and surface-water interchange with lakes is measured. Ground water is generally calculated as the residual. This practice can lead to serious misunderstandings about the interaction of lakes and ground water, especially when the error of measurement inherent in precipitation and particularly evaporation is considered. Further, only through careful field techniques can streamflow measurement error be kept to relatively low values.

Some misconception of the interaction of lakes and ground water has resulted from lack of understanding of ground-water flow, which leads to inadequate instrumentation and data collection. Poorly executed studies have led to various erroneous ideas concerning the interaction of lakes and ground water, to the detriment of sound lake management. Some scientists and managers believe all lakes are discharge points of the ground-water system and therefore do not lose water through their beds. Others believe that lakes are points of recharge to the ground-water system. Some believe ground water flows in

one side of lakes and out the other, a flow-through condition. Others believe all three situations exist.

Most studies of the interaction of lakes and ground water have been in response to a need for water budget information for a particular lake or groups of lakes. Some studies have not used observation-well instrumentation to define the ground-water flow systems, but instead assumed certain hydrogeologic conditions. Generally those that used wells either used too few wells, that is they assumed a simple relationship between lakes and ground water that could be determined by one or two wells near the shoreline, or they installed too many wells within the immediate drainage basin of the lake. Some studies assumed that definition of the water table near a lake was sufficient to understand the interactions.

The relation of ground water to prairie potholes in North Dakota was studied by Eisenlohr and others (1972). Although in the early stages of this study the ground-water component was calculated as a residual, a seepage measuring device was subsequently developed. In latter stages of the study, wells were placed near some potholes to determine the relationship of ground-water levels to pothole water levels (Sloan, 1972).

The ground-water relation to small lakes in Minnesota was studied by Manson and others (1968) and Allred and others (1971) by placing one or several wells near the lake shores. The study approach was similar to that of Eisenlohr and others (1972). The general conclusion of these studies was that most of the lakes studied had a net loss to ground water.

In a study of Lake Sallie, Minnesota (McBride, 1969), the ground-water component of the lake-water budget was a primary interest. Wells were placed within the entire drainage basin of Lake Sallie to define lateral ground-water movement. At some sites several closely spaced wells were completed at different depths to define the vertical component of ground-water flow. Flow nets were then constructed to calculate the quantities of ground water moving into and, in one small area during part of the year, out of Lake Sallie. McBride used a digital modeling technique to define the vertical distribution of hydraulic head in the ground-water system near a lake. His models are of the flow within the immediate drainage basin of the lake itself—from the local ground-water divide to the midpoint of the lake (McBride and Pfannkuch, 1975).

Studies of the interaction between lakes and ground water similar to those conducted by McBride (1969), although not using simulation modeling, were done in Wisconsin by Hackbarth (1968), Hennings (1974), and Possin (1973). The lakes in these studies are the flow-through type—ground water enters one side of the lakes, and the lakes leak to the ground-water system on the other side.

Meyboom (1966, 1967) studied ground-water flow systems in the vicinities of lakes and potholes in the prairie provinces of Canada. Meyboom's work is some of the first to examine the problem of determining ground-water flow systems and the strength and position of ground-water divides or absence of such divides beneath lakes. Studies by Freeze (1969a, 1969b) consider the relationship of ground-water flow systems within large drainage basins to lakes in the prairie provinces of Canada. The scale of the hydrologic sections, however, is such that the detailed flow patterns by the lakes can not be defined.

Williams (1968) examined ground-water flow systems in vertical sections near small depressions, and the relationship of those flow systems to wetlands in northern Illinois. The techniques of investigation and results of the study were similar to the work of Meyboom. Studies similar to and using the techniques of Meyboom were also done in East Germany by Schumann (1973).

A general overview of studies of the interaction of lakes and ground water, including a literature review, is given by Born and others (1974). They also discuss and present conceptual diagrams of many variations of ground-water flow systems near lakes.

The relationship of ground water to large lakes and reservoirs has been studied by several Russian hydrogeologists. Zektzer (1973) discussed the role of ground-water flow in water and salt balances of Lake Baikal and the Caspian Sea. Zektzer and Kudelin (1966) discussed the methods of determining ground-water flow to lakes with special reference to Lake Ladoga, USSR. Payne (1970) used radioactive tracer techniques to study the ground-water aspect of the water balance of Lake Challa, Africa. Haefeli (1972) has calculated the ground water inflow into Lake Ontario from the Canadian side. The study made use of the cross-sectional digital ground-water flow model of Freeze (1969b). Van Everdingen (1972), as part of an intensive study of the Lake Diefenbaker, Saskatchewan, site, constructed a series of piezometer nests (closely-spaced group of wells, each well completed at a different depth) before the dam was constructed. The changes in the potentiometric level of different aquifers in the ground-water system were observed as the lake filled. The study showed reversals of flow within some of the aquifer zones as a result of the creation of Lake Diefenbaker. A similar study is under way at the Kendrid Lake site, North Dakota, by Downey and Paulson (1974).

Careful review of the above literature leads one to the conclusion that much work needs to be done to identify and evaluate the factors that control lake hydrology, especially the factors that control the relationship of ground water to lakes. The general principles underlying the interaction of lakes and ground water need to be defined on theoretical grounds to solve even such basic problems as determining the optimum number and placement of observation wells needed to define ground-water flow systems near lakes.

A logical first step in defining the general principles

controlling the interaction of lakes and ground water is to use simulation modeling to examine the detailed patterns of ground-water flow around and beneath lakes for a wide variety of hydrogeologic settings.

PURPOSE AND SCOPE

The purpose of this report is to examine ground-water flow systems near lakes through digital models simulating ground-water flow in vertical sections. Use of such models makes it possible to examine the general principles of the interaction of lakes and ground water. By varying shape and altitude of the water table in relation to lake levels, lake depth, sediment distribution, size and position of aquifers within the ground-water system, ratio of horizontal to vertical hydraulic conductivity, ratio of hydraulic conductivity of aquifers to that of the surrounding finer-grained materials, and thickness of the ground-water reservoir, it is possible to locate the position and strength (explained later) of the divide that exists under a lake or the percentage of the lake bottom through which water moves to the ground-water system if there is no continuous divide. Although the cross sections are hypothetical, the values of the parameters listed above are realistic and representative of physiographic and hydrogeologic conditions in glacial terrane, the geologic environment in which most natural lakes occur. Lakes in this type of terrane are of primary interest in this study, but the models used to define the interaction of lakes and ground water and the general principles evolved from this study should have general application to all types of geologic terrane.

ACKNOWLEDGMENT

This study constituted part of a dissertation (Winter, 1976a), which was submitted to the Faculty of the Graduate School at the University of Minnesota in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Dr. H. O. Pfannkuch provided overall guidance during the course of the study. With minor modifications the dissertation was released to the open-file (Winter, 1976b).

GROUND-WATER FLOW SYSTEMS

THEORETICAL BACKGROUND

This study is concerned only with two-dimensional, steady-state, non-homogeneous and (or) anisotropic, cross-sectional systems. Thus the basic equation of ground-water flow that is used in this report for defining the head distribution within the ground-water system is

$$\frac{\delta}{\delta x}\left[K(x,z)\frac{\delta h}{\delta x}\right]+\frac{\delta}{\delta z}\left[K(x,z)\frac{\delta h}{\delta z}\right]=0, \qquad (1)$$

where K(x,z)=hydraulic conductivity in the two coordinate directions and

$\frac{\delta h}{\delta x}, \frac{\delta h}{\delta z}$= gradient of hydraulic head.

Equation 1 results from coupling Darcy's equation with the equation of continuity. It assumes that fluid density is constant and the coordinate axes are aligned collinear with the principal directions of anisotropy. Development of the equation is discussed in most textbooks of ground-water hydrology (e.g., Domenico, 1972; DeWiest, 1965).

In order to solve equation 1, it is necessary to define mathematically the boundary conditions for the region of interest. A general model for the type of flow section of interest in this report is shown in figure 1. This figure represents an x-z coordinate system that has the origin in the lower left corner. For any point (P) in the system there corresponds a value of hydraulic head. Because there is no flow across the vertical boundaries projected down from the major divide and the major sink, the head gradient is zero ($\frac{\delta h}{\delta x}=0$) along the two sides of the diagram. It is also assumed that the base of the system is impermeable, thus $\frac{\delta h}{\delta z}=0$. The pressure along the water table is atmospheric and the head (h) there is a function of x only. The hydraulic conductivity (K) values are different for each geologic unit within the system. For this study, the size and position of zones of high hydraulic conductivity (termed aquifers for convenience) are varied, and the degree of anisotropy is varied.

Recent development of numerical methods as approximate solutions to the equation of ground-water flow (Remson and others, 1971; Trescott and Pinder, 1975; Cooley, 1974; Prickett and Lonnquist, 1971; Freeze, 1969b) has made it possible to simulate complex ground-water flow systems. Although a variety of numerical techniques are being developed, the finite-difference method has been well documented and has been used successfully in a number of studies. The finite-difference models used herein have been developed by the U.S. Geological Survey over a number of years (Pinder and Bredehoeft, 1968; Pinder, 1970; Trescott, 1973; Trescott and Pinder, 1975).

The alternating-direction-implicit method (ADI) was used to calculate the distribution of hydraulic potential within some of the cross-sectional simulations but, as more complex models were considered, it was necessary to turn to the strongly implicit procedure (SIP) (Stone, 1968). As an example of SIP's greater efficiency, some checkruns were made on the same section, using both numerical techniques; ADI did not converge after 99 iterations, whereas SIP needed as few as 16. It was found that SIP adequately handled all conceivable simulations except one, where extremely high hydraulic conductivity contrasts existed in close proximity, both in the vertical and horizontal directions.

MODELS OF HYDROLOGIC SECTIONS

Only two comprehensive theoretical studies appear to have been published on modeling ground-water flow in

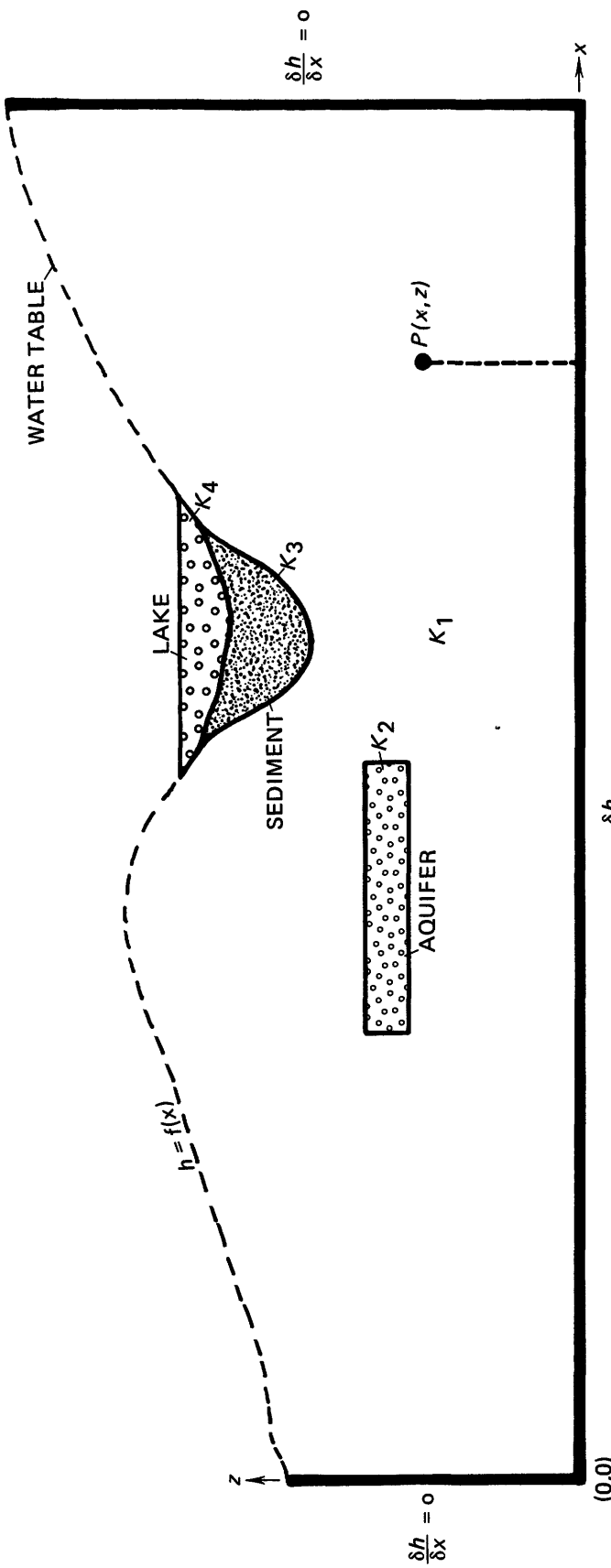


FIGURE 1.—Sketch showing physical meaning of mathematical expressions for boundaries of hydrologic-section models.

vertical section (Tóth, 1963; Freeze, 1969b). Subsequent work based on the report by Freeze has been done by Haefeli (1972) and by Freeze (1969a). These studies have concentrated on ground-water-flow patterns in vertical section in large basins and, although lakes occur along some of the sections modeled, the scale of the sections were such that detailed flow patterns in the immediate vicinity of lakes could not be shown.

Tóth's work is based on an analytical solution to the ground-water-flow equation, whereas the work of Freeze is based on a numerical solution. Freeze (1969b) discusses the advantages and disadvantages of each approach. In the analytical-solution approach Tóth had to make some rigid simplifying assumptions: The field has to be approximated by a rectangle; the ratio of horizontal to vertical hydraulic conductivity must be 1, that is, the porous media must be isotropic; the water table is simulated by superimposing a sine curve on a low regional slope. The analytical approach requires that equations be set up for each individual case considered according to the boundary configurations. There is no general analytical solution to the ground-water-flow equation that is valid for all boundary conditions at the same time.

The advantages of the numerical solution as outlined by Freeze (1969b), on the other hand, are as follows: Many of the restrictions of the analytical solution are removed; the true shape of the water table can be approximated, that is, it is not restricted to the equation for a sine curve; equation 1 can be handled in the numerical solution, that is, anisotropic and heterogeneous conditions can be simulated. The numerical solution available in the USGS program is general; it was designed to handle a wide variety of hydrogeologic problems, including the vertical section simulations used in this study.

Both basic studies by Tóth and Freeze assume no-flow boundaries at the base of the system and no-flow boundaries beneath the regional topographic highs and lows. In addition, the water table is at steady state.

An example of one of Tóth's cross-sectional ground-water flow simulations is shown in figure 2. The simulation is of a thick ground-water system that has low regional slope and low local relief. Although Tóth presents many such diagrams showing the effects on ground-water flow of many combinations of slope, relief and system thickness, this diagram best depicts his delineation and definition of local, intermediate, and regional flow systems.

An example of the flexibility of numerical models in closely simulating field conditions is shown in figure 3 (Freeze, 1969b). The diagram is of a hydrogeologic setting that has a variable water table in different parts of the section, anisotropic media, and zones of different hydraulic conductivities.

DIGITAL MODELS OF GROUND-WATER FLOW NEAR LAKES

PRACTICAL CONSIDERATIONS AND ASSUMPTIONS OF THIS STUDY

The boundary conditions assumed for this study relate closely to those of Freeze (1969b), that is: (1) The base of the system is considered to be impermeable; (2) the vertical no-flow boundaries at each end of the section are considered to be controlled by the major topographic high and the major drain on the ground-water system; and (3) the upper boundary of the flow system is the water table and it is at steady state. In the model used for this study, the steady-state water table is specified by assigning effectively infinite storage to the water-table nodes. Freeze discusses thoroughly the justification for these boundary conditions and particularly the assumption that vertical no-flow boundaries exist at the two end positions. As he points out, many workers have found that vertical no-flow boundaries do not occur beneath every topographic high. This is undoubtedly true, but the assumption that they do exist beneath the major high and low is considered to be valid.

Although the sections discussed in this report are hypothetical, they closely approximate field conditions for lakes in glacial terrane. The variations in height of the water table relative to lake level are reasonable for this type of terrane. Although the hydraulic conductivities that have been assigned to the geologic matrix in general are representative of silty till, in the simulations of this study, the relative values of hydraulic conductivity are the controlling factor, not the actual values. The simulated sections apply equally to geologic settings that have the given relative hydraulic conductivities, whether the setting is sand within till, or gravel within sand. The hydraulic conductivities assigned to the zones of higher relative hydraulic conductivity vary from 100 to 1,000 times greater than the surrounding geologic materials. There are, of course, some zones within glacial drift that have hydraulic conductivity values greater than 1,000 times that of the surrounding materials, but the values chosen are representative of a great many geologic settings. For convenience in this report, the geologic matrix is referred to as "till," and the zones of relatively higher hydraulic conductivity are referred to as "aquifers."

The hydraulic conductivities assigned to lake sediments are as low as can be assigned with the computer program used. In most lakes, the littoral zone is free of fine grained sediment; therefore, in the models that considered lake sediments, the sediments purposely were not extended to the shore line.

Lake water was simulated by assigning very high

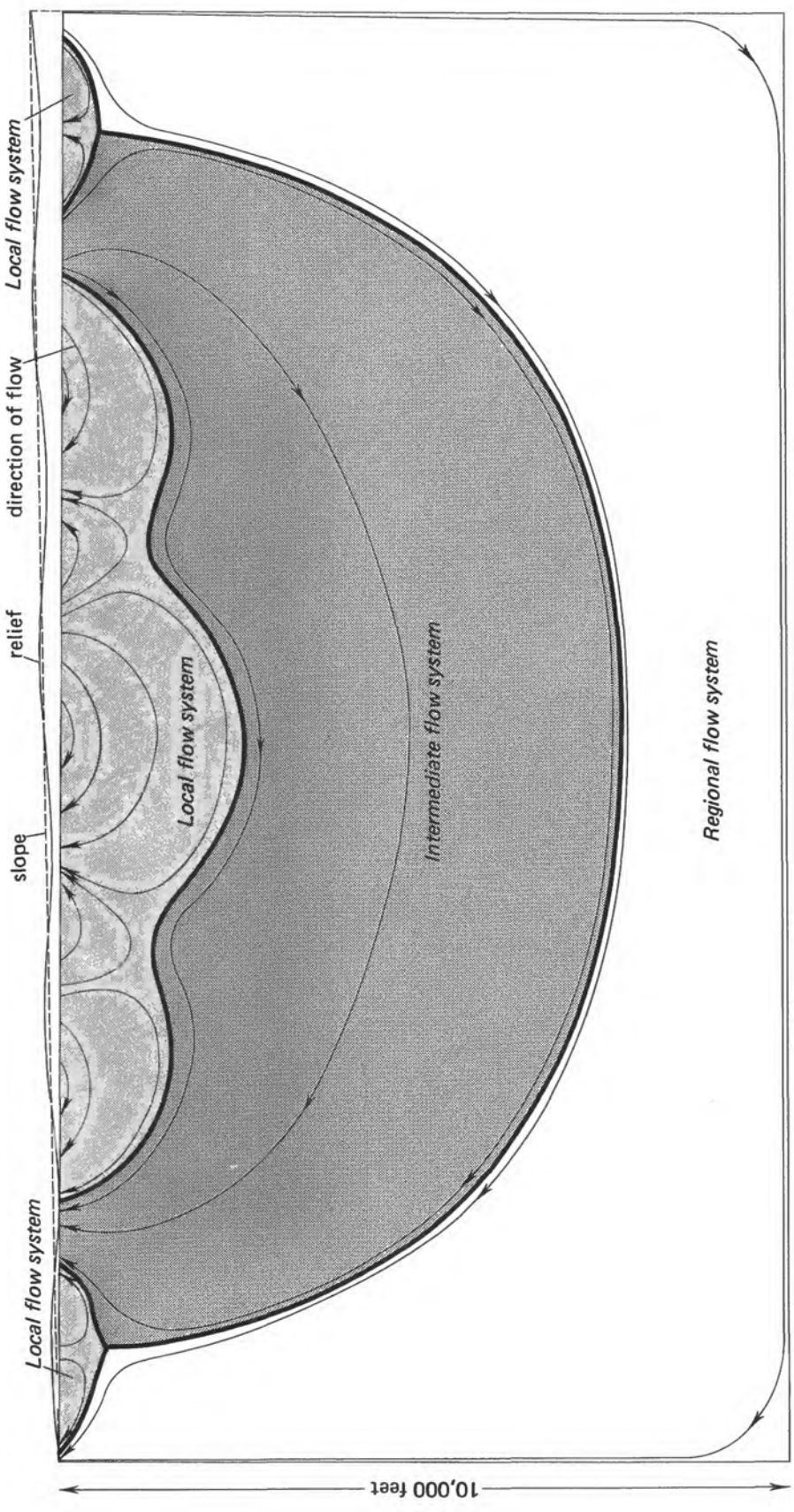


FIGURE 2.—Hydrologic section showing local, intermediate, and regional ground-water flow systems determined from an analytical solution to the ground-water-flow equation. (From Tóth, 1963.)

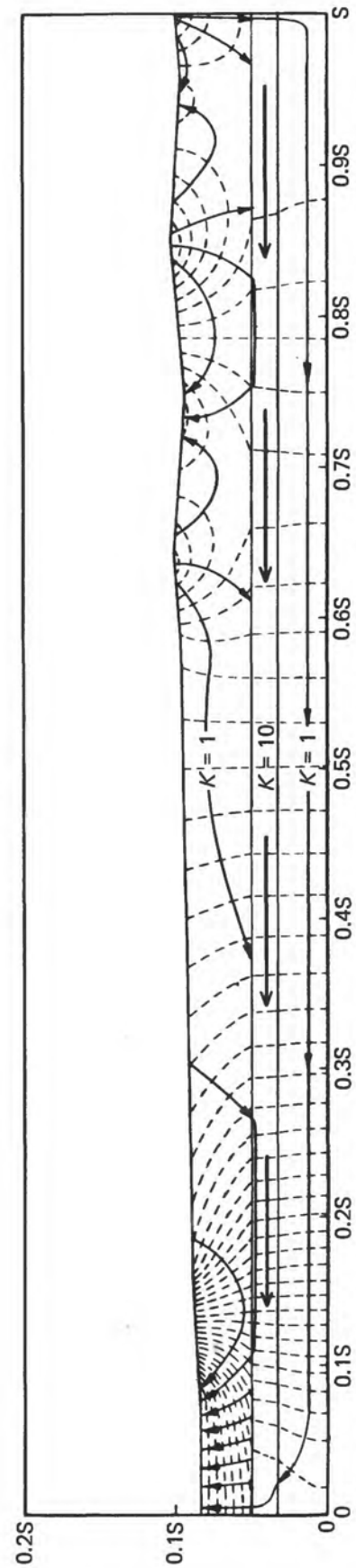


FIGURE 3.—Hydrologic section showing ground-water flow systems determined from a numerical solution to the ground-water-flow equation. (From Freeze, 1969b.)

hydraulic conductivity values to the nodes within lakes. This proved to adequately simulate lakes because the calculated head values were identical to the initial head values within each lake simulated in this study.

The least well known parameter needed in the ground-water-flow model is the ratio of horizontal to vertical hydraulic conductivity (K_h/K_v). This ratio has generally not been determined in glacial terrane and it is a point around which much of the discussion of the following section of this report centers. It will be shown that it is critical to the interaction of lakes and ground water. If the ratio is less than 100, lakes rarely lose water to the ground-water system under the conditions simulated in the models and if the ratio is greater than 1,000, lakes lose water under many conditions. If the ratio is between 100 and 1,000, other factors that control ground-water flow become more important in the relationship of ground water to lakes.

Weeks (1969) measured K_h/K_v within a single outwash sand and gravel aquifer in Wisconsin and found the ratio to be not more than 20. Vecchioli and others (1974) calculated K_h/K_v for part of the drift section of Long Island, New York as approximately 500. Bennett and Giusti (1971), in using electric-analog techniques to study ground-water flow in the coastal plain of Puerto Rico, show that the ratio had to be 1,000 for the simulations to match field data. The importance of this parameter in ground-water-flow modeling has been recognized because it is the topic of recent papers by Freeze (1972) and Gillham and Farvolden (1974). Freeze concludes that K_h/K_v values of 100 or larger are not uncommon, and in fact were necessary to correlate simulations with field measurements in his study of the Old Wives Lake basin in Saskatchewan (Freeze, 1969a). Gillham and Farvolden (1974) tested the sensitivity of the ratio and found it to be particularly important in areas of recharge and discharge.

Considering the above studies, the models discussed in the following section of this report use both 100 and 1,000 as lower and upper examples.

GROUND-WATER-FLOW DIAGRAMS

Much of the remainder of this report is a discussion of ground-water flow systems near lakes, which are best illustrated by diagrams showing ground-water flow in cross section. Understanding of the important features of this type of diagram is basic to the discussion of the simulation results. A ground-water-flow diagram shows the distribution of hydraulic head within the ground-water system. After the head is calculated for each node, lines of equal head, equipotential lines, are drawn. Ground-water flow lines are drawn perpendicular to the equipotential lines, if the medium is isotropic. Equipotential lines are the projections of water-table contours into the subsurface (figure 4).

The finite difference grid used in this study is a network of uniform rectangles. About 900 nodes were used for the one-lake simulations and about 1,800 nodes for the three-lake simulations.

To give the most accurate picture of ground-water flow systems, and to estimate relative quantities of ground water moving through various parts of the ground-water reservoir, a flow net should be drawn. Construction of a quantitative flow net in a medium that is isotropic ($K_h/K_v=1$), requires that flow lines and equipotential lines be orthogonal such that curvilinear squares are formed (Harr, 1962).

If the medium is anisotropic ($K_h/K_v \neq 1$) the squares are deformed according to the degree of anisotropy. In this study, K_h/K_v is either 100 or 1,000. To compensate for the anisotropy, in homogeneous media equation 1 can be transformed to the LaPlace equation by a transformation of coordinates. The scale factor used to do this, which was not applied to the diagrams in this report (discussed later), is the square root of the ratio K_h/K_v (Harr, 1962, p. 29).

A requirement for constructing precise flow nets is that the section have no vertical exaggeration (Van Everdingen, 1963). Vertical exaggeration is usually used for convenience in illustrating important details of geology and ground-water movement that would be lost if the true scales were used. The sections discussed in this study have a vertical exaggeration of 80:1. Because the graphical correction of Van Everdingen (1963) was not applied to the sections in this study, they cannot be used as exact quantitative diagrams. The diagrams of Van Everdingen (1963) provide good examples of the effect of the correction on the ground-water-flow fields. The effect basically is that the corrected flow nets are much more rectangular and the local systems extend deeper into the ground-water reservoir than in flow sections not corrected for vertical exaggeration. The flow nets (figures 4 and 5) were drawn as if the porous medium were isotropic and homogeneous merely to show the general concept of flow nets and the different-magnitude flow systems that can occur near lakes and within the ground-water reservoir. Although the two flow nets drawn for this study are not quantitatively precise, they do show relative proportions of flow in different parts of the ground-water system.

The ground-water system illustrated in figure 4 consists of several flow systems of different magnitude. The upper part of the ground-water system consists largely of local flow systems where water moves from high points on the water table (water-table mounds) to adjacent lowlands occupied by lakes. Regional ground-water flow occurs deep in the system. Recharge to the regional flow system occurs at the major drainage divide and discharge from this system is to the major drain (stream). A zone of intermediate flow (darkly stippled area) is recharged at the water-table mound between lakes 2 and 3 and is discharged into lake 1. It should be noted, but will be discussed in more detail later, that much more ground water moves through local flow systems than through the deep

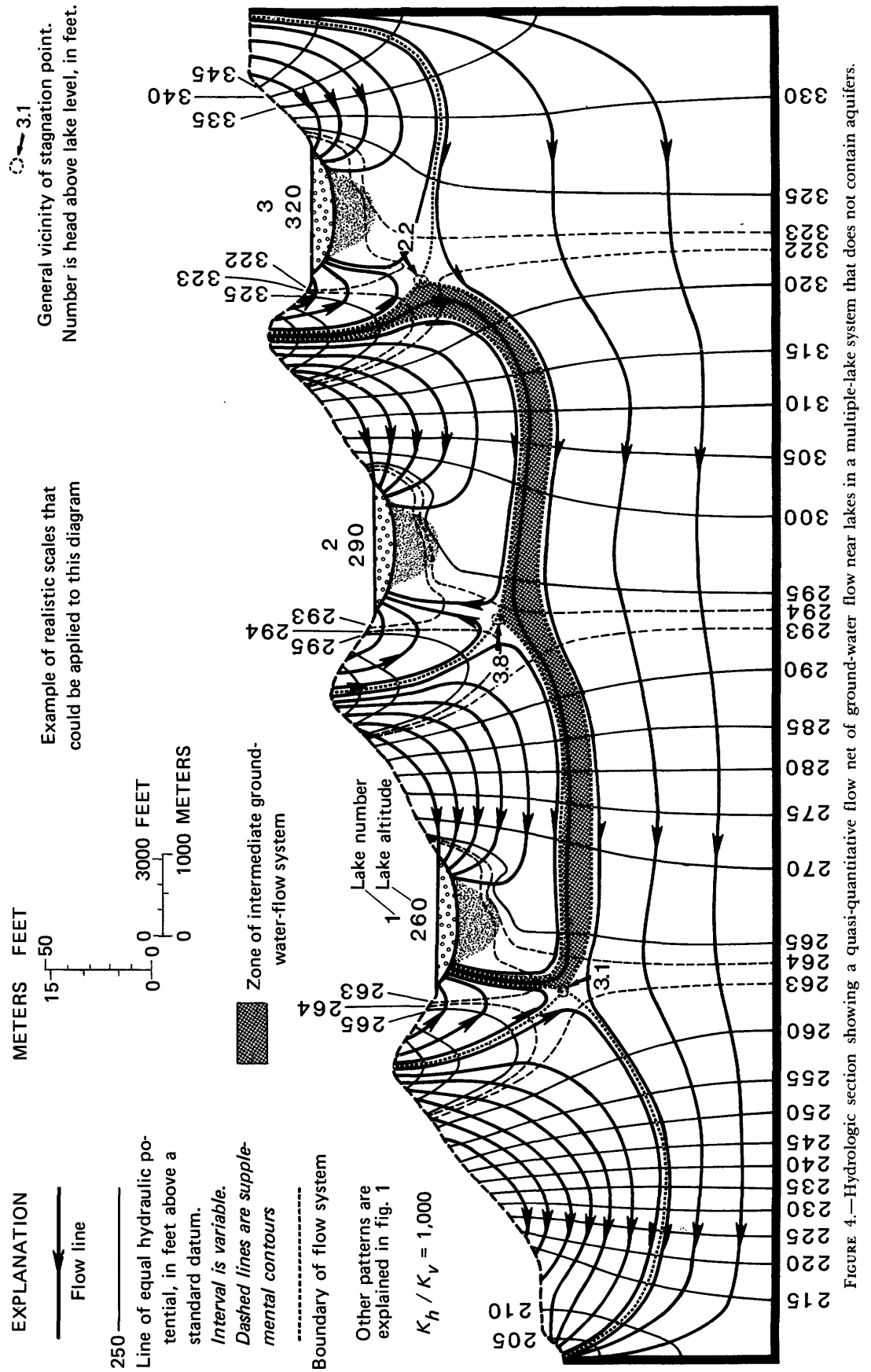


FIGURE 4.—Hydrologic section showing a quasi-quantitative flow net of ground-water flow near lakes in a multiple-lake system that does not contain aquifers.

regional system as shown by the closer spacing of the flow lines in the local systems. A thorough discussion of similar type ground-water-flow diagrams is given by Tóth (1963), Meyboom (1966, 1967), and Freeze (1969b).

Of special interest to this study are the lines, hereafter referred to as divides, separating the several types of flow systems. In following the line dividing the zone of local flow from zones of larger magnitude flow (by lake 3, fig. 4, for example), it should be noticed that there is a point on the divide at which the head is a minimum compared to every other point along the divide. This point of minimum head occurs beneath the shoreline on the downslope side of the lake. In the case illustrated, the hydraulic head at this point is 2.2 feet (0.7 m) higher than the water-level altitude of lake 3. The hydraulic head everywhere else along the divide is greater than 2.2 feet (0.7 m) above the lake-level altitude. Thus, under the given conditions, it is impossible for water to move from the lake to the ground-water system because the hydraulic gradient is upward toward the lake bottom.

This point of minimum head is the stagnation point commonly referred to in the ground-water-flow literature (for example, Harr, 1962). It is a point in the flow field at which vectors of flow are equal in opposite directions and therefore cancel. A value of head exists at the stagnation point and, as will be shown below, it is this value of head relative to the head represented by lake level that is of prime interest in understanding the interaction of lakes and ground water. If a stagnation point exists that has a head greater than that of lake level, a continuous ground-water divide exists beneath the lake making it impossible for water to move against the hydraulic gradient from the lake to the ground-water system. The position of the stagnation point is determined by the distribution of head within the ground-water system.

The stagnation point is a point of diversion of ground-water-flow paths (fig. 4). Water moving downward from the water-table mound on the downslope side of the lake is diverted upward toward the lake. A small amount of water that moves beneath the lake from the upslope side is diverted upward toward the lake on the downslope side. Water moving in the local or intermediate flow systems of the lakes at lower altitudes is diverted downslope and water moving in the regional flow system is diverted deeper into the ground-water reservoir.

Much of the remainder of the report is concerned with the effect of varying the height of the water table in relation to lake level, K_h/K_v, K_{aq}/K_t (ratio of the hydraulic conductivity of aquifers to that of the surrounding till), position and size of aquifers, and lake depth, on the position and head value of the stagnation point relative to lake level.

To illustrate the effect of varying several parameters on the ground-water flow systems in general and the stagnation point in particular, figures 4 and 5 can be compared. The presence of aquifers of limited extent, which have hydraulic conductivity 1,000 times greater than the till and are at an intermediate depth within the ground-water system, change the configuration of the flow systems. The aquifers also decrease the head at the stagnation points relative to the level of each lake and move the points closer to the bottom of lakes 1 and 2. In addition to having a limited aquifer beneath the water-table mound between lakes 2 and 3, the height of the water table was decreased on both sides of lake 3. These two changes near lake 3 result in reduced local ground-water flow into one-half of lake 3 on the upslope side, a small amount of ground-water flow into the littoral zone of the lake on the downslope side, and loss of lake water to the ground-water system through most of the downslope half of the lake bottom.

To appreciate fully the discussion in the following part of the report, the diversion of ground-water-flow lines caused by the presence of aquifers of limited extent within the till should be noted (fig. 5). It should be noted also that an intermediate flow system was sketched in figure 4, but not in figure 5. Although an intermediate flow system could have been included in figure 5 and deleted from figure 4, the intermediate system was included in figure 4 to illustrate where such systems can occur, where they are recharged, and where they discharge. The intermediate system could be recharged at any of the upper three water table mounds or discharged into any of the lower lakes or the major drain. Such systems have importance especially in explaining differences in water chemistry in lakes occurring at different altitudes in a region.

Ground-water chemistry is controlled partly by the length of time a particle of water is in contact with minerals in the geologic framework through which the water flows. Thus, the longer the flow path, or the lower the hydraulic conductivity, the longer the residence time, and the greater will be the opportunity for chemical interchange. For lakes situated on geologic materials of similar hydraulic conductivity, those that receive ground water from intermediate or large local ground-water flow systems are more likely to contain more, and a wider variety of, dissolved minerals than lakes that receive ground water from small local flow systems. It will be seen in the remainder of the report that the size of local flow systems alone can vary widely. Therefore, the large variation in lake-water chemistry that is so frequently noted in lakes in close proximity in many lake regions is not at all surprising. On the contrary, after becoming aware of the factors that control the interaction of lakes and ground water discussed in this report, and realizing that virtually every lake has its unique ground water contribution, a wide variety in the chemistry of lakes should be expected.

Because the stagnation point is the key to understanding the relation of ground-water to lakes and it is determined by the distribution of head, the remainder of the illustrations in the report are contoured computer

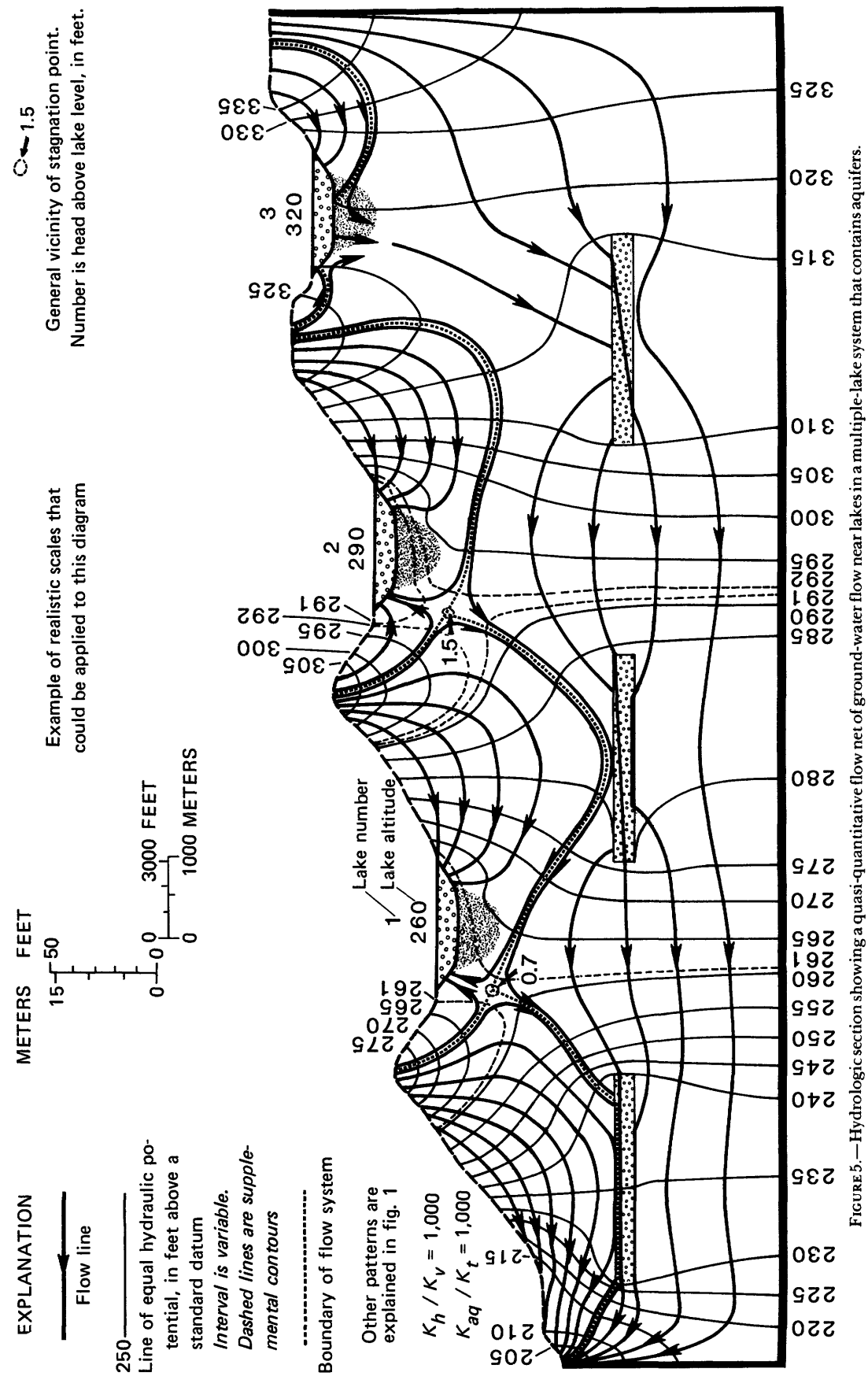


FIGURE 5.—Hydrologic section showing a quasi-quantitative flow net of ground-water flow near lakes in a multiple-lake system that contains aquifers.

printouts that show only isopotential lines. The isopleth interval is variable; only enough lines were drawn to depict the general distribution of hydraulic head, the specific location and head of the stagnation point, or the percent of lake bottom through which the lake loses water to the ground-water system. Figure 4, a specially constructed flow net, can be compared with figure 6, a contoured computer printout, to aid in understanding the remainder of the illustrations in this report. Both diagrams are of identical settings.

The following sections of the report discuss two general settings. In the first, one lake is situated within the side of a drainage basin. The interaction of lakes and ground water is thoroughly studied for this type of setting by examining all possible combinations of the parameters mentioned previously. In the second general setting, three lakes are situated within the side of a drainage basin to examine the relationship of the lakes to each other and to compare the results to the one-lake setting.

The diagrams of vertical ground-water flow are discussed in dimensionless terms. But because lakes in glacial terrane are of primary interest in this study, the dimensions expected to be of most general interest are also given.

It must be kept in mind, however, that the specific results of this study apply to ground-water systems that approximate the given conditions. If the boundaries were greatly changed relative to each other, the problem would then be changed. However, if the new problem were analyzed as in this study, the general conclusions would be similar to this study.

ONE-LAKE SYSTEM

The approximate dimensions, relative to total length and thickness of the ground-water system, of features in the one-lake system are given in the following paragraphs and in figure 7. Realistic examples of the dimensions are shown in parentheses.

The thickness of the system ranges from $0.35T$ (70 ft; 21 m) at the lower end of the basin to T (as much as 200 ft; 61 m) at the upper end. The length of the system (L) is approximately 6 miles (9 km). The height of the water table above lake level is varied between $0.20T$ and $0.35T$ (40 and 70 ft; 12 and 21 m) on the upslope side of the lake and between $0.05T$ and $0.10T$ (10 and 20 ft; 3 and 6 m) on the downslope side. Lake depths simulated are $0.05T$ and $0.25T$ (10 and 50 ft; 3 and 15 m). Values of K_h/K_v (horizontal to vertical hydraulic-conductivity ratio) used in the simulations are 100 and 1,000. Simulated aquifers vary from full aquifers ($0.05T \times L$) that extend the entire length of the basin to aquifers of limited extent ($0.05T \times 0.25L$) that occur upslope from the lake (center point at $0.85L$), beneath the lake (center point at $0.60L$), and downslope from the lake (center point at $0.35L$). The aquifers are placed both at the base and at an intermediate level (center point at $0.25T$ above the base of the system) of the ground-water reservoir. The lake surface is at $0.65T$ above the base and the midpoint is about $0.60L$ from the downslope end of the section for all simulations of the one-lake system. The system simulated can be thought of as a ground-water reservoir that has a datum of 100 feet (30 m) (bottom of the ground-water reservoir). The values of head are in feet relative to that datum, thus the lake surface has an altitude of 230 feet (70 m), the higher water table at the upslope end of the section 300 feet (100 m), and the water table at the downslope end 170 feet (52 m).

A large number of simulations could be run varying each of these parameters. Generally, the parameters are varied between two values so the general direction of change of the stagnation point could be determined. If a change in a parameter lowers the head at the stagnation point relative to lake level, an even greater change of that parameter in the same direction would lower the head at the point even more.

The pattern of ground-water flow near a lake that has a water table $0.35T$ higher than lake level on the upslope side and $0.1T$ higher on the downslope side, has no sediments, and K_h/K_v=1,000, is shown in figure 8. A ground-water divide occurs deep beneath the lake that has a head at the stagnation point $0.009T$ (1.8 ft; 0.5 m) higher than lake level. The position of the stagnation point is approximately $0.2T$ above the base of the system. In contrast, if lake sediments are simulated, and all other parameters are held constant, the ground-water divide shifts slightly upward, and the head at the stagnation point increases to $0.02T$ (4.2 ft; 1.3 m) higher than lake level (fig. 9). Thus, it is evident that the presence of lake sediments has a significant effect on the position and head of the stagnation point. Because lakes without sediments are virtually unknown, much of the remainder of this report is concerned with lakes that have a sediment layer.

The effect on the interaction of lakes and ground water of lowering the water table $0.05T$ (10 ft; 3 m) on the downslope side and holding all other parameters as in figure 9, is shown in figure 10. The head at the stagnation point drops to $0.007T$ (1.4 ft; 0.4 m) above lake level and the point moves closer to the bottom of the lake. Again, holding all parameters as in figure 10, but lowering the water table on the upslope side of the lake to $0.20T$ (40 ft; 12 m) above lake level, decreases the head at the stagnation point to $0.004T$ (0.9 ft; 0.3 m) above lake level (fig. 11). The stagnation point remains at about the same position as in figure 10. This suggests that the height of the water table relative to lake level on the upslope side of a lake has less influence on the stagnation point of the ground-water divide beneath a lake than that on the downslope side.

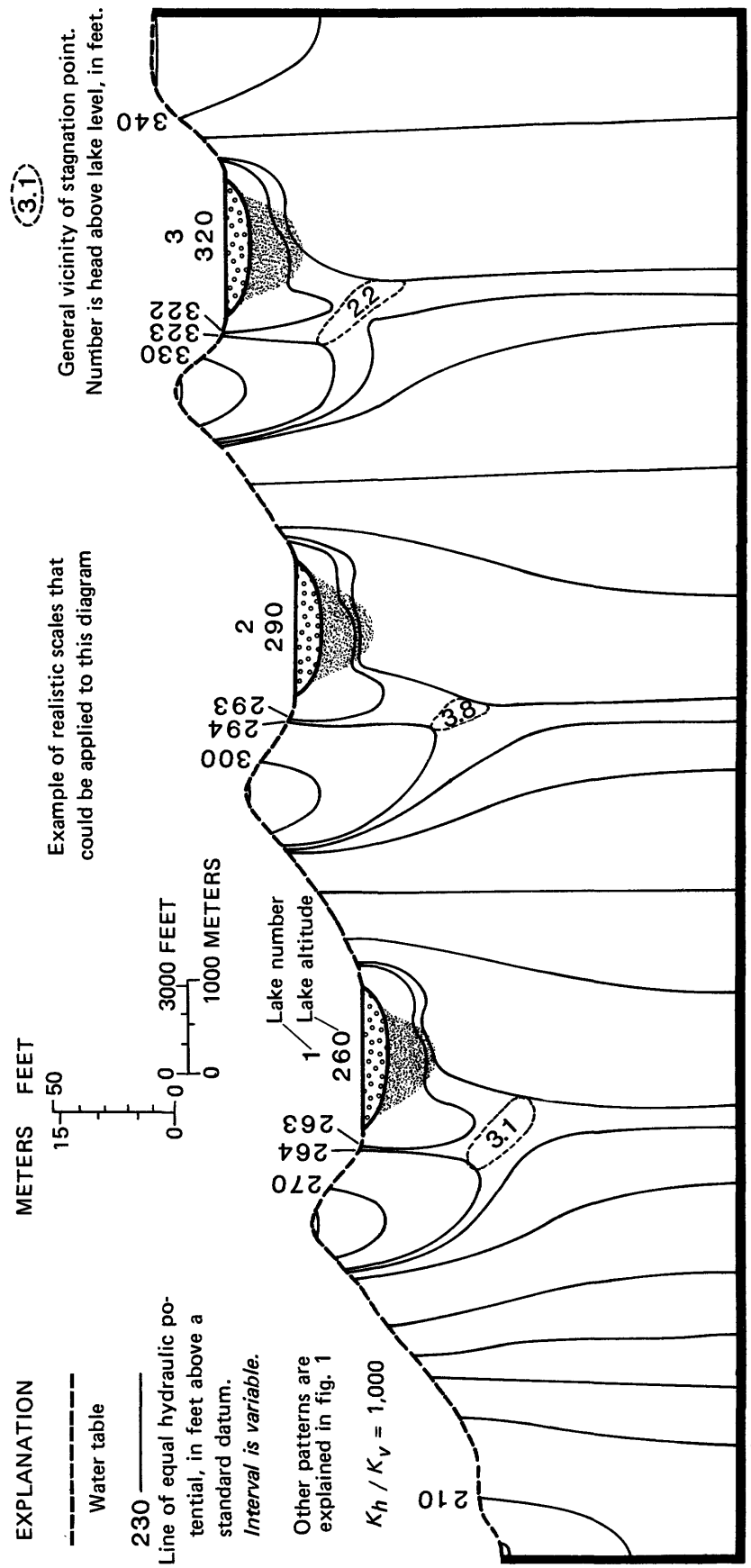


FIGURE 6.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that does not contain aquifers.

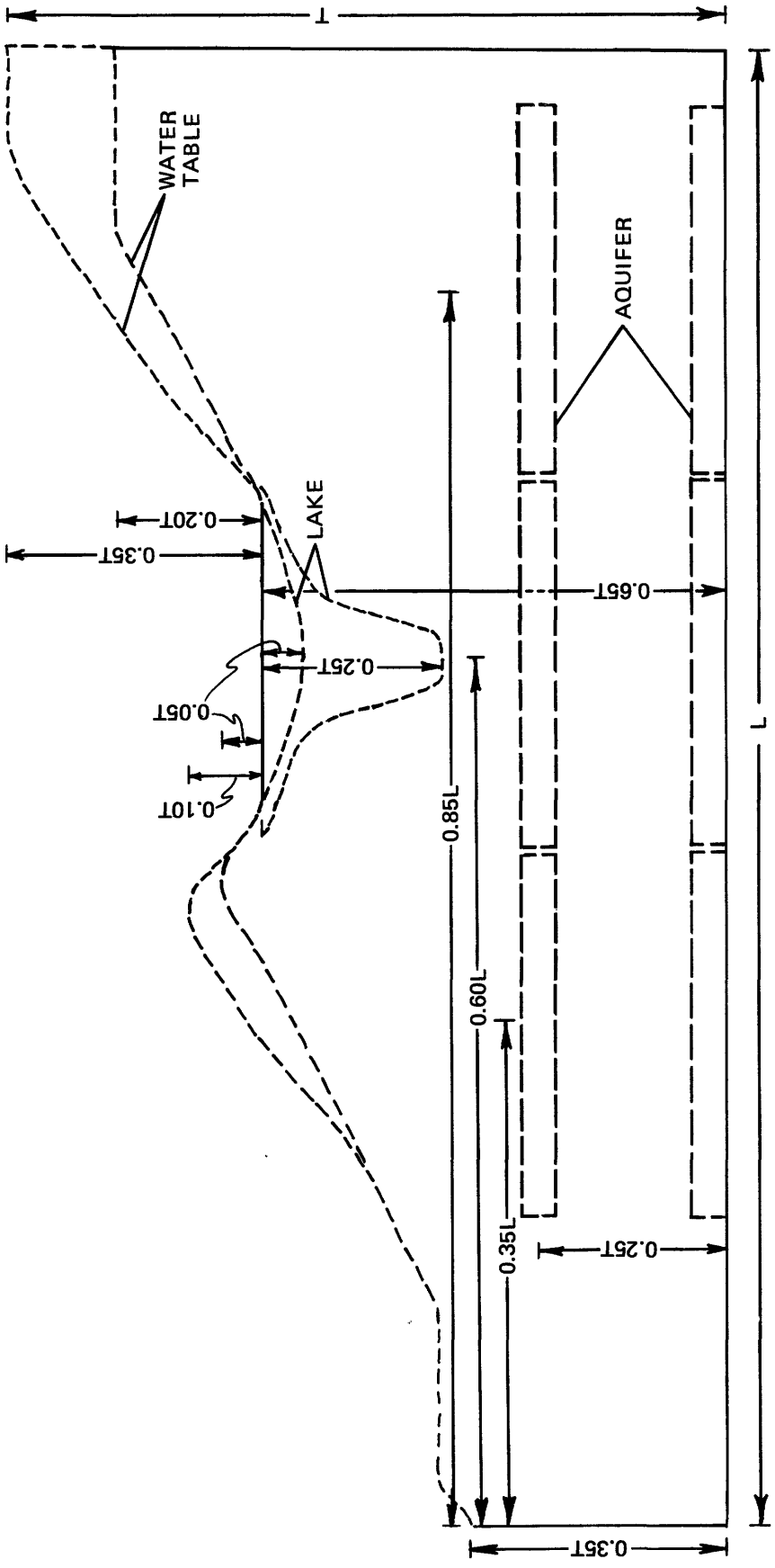


FIGURE 7.—Hydrologic section showing the dimensions of features included in the diagrams of the one-lake system.

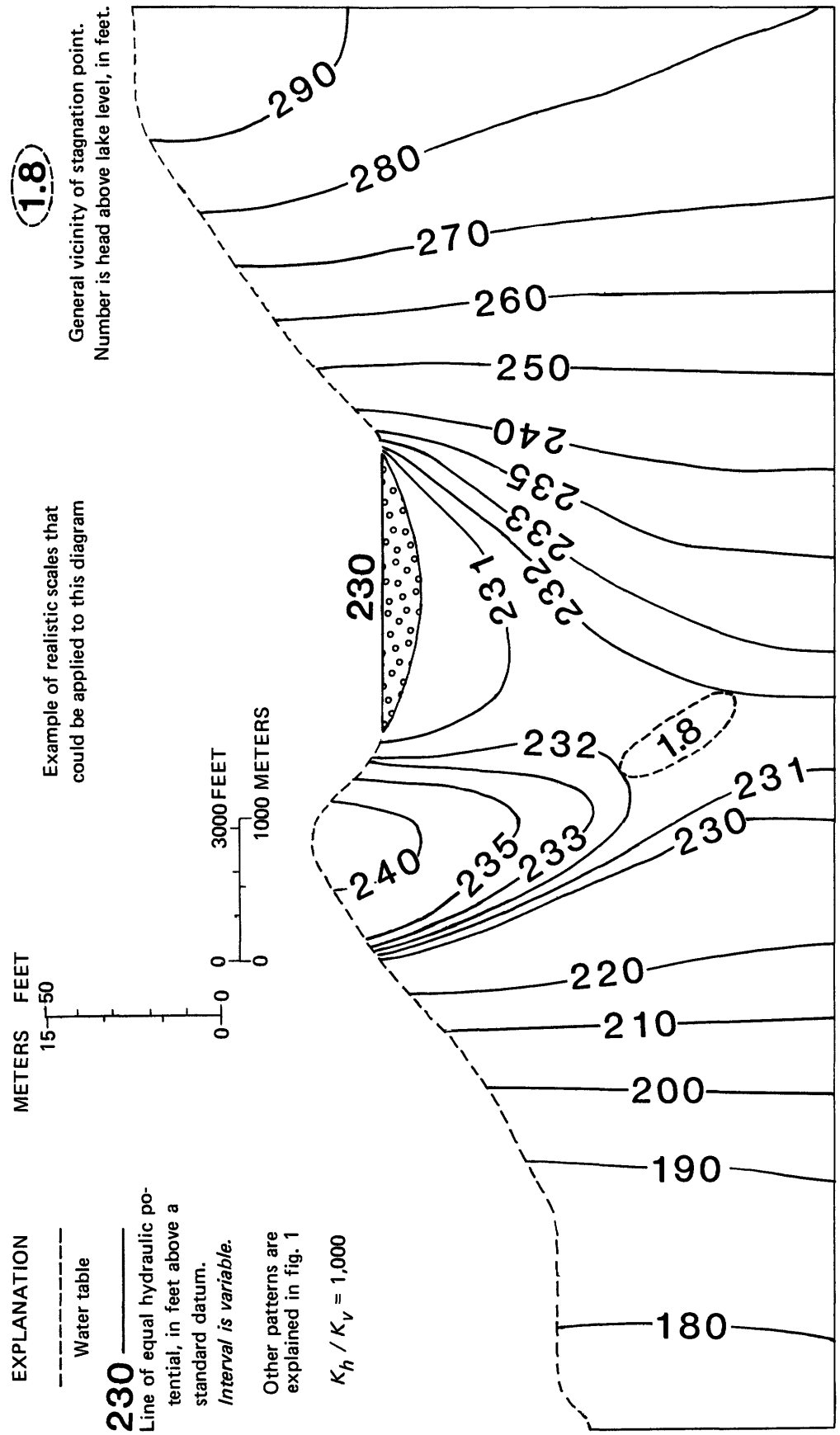


FIGURE 8.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that does not contain aquifers or lake sediments.

The presence of extensive aquifers within the ground-water reservoir has a significant effect on the interaction of lakes and ground water as seen in figure 12. Given the same setting as in figure 9, but simulating an aquifer at the base of the ground-water system that extends the full length of the basin and has K_{aq}/K_t=100, decreases the head at the stagnation point from $0.02T$ (4.2 ft; 1.3 m) (figure 9) to $0.001T$ (0.2 ft; 0.1 m) higher than lake level. Again, holding all parameters constant, but increasing K_{aq}/K_t to 1,000 causes the lake to lose water to the ground-water system through its entire bed (fig. 13).

The effect on the interaction of lakes and ground water of raising the extensive aquifer vertically to the $0.25T$ (intermediate) level in the ground-water system, where the setting is otherwise similar to figure 12, is shown in figure 14. The weak ground-water divide (head at the stagnation point is $0.001T$ (0.2 ft; 0.1 m) higher than lake level) in the former is obliterated and the lake loses water through three-eighths of its bed.

The position of smaller aquifers of limited extent within the ground-water reservoir also has varying influences on the interaction of lakes and ground water. All parameters other than the location of the limited aquifer at the base of the ground-water system are held constant in figures 15, 16, and 17. In the simulation that has a limited basal aquifer upslope from the lake ($0.85L$) (figure 15), the head at the stagnation point is $0.006T$ (1.3 ft; 0.4 m) above lake level. With the limited basal aquifer beneath the lake ($0.60L$) (figure 16), the head at the stagnation point is $0.009T$ (1.8 ft; 0.5 m) above lake level. The limited basal aquifer underlying the water-table mound on the downslope side of the lake ($0.35L$) causes the lake to lose water through three-eighths of its bed (figure 17).

Similar patterns of ground-water flow near lakes hold for settings that have aquifers at the same position laterally but moved vertically to $0.25T$ above the base of the ground-water system. One difference is that, if a limited aquifer directly beneath a lake is raised vertically, it tends to increase the head at the stagnation point. In a section simulating this situation, the head at the stagnation point increases from $0.009T$ (1.8 ft; 0.5 m) (figure 16) to $0.012T$ (2.5 ft; 0.8 m) higher than lake level with the aquifer at the higher position. If the limited aquifer is raised to directly under, and in contact with, the lake sediments, the head at the stagnation point increases to $0.016T$ (3.3 ft; 1.0 m) higher than the lake level. If the aquifer is at an intermediate level but downslope from the lake ($0.25T$, $0.35L$), a situation parallel to that shown in figure 17, the percentage of lake bottom through which water moves to the ground-water system increases from three-eighths to four-eighths.

These simulations suggest that the position of limited aquifers beneath or upslope from a lake has little influence on the interaction of lakes and ground water. But if the limited aquifer underlies the water-table mound on the downslope side of the lake, there is a strong tendency for the head at the stagnation point to be only slightly above lake level, if at all; in the latter case the lake loses water through part of its bed.

The effect of lake depth on the interaction of lakes and ground water can be seen by comparing figure 18 with figure 12. All parameters in these two simulations, except depth, are identical. The small difference between lake level and head at the stagnation point associated with the shallow lake (fig. 12) is eradicated in the deep-lake setting, and the lake loses water through about six tenths of its bed. This example is one of the more dramatic in comparing ground-water flow near shallow and deep lakes. In some simulations the difference is not as great, but in all cases the difference between lake level and the head at the stagnation point for deep lakes is less, or they have more tendency to lose water, than shallow lakes in equivalent settings.

It is evident that a large number of simulations would be needed to examine all possible combinations of the variables considered in this study. To keep the analysis as simple as possible, yet show the underlying relationships of the interaction of lakes and ground water, a parallel series of lake-ground water settings are compared and summarized in table 1. At first glance the table might seem complex, but with a little study it is not so formidable. It should be realized that many variables are summarized in this one table.

The table consists of four quadrants, each of which is subdivided into four subquadrants. Each subquadrant has an upper and a lower part. For ease of discussion, the different parts of the table are referred to as shown in figure 19. The major quadrants are the combinations of hydraulic conductivity (K_h/K_v and K_{aq}/K_t) used in the study. In quadrant I, both ratios are 100 and in quadrant IV, both are 1,000. Within the subquadrants are combinations of the height of the water table above lake level for both sides of the lake. In subquadrant I-1 the water table is $0.35T$ (70 ft; 21 m) higher on the upslope side and $0.10T$ (20 ft; 6 m) higher on the downslope side. In subquadrant I-4, the water table on the upslope side is $0.20T$ (40 ft; 12 m) higher than lake level and $0.05T$ (10 ft; 3 m) higher on the downslope side. Within each of the subquadrants, the upper part (a) refers to shallow lakes and the lower part (b), refers to deep lakes. Within each part (a and b), the position and size of the aquifers are listed in a parallel fashion as follows:

FB–Full (extensive) aquifer at the base of the ground-water system.

FM–Full (extensive) aquifer at an intermediate level ($0.25T$) of the ground-water system.

PBU–Partial (limited extent) aquifer at the base of the ground-water system upslope from the lake ($0.85L$).

PBB–Partial (limited extent) aquifer at the base of the ground-water system beneath the lake ($0.60L$).

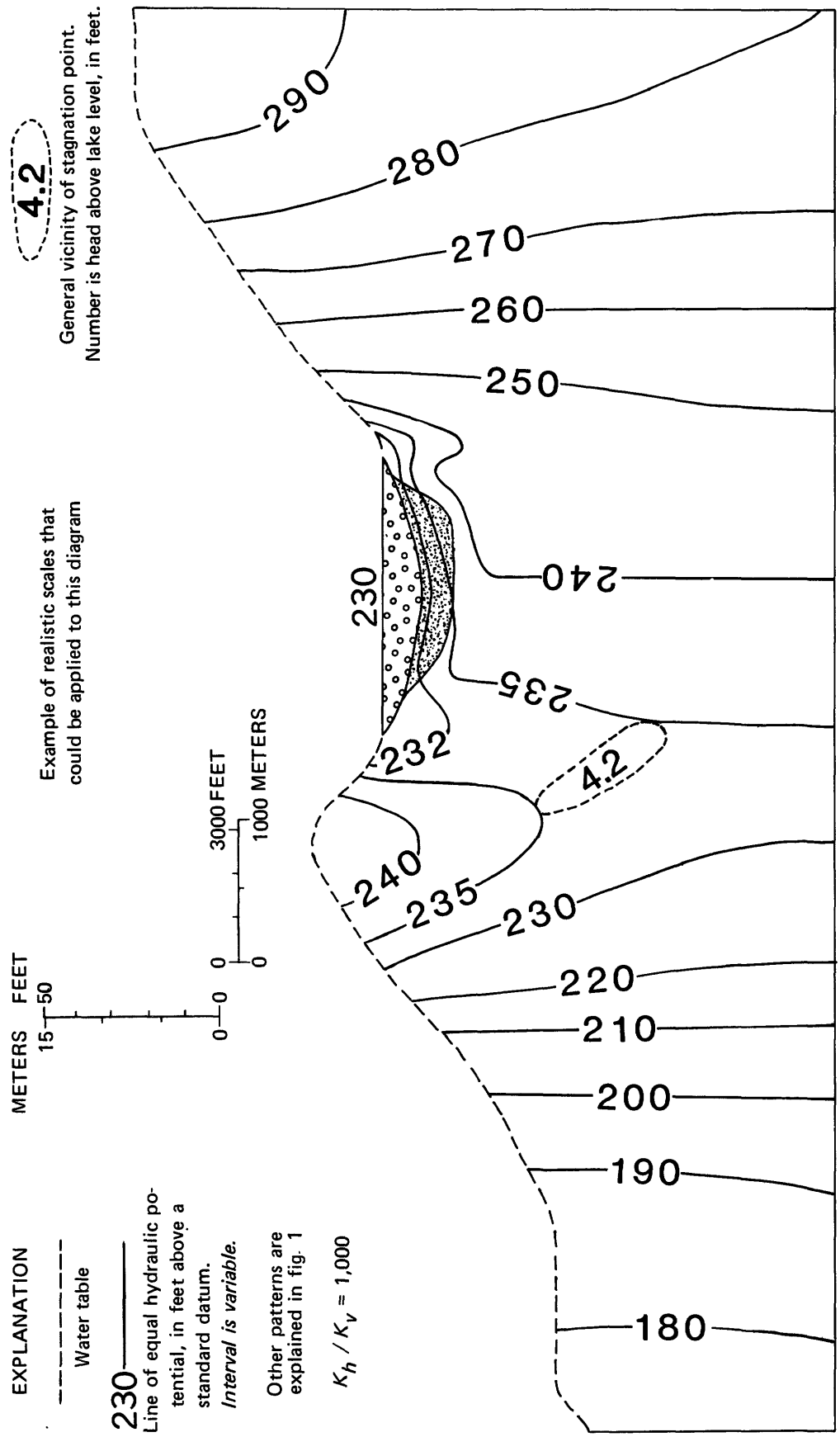


FIGURE 9.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that contains lake sediments but does not contain aquifers.

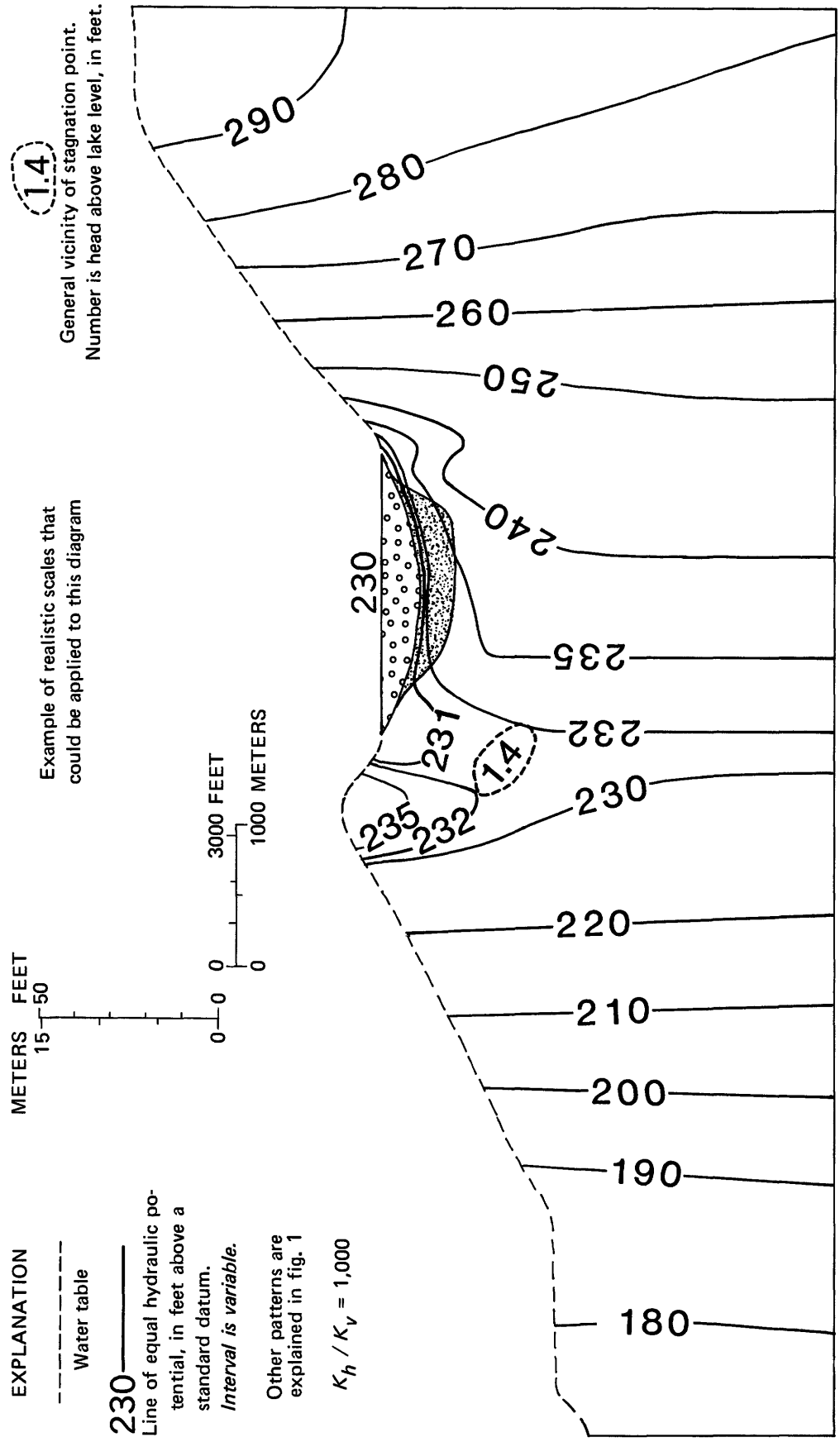


FIGURE 10.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has a low water-table mound on the downslope side of the lake and does not contain aquifers.

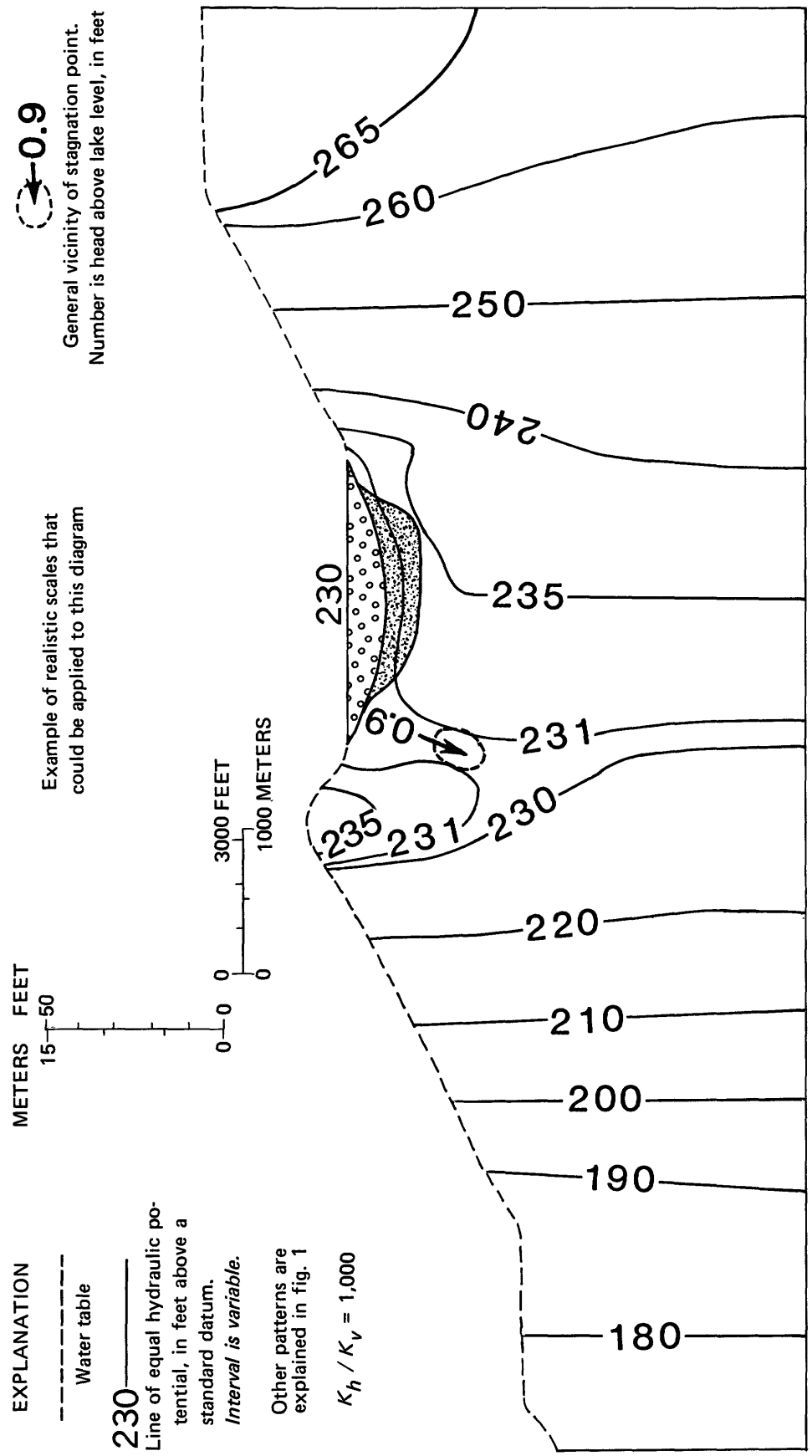


FIGURE 11.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has low water-table mounds on both sides of the lake and does not contain aquifers.

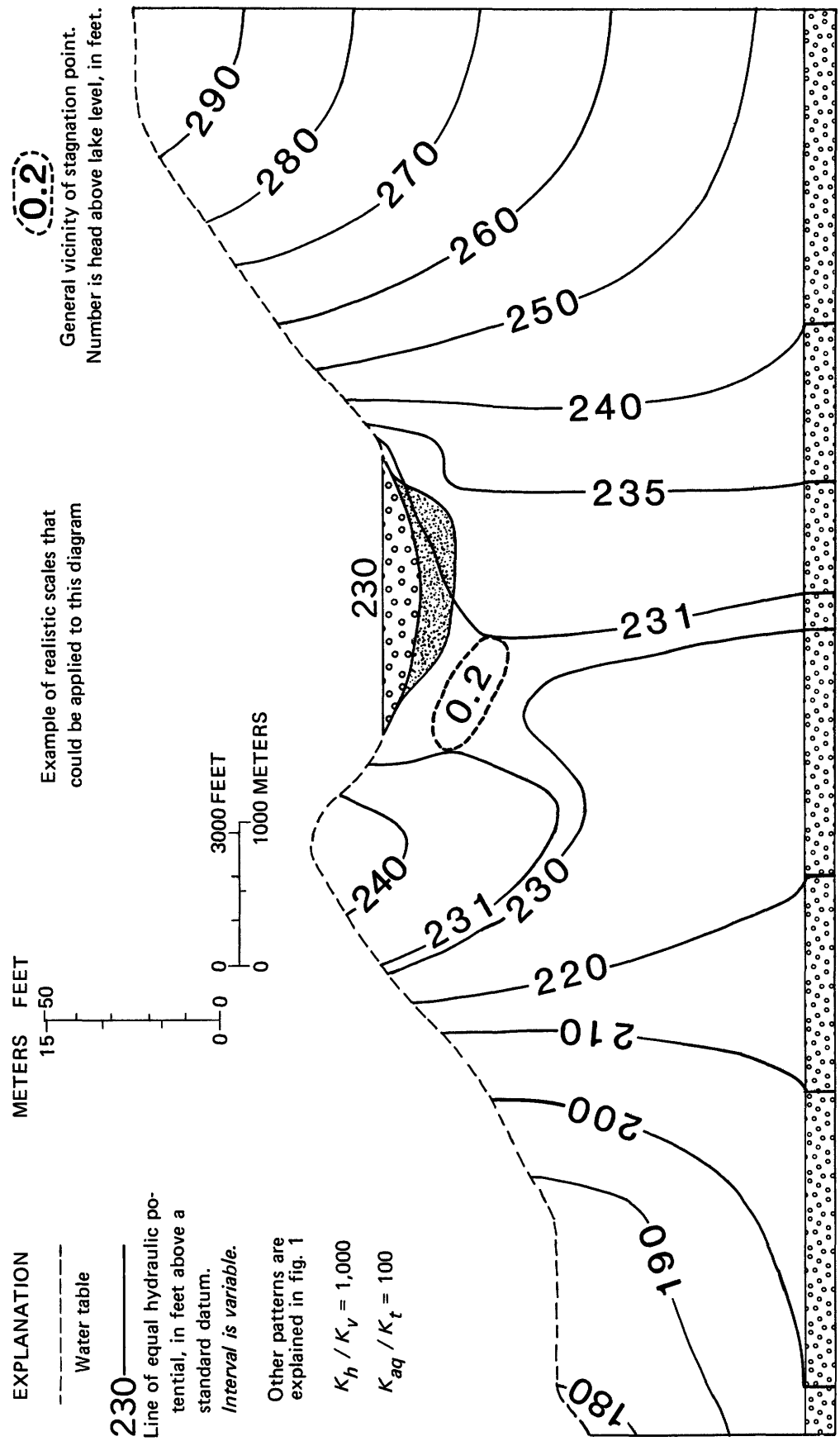


FIGURE 12.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has an extensive aquifer of relatively low hydraulic conductivity at the base of the system.

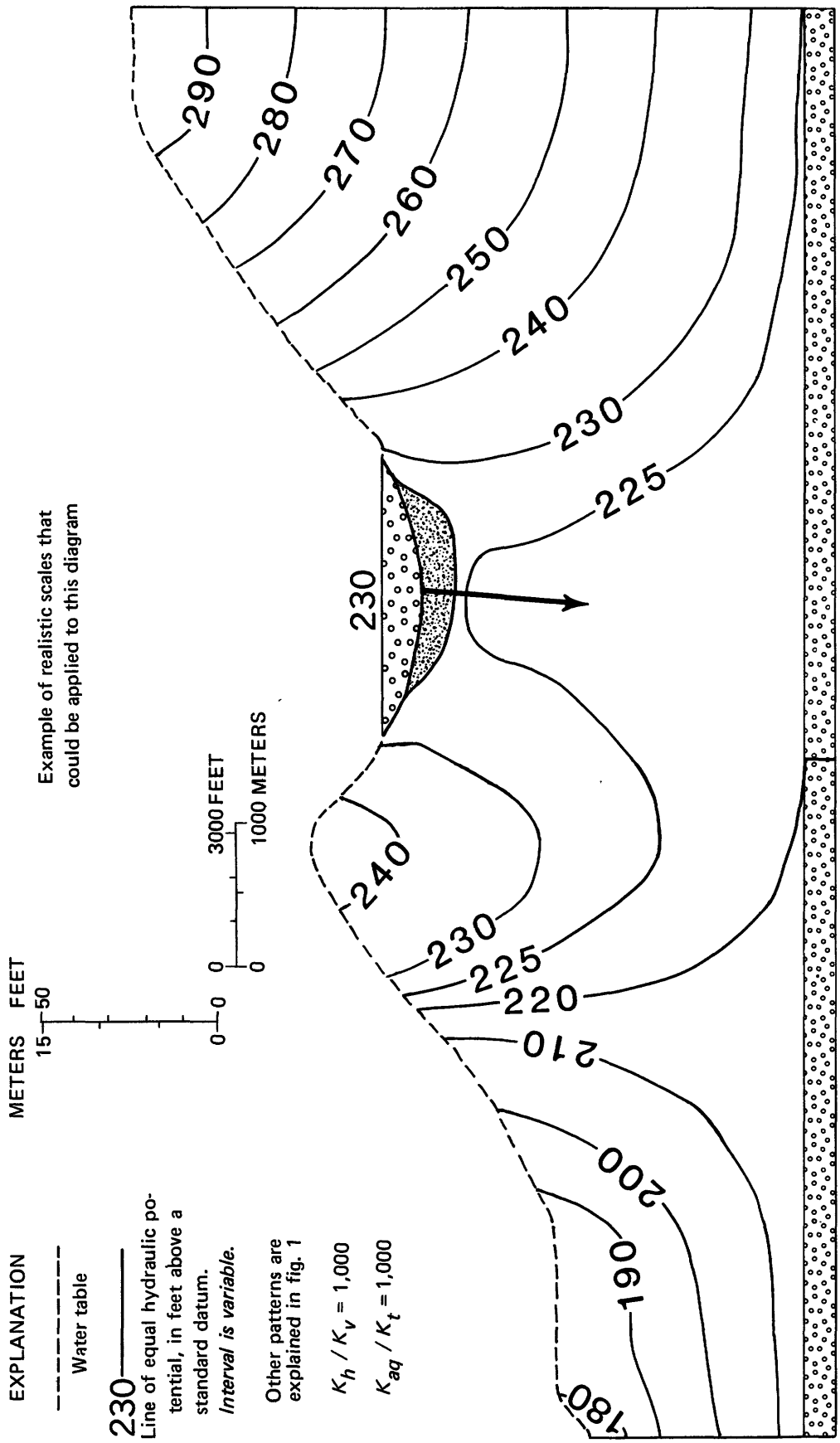


FIGURE 13.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has an extensive aquifer of relatively high hydraulic conductivity at the base of the system.

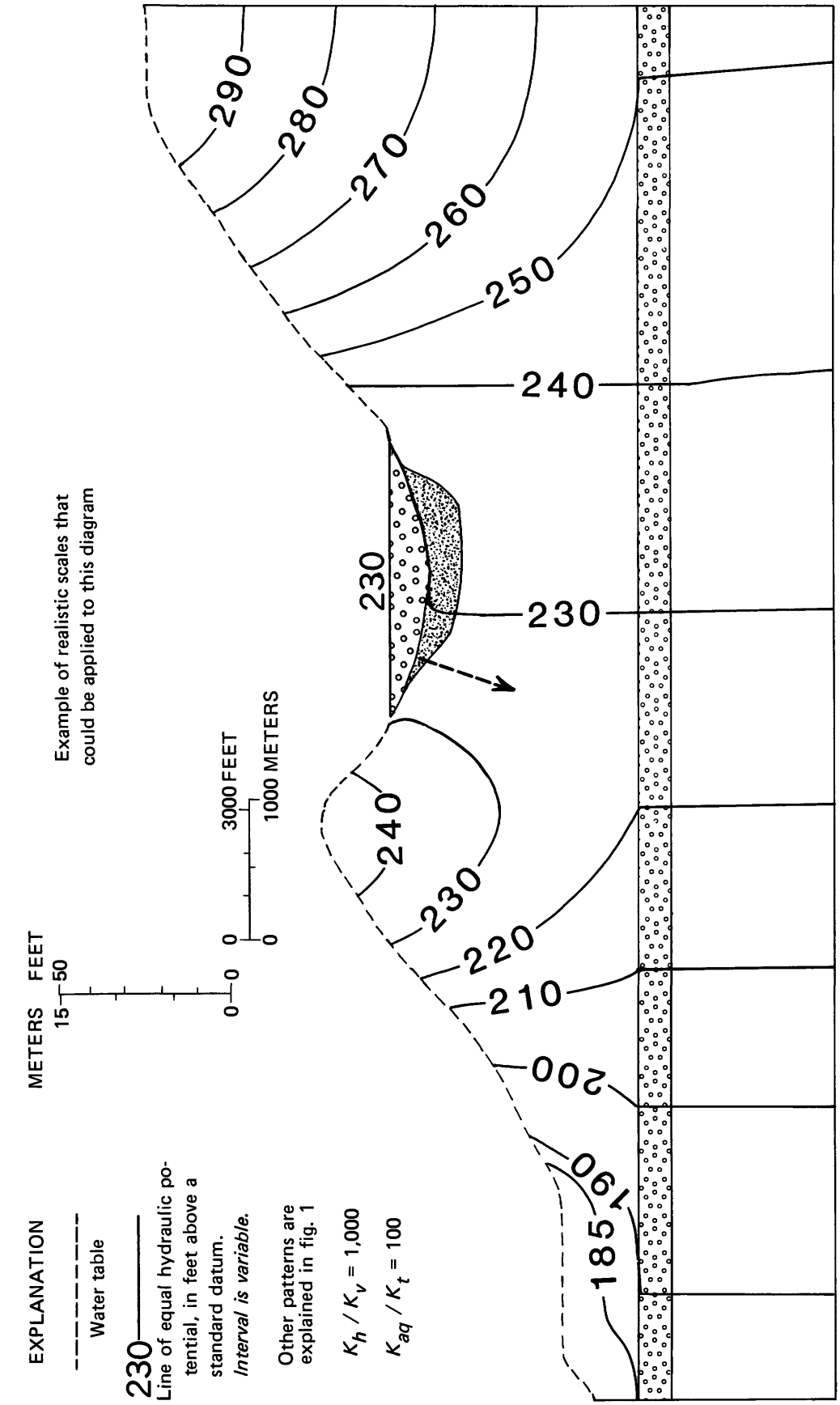


FIGURE 14.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has an extensive aquifer of relatively low hydraulic conductivity in the middle of the system.

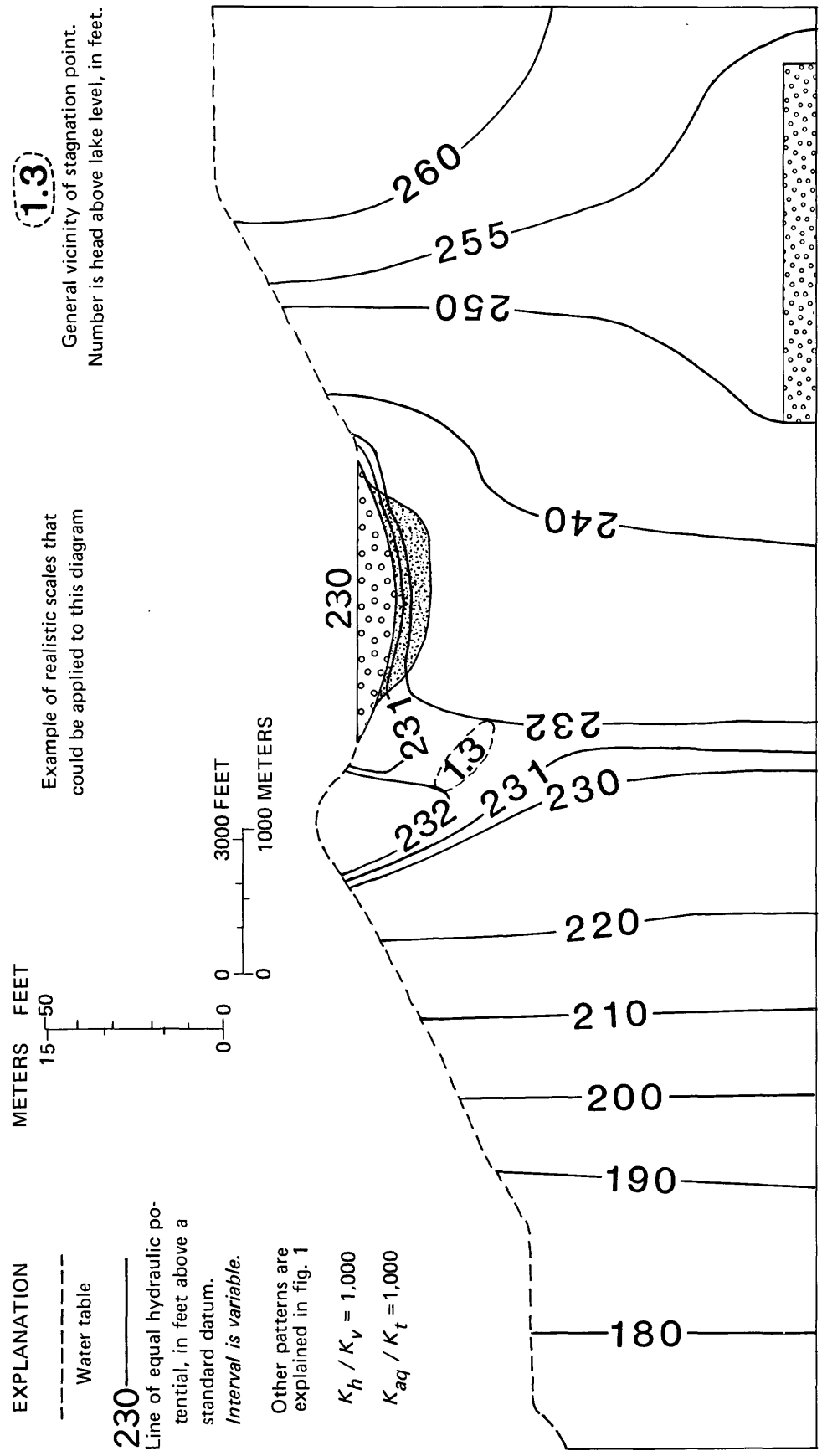


FIGURE 15.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has an aquifer of limited extent upslope from the lake at the base of the system.

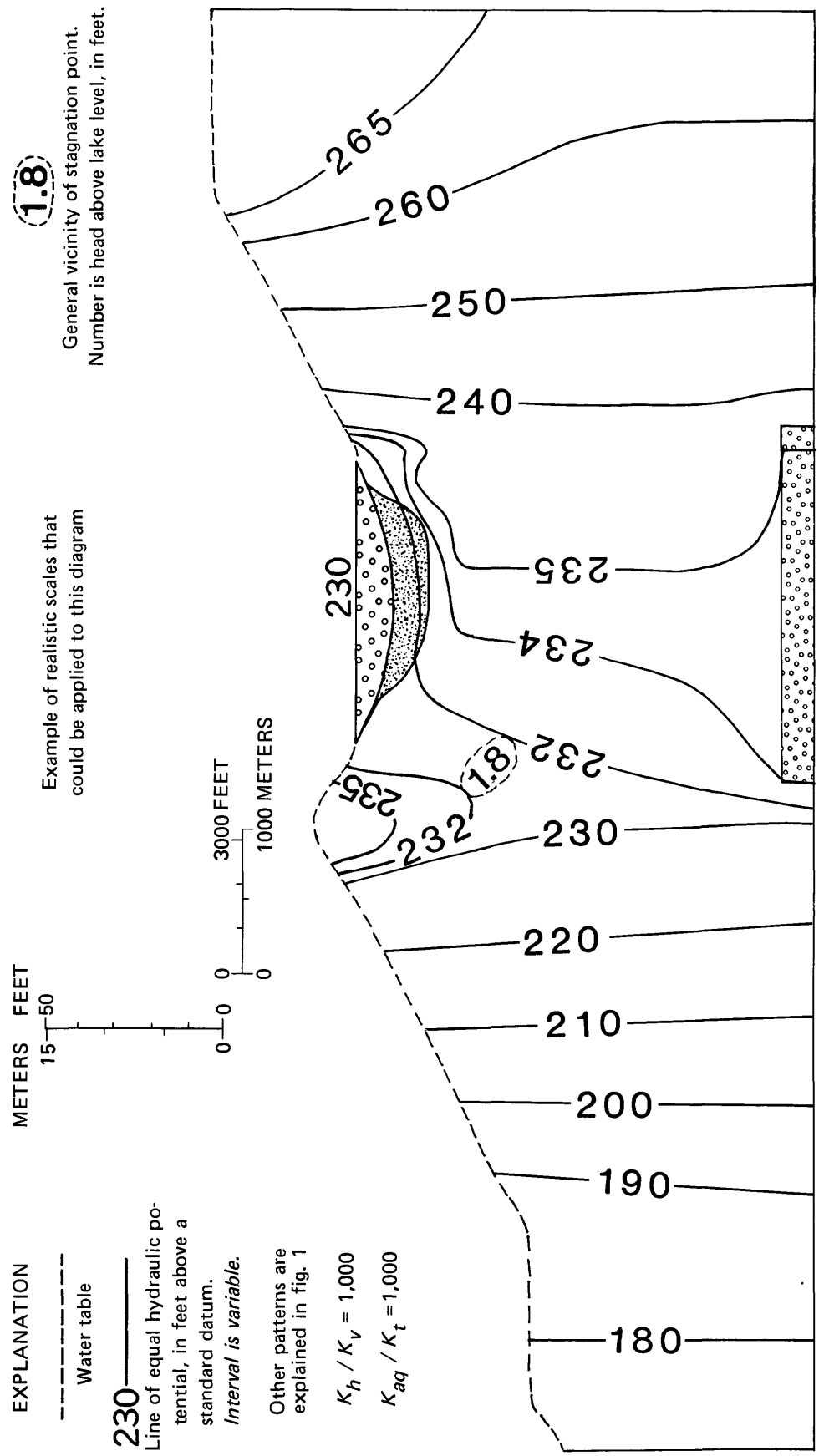


FIGURE 16.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has an aquifer of limited extent beneath the lake at the base of the system.

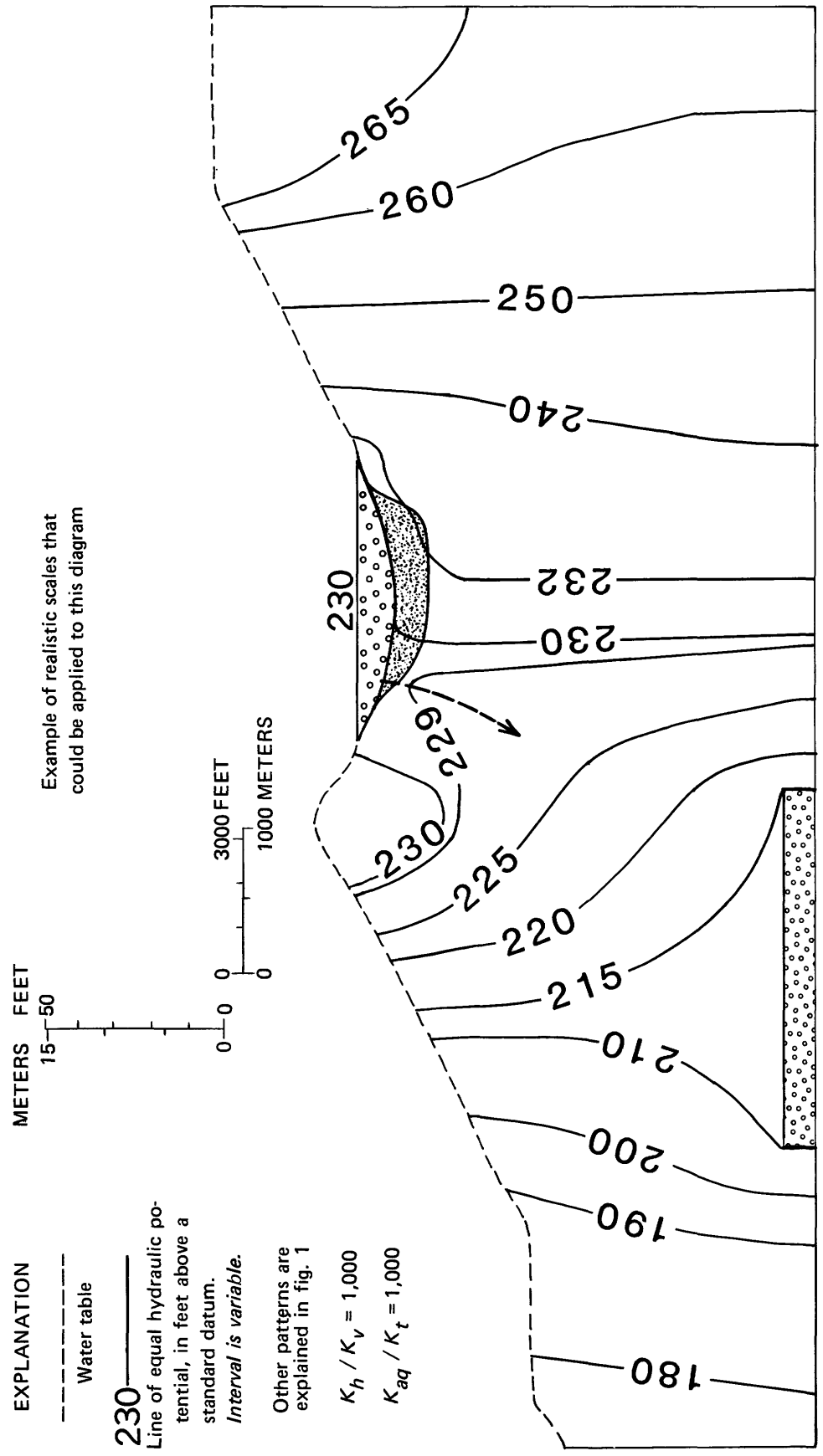


FIGURE 17.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has an aquifer of limited extent downslope from the lake at the base of the system.

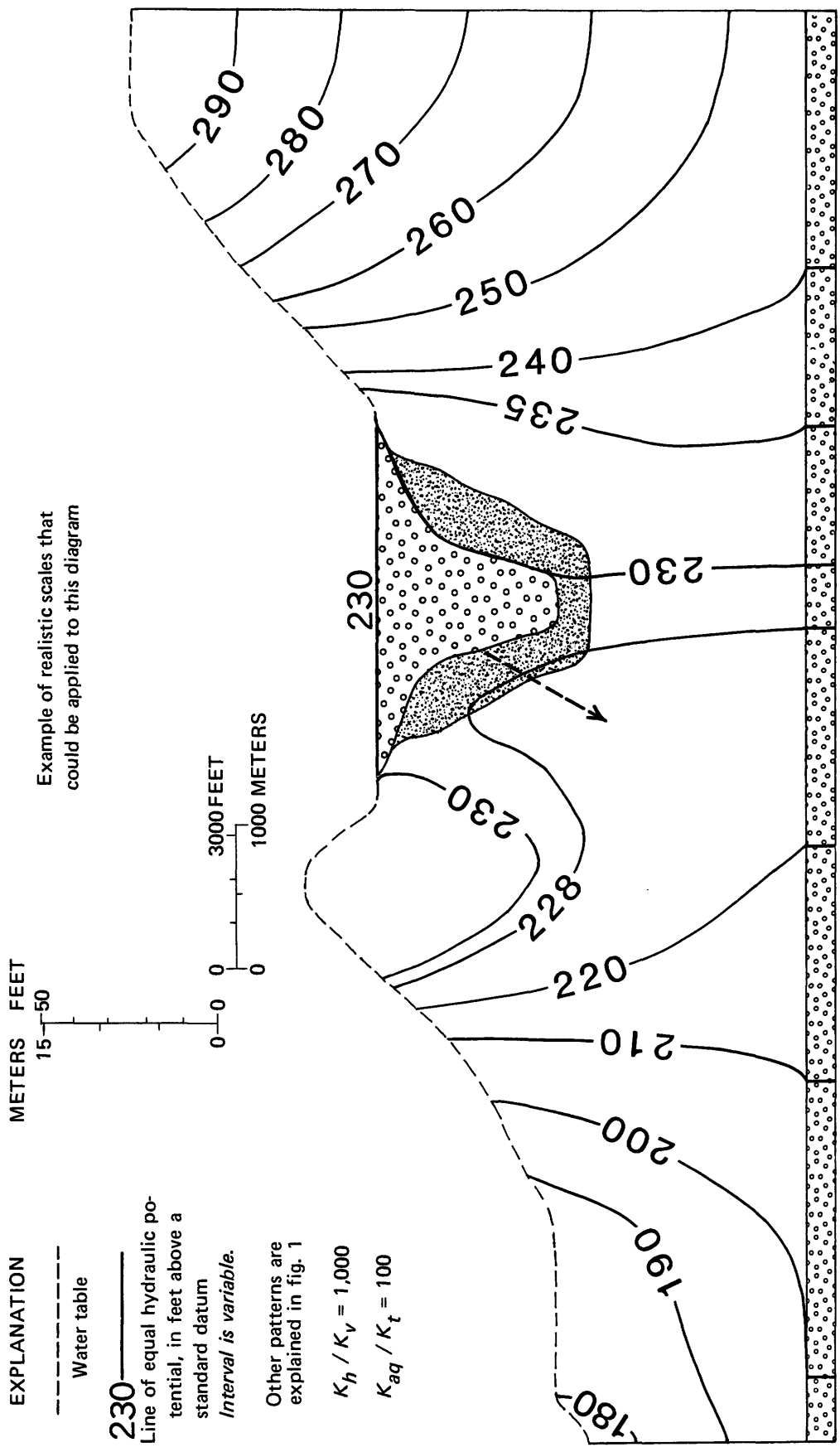


FIGURE 18.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a one-lake system that has a deep lake and an extensive aquifer of relatively low hydraulic conductivity at the base of the system.

TABLE 1.—*Results of digital simulations of the one-lake system—comparison of the effects of all combinations of the parameters tested that control ground-water flow on lake-ground water interaction.*

[0.35T, 0.10T: height of water table above lake level on upslope and downslope sides, respectively]

K_h/K_v 10^2 | 10^3

K_{aq}/K_t 10^2

0.35T, 0.10T					0.35T, 0.05T				0.35T, 0.10T				0.35T, 0.05T			
[13][1]	10^2-FB[2]	(4[4]	(0.1)[5]	D[6]	24)	10-FB	(1.3)	D	21)	10-FB	(0.2)	D	25)	10-FB	(4/8)	L
34)	FM		(5.0)	L	36)	FM	(1.7)	D	35)	FM	(3/8)	L		FM		L
	PBU			D		PBU		D		PBU		D		PBU		D
	PBB			D		PBB		D		PBB		D		PBB		D
	PBD			D		PBD		D	40)	PBD	(0.8)	D	43)	PBD	(1/8)	L
	PMU			D		PMU		D		PMU		D		PMU		D
	PMB			D		PMB		D		PMB		D		PMB		D
	PMD			D	56)	PMD	(0.1)	D	55)	PMD	(1/8)	L		PMD		L
[16)	FM	(2)	(0.7)	D					[14)	FB	(6.8)	L]				
15)]	FM	(4)	(⊂⊃)[7]	D/L												
	50-FB			D	66)	50-FB	(0.7)	D	65)	50-FB	(6/10)	L	67)	50-FB	(6/10)	L
	FM			D	70)	FM	(0.8)	D		FM		L		FM		L
	PBU			D		PBU		D		PBU		D		PBU		D
	PBB			D		PBB		D		PBB		D		PBB		D
	PBD			D	76)	PBD	(3/10)	L	74)	PBD	(4/10)	L		PBD		L
	PMU			D		PMU		D		PMU		D		PMU		D
	PMB			D		PMB		D		PMB		D		PMB		D
79)	PMD		(RF[8] 0.5)	D		PMD		L		PMD		L		PMD		L
0.20T, 0.10T					0.20T, 0.05T				0.20T, 0.10T				0.20T, 0.05T			
28)	10-FB		(2.8)	D	31)	10-FB	(0.5	D	29)	10-FB	(5/8)	L	32)	10-FB	(7/8)	L
	FM			D	37)	FM	(0.6)	D		FM		L		FM		L
	PBU			D		PBU		D		PBU		D		PBU		D
	PBB			D		PBB		D		PBB		D		PBB		D
44)	PBD		(RF 0.5)	D	48)	PBD	(⊂⊃)	D/L	45)	PBD	(0.2)	D		PBD		L
	PMU			D		PMU		D		PMU		D		PMU		D
	PMB			D		PMB		D		PMB		D		PMB		D
	PMD			D	58)	PMD	(⊂⊃)	D/L	57)	PMD	(2/8)	L		PMD		L
68)	50-FB		(1.3)	D	69)	50-FB	(0.1)	D		50-FB		L		50-FB		L
71)	FM		(2.1)	D	72)	FM	(0.4)	D		FM		L		FM		L
	PBU			D		PBU		D		PBU		D		PBU		D
	PBB			D		PBB		D		PBB		D		PBB		D
77)	PBD		(0.3)	D		PBD		L		PBD		L		PBD		L
	PMU			D		PMU		D		PMU		D		PMU		D
	PMB			D		PMB		D		PMB		D		PMB		D
80)	PMD		(RF 0.6)	D	81)	PMD	(2/10)	L		PMD		L		PMD		L
0.35T, 0.10T					0.35T, 0.05T				0.35T, 0.10T				0.35T, 0.05T			
22)	10-FB		(2/8)	L	26)	10-FB	(3/8)	L	23)	10-FB	(8/8)	L	27)	10-FB	(8/8)	L
20)	FM		(7/8)	L		FM		L	19)	FM(2)	(8/8)	L		FM		L
	PBU			D		PBU		D		PBU		D		PBU		D
	PBB			D		PBB		D		PBB		D		PBB		D
41)	PBD		(0.1)	D		PBD		L	42)	PBD	(0.4)	D		PBD		L
	PMU			D		PMU		D		PMU		D		PMU		D
	PMB			D		PMB		D		PMB		D		PMB		D
	PMD			L		PMD		L		PMD		L		PMD		L
[17)	FM	(4)	(8/8)	L					[19a)	FM(4)	(8/8)	L]				
18)]	FM	(2)	(7/8)	L												
	50-FB			L		50-FB		L		50-FB		L		50-FB		L
	FM			L		FM		L		FM		L		FM		L
	PBU			D		PBU		D		PBU		D		PBU		D
	PBB			D		PBB		D		PBB		D		PBB		D
75)	PBD		(5/10)	L		PBD		L		PBD		L		PBD		L
	PMU			D		PMU		D		PMU		D		PMU		D
	PMB			D		PMB		D		PMB		D		PMB		D
	PMD			L		PMD		L		PMD		L		PMD		L
0.20T, 0.10T					0.20T, 0.05T				0.20T, 0.10T				0.20T, 0.05T			
30)	10-FB		(6/8)	L	33)	10-FB	(7/8)	L		10-FB		L		10-FB		L
	FM			L		FM		L		FM		L		FM		L
	PBU			D		PBU		D		PBU		D	38)	PBU	(1.3)	D
	PBB			D		PBB		D		PBB		D	39)	PBB	(1.8)	D
46)	PBD		(⊂⊃)	D/L	49)	PBD	(2/8)	L	47)	PBD	(2/8)	L	50)	PBD	(3/8)	L
	PMU			D		PMU		D		PMU		D	52)	PMU	(1.4)	D
	PMB			D		PMB		D		PMB		D	53)	PMB	(2.5)	D
	PMD			L		PMD		L		PMD		L	59	PMD	(4/8)	L
													[54)	PMB	(3.3)	D
													51)]	PBU & PBB	(2/8)	L
	50-FB			L		50-FB		L		50-FB		L		50-FB		L
	FM			L		FM		L		FM		L		FM		L
	PBU			D		PBU		D		PBU		D		PBU		D
	PBB			D		PBB		D		PBB		D	73)	PBB	(1.6)	D
	PBD			L		PBD		L		PBD		L		PBD		L
	PMU			D		PMU		D		PMU		D	78)	PMU	(1.2)	D
	PMB			D		PMB		D		PMB		D		PMB		D
	PMD			L		PMD		L		PMD		L		PMD		L

[1] Simulation number, keyed to table 2.

[2] Lake depth. In each cell, entries above dashed line are shallow lakes (0.05T) and those below it are deep lakes (0.35T).

[3] Aquifer position. (See text for explanation.)

[4] Thickness of aquifer if greater than 0.05T; 2=0.10T, 4=0.20T.

[5] If decimal, height of head, in feet, of stagnation point above lake level; if fraction, proportion of lake bed that leaks.

[6] D, divide exists beneath lake; L, lake loses water through its bed.

[7] ⊂⊃ indicates the stagnation point is at the threshold of being obliterated—the head value is the same as lake level.

[8] RF, influence of the water-table mound on the downslope side of a lake extends to the base of the ground-water system, such that at the base the gradient of head is to the right (upslope direction) and there is no regional movement beyond that point.

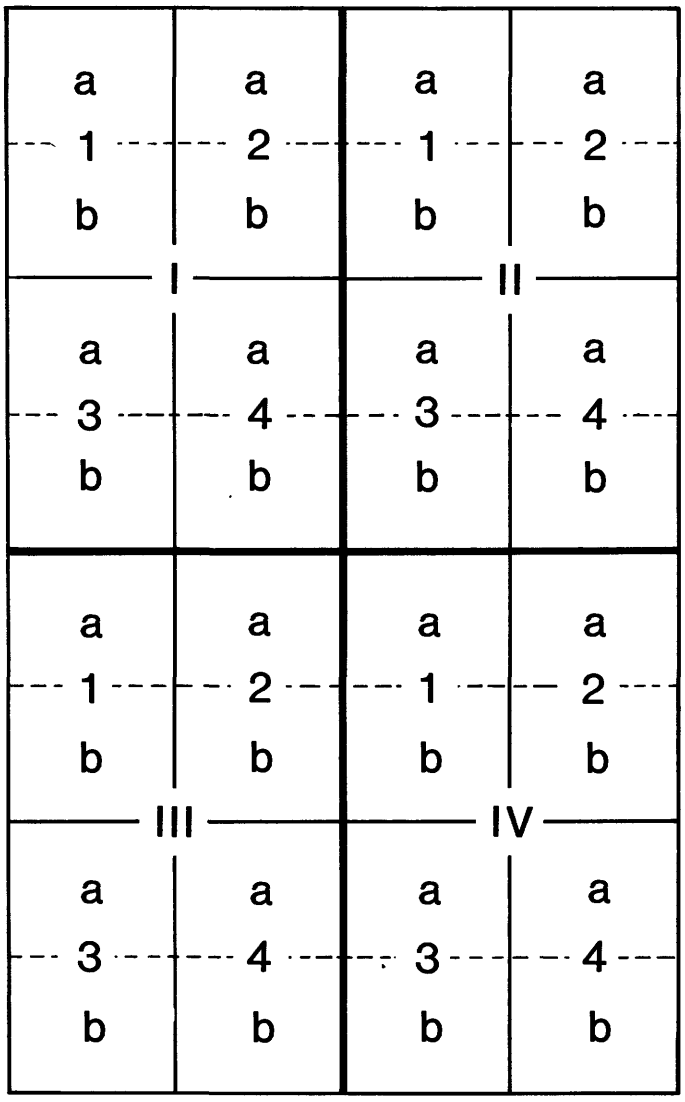


FIGURE 19.—Sketch showing key to table 1.

PBD–Partial (limited extent) aquifer at the base of the ground-water system downslope from the lake ($0.35L$).

PMU–Partial (limited extent) aquifer at an intermediate level of the ground-water system upslope from the lake ($0.25T$, $0.85L$).

PMB–Partial (limited extent) aquifer at an intermediate level of the ground-water system beneath the lake ($0.25T$, $0.60L$).

PMD–Partial (limited extent) aquifer at an intermediate level of the ground-water system downslope from the lake ($0.25T$, $0.35L$).

The simulations shown in brackets in table 1 are included for comparison purposes. They are generally of settings similar to one in the subquadrant but, for example, the aquifer might be more than one node thick.

Table 2 is a general summary of the one-lake simulations run for this study, and it includes those simulations in which aquifers were not included.

The parallel construction of table 1 makes it relatively easy to compare the effect of changes in the various parameters on the interaction of lakes and ground water. If interest is in the effect of different hydraulic conductivity ratios for given water-table combinations, aquifer size and position, and lake depth, that setting is found in equivalent positions in the major quadrants. For example, if one wishes to compare settings where K_{aq}/K_t is 100 to another where it is 1,000, and the setting has a water table $0.35T$ (70 ft; 21 m) higher than lake level on the upslope side and $0.05T$ (10 ft; 3 m) higher on the downslope side, K_h/K_v is 1,000, and the lake is $0.05T$ (10 ft; 3 m) deep, subquadrant II-2a can be compared with subquadrant IV-2a for whatever aquifer situation is of interest. If interest is in comparison of different water table configurations for given hydraulic conductivity ratios, this can be done within a major quadrant.

The arrangement of table 1 is such that there is a general trend for the difference between lake level and head at the stagnation point to become less and for the potential for water loss from the lake to increase as one moves from quadrant I to quadrant IV. An example of this can be seen by comparing the PBD setting for shallow lakes in each subquadrant 3. In subquadrant I-3, a ground-water divide exists that extends to the base of the ground-water reservoir (RF 0.5) (RF indicates reverse flow along the base of the system). In subquadrant II-3 the ground-water divide weakens to where the head at the stagnation point is $0.001T$ (0.2 ft; 0.1 m) higher than lake level. In subquadrant III-3 the ground-water divide is at the threshold of being obliterated (⊂) and the lake losing water. And in subquadrant IV-3, where the hydraulic conductivity ratios are highest, the lake loses water through two-eighths of its bed.

For the type of hydrogeologic settings considered in this report, knowing the effect of a certain direction of change of a given parameter on the head at the stagnation point makes simulation of every possible combination of parameters unnecessary. If it can be shown that a ground-water divide exists beneath a lake in a setting that has greatest potential for water loss (for example, PBU in subquadrant IV-4) then an even stronger divide will exist in settings where this potential is less. Conversely, if a lake loses water in a setting that has greatest potential for a divide to exist (for example, PBD in sub-quadrant I-2b then it should lose even more water in settings where the potential for water loss is greater. In these cases, one simulation is sufficient to determine the relationship for eight others. In some situations, the simulation may have even greater implications because if a shallow lake loses water for a given setting, a deep lake in a similar setting will lose even more water.

TABLE 2.—*Summary of simulations of one-lake system*

Row Number	Simulation identification number	Lake Depth		Lake Sediments		K_h/K_v				K_{aq}/K_t		Aquifer: Full[1]	Aquifer: Partial[2]							Height of water table above lake (relative to total system thickness)				Results	
		0.05T	0.25T	Yes	No	1	10^2	10^3	10^4	10^2	10^3	None	Base	Middle	Upslope	Beneath	Downslope	Upslope	Beneath	Downslope	Upslope	Side	Downslope	Side	Head at stagnation point above lake level	Percent of bed that loses water.
															Base			0.25T			0.35	0.20	0.10	0.05		
1	3-11:20.71	X			X	X						X									X		X		RF(20)	
2	3-11:17.24	X			X		X					X									X		X		RF(12)	
3	3-12: 3.80	X			X			X				X									X		X		1.8	
4	3-13:14.95	X			X				X			X									X		X			5/8
5	3-14: 9.31	X			X		X					X									X			X	RF(4)	
6	3-14:20.74	X			X			X				X									X			X	0.2	
7	3-24: 4.11	X			X			X				X										X	X		1.4	
8	3-21: 8.58	X			X		X					X										X		X	RF(4)	
9	3-21: 7.43	X			X			X				X										X		X	0.1	
10	3-27: 8.99	X		X				X				X									X		X		4.2	
11	3-28: 4.71	X		X				X				X									X			X	1.4	
12	4-1 : 9.16	X		X				X				X										X		X	0.9	
13	3-17:23.54	X			X		X			X				X[3]							X		X		0.1	
14	3-18:24.67	X			X			X		X				X[4]							X		X			6/8
15	3-17:22.66	X			X		X			X				X[3]							X		X			
16	3-18: 5.60	X			X		X			X				X[4]							X		X		0.7	
17	3-17: 8.17	X			X		X				X			X[3]							X		X			8/8
18	3-18:23.72	X			X		X				X			X[4]							X		X			7/8
19	3-14:10.57	X			X			X			X			X[3]							X		X			8/8
20	3-19:23.22	X		X			X				X			X[4]							X		X			7/8
21	3-28:10.08	X		X				X		X				X							X		X		0.2	
22	3-19:25.64	X		X			X				X			X							X		X			2/8
23	3-31: 9.19	X		X				X			X			X							X		X			8/8
24	4-11: 7.31	X		X			X			X				X							X			X	1.3	
25	3-28: 9.55	X		X				X		X				X							X			X		4/8
26	4-11: 3.37	X		X			X				X			X							X			X		3/8
27	3-28: 9.51	X		X				X			X			X							X			X		8/8
28	4-10: 3.79	X		X			X			X				X								X	X		2.8	
29	3-31: 5.28	X		X				X		X				X								X	X			5/8
30	4-10: 6.05	X		X			X				X			X								X	X			6/8
31	8-4 :16.83	X		X			X			X				X								X		X	0.5	
32	4-1 : 9.73	X		X				X		X				X								X		X		7/8
33	4-14: 3.41	X		X			X				X			X								X		X		7/8
34	8-4 :16.88	X		X			X			X					X						X		X		5.0	
35	8-4 : 4.11	X		X				X		X					X						X		X			3/8
36	8-5 :17.21	X		X			X			X					X						X			X	1.7	
37	8-5 :16.60	X		X			X			X					X							X		X	0.6	
38	4-4 : 9.43	X		X				X			X					X						X		X	1.3	
39	4-1 :12.80	X		X				X			X						X					X		X	1.8	
40	4-4 : 8.02	X		X				Y		X								X			X	X			0.8	
41	8-6 :16.17	X		X			X				X							X			X		X		0.1	
42	8-5 :20.62	X		X				X			X							X			X		X		0.4	
43	8-5 :18.13	X		X				X		X								X			X			X		1/8
44	4-3 :11.40	X		X			X			X								X				X	X		RF(0.5)	
45	4-4 : 4.46	X		X				X		X								X				X	X		0.2	
46	4-3 : 9.54	X		X			X				X							X				X	X			
47	4-4 :10.74	X		X				X			X							X				X	X			2/8
48	4-3 :10.65	X		X			X			X								X				X		X		
49	4-3 : 5.08	X		X			X				X							X				X		X		2/8
50	4-3 :10.15	X		X				X			X							X				X		X		3/8
51	4-7 :10.38	X		X				X			X					X		X				X		X		2/8
52	8-4 :16.90	X		X				X			X						X					X		X	1.4	
53	4-8 : 4.98	X		X				X			X								X			X		X	2.5	
54	4-9 : 4.78	X		X				X			X								X[5]			X		X	3.3	
55	4-4 : 8.96	X		X				X		X										X	X		X			1/8
56	8-5 :17.07	X		X			X			X										X	X			X	0.1	
57	4-4 : 8.00	X		X				X		X										X		X	X			2/8
58	8-4 :16.87	X		X			X			X										X		X		X		
59	4-2 :11.88	X		X				X			X									X		X		X		4/8
60	3-24: 7.79		X		X			X				X									X			X		
61	3-24: 7.95		X		X			X				X										X	X		0.9	
62	3-22: 8.99		X		X		X					X										X		X	RF(4)	
63	3-27: 4.18		X		X			X				X										X		X		
64	8-7 :16.73		X	X				X				X										X		X	0.5	
65	8-7 : 4.70		X	X				X		X				X							X		X			6/10
66	8-6 :15.40		X	X			X			X				X							X			X	0.7	
67	8-6 :19.32		X	X				X		X				X							X			X		6/10
68	8-7 :15.83		X	X			X			X				X								X	X		1.3	
69	8-7 :15.36		X	X			X			X				X								X		X	0.1	
70	8-6 :15.61		X	X			X			X					X						X			X	0.8	
71	8-7 :15.30		X	X			X			X					X							X	X		2.1	
72	8-7 :14.90		X	X			X			X					X							X		X	0.4	
73	8-7 :21.19		X	X				X			X						X					X		X	1.6	
74	8-6 :16.11		X	X				X		X							X				X		X			4/10
75	8-7 :15.98		X	X			X				X						X				X		X			5/10
76	8-6 :16.16		X	X			X			X							X				X			X		3/10
77	8-7 :16.50		X	X			X			X							X					X	X		0.3	
78	8-7 :21.18		X	X				X			X								X			X		X	1.2	
79	8-6 :17.23		X	X			X			X										X	X		X		RF(0.5)	
80	8-7 :17.45		X	X			X			X										X		X	X		RF(0.6)	
81	8-7 :16.30		X	X			X			X										X		X		X		2/10

[1]Aquifer extends full length of the basin.
[2]Aquifer does not extend full length of the basin.
[3]Aquifer thickness is 0.20T.
[4]Aquifer thickness is 0.10T.
[5]Aquifer is in contact with base of sediments.

Some general relationships concerning the one-lake system can be deduced from table 1. For most hydrogeologic settings as simulated in this study, the following changes in parameters tend to weaken the difference in head between the lake and the stagnation point beneath a lake or tend to cause a lake to lose water: (1) Lowering the water table on either side of a lake (lowering it on the downslope side has a greater effect than lowering it on the upslope side), (2) increasing K_h/K_v, (3) increasing the hydraulic conductivity of aquifers relative to the till, which has a slightly greater effect than increasing K_h/K_v, (4) increasing the depth of a lake, and (5) raising aquifers from the base to an intermediate level in the ground-water system. An exception to statement 5 is the situation where an extensive aquifer that has low K_h/K_v and low K_{aq}/K_t (quadrant I, table 1) is raised from the base to an intermediate level. In this case the head at the stagnation point increases slightly.

Aquifers that extend the full length of the ground-water basin have a greater effect on the interaction of lakes and ground water than limited aquifers. If no aquifer is present, a lake generally will not lose water even if K_h/K_v is 1,000 (table 2). Limited aquifers upslope and beneath a lake have little effect on the ground-water divide beneath a lake. Under the conditions simulated in this study, aquifers in these positions will not cause the divide to weaken regardless of the hydraulic conductivity of the medium. Limited aquifers downslope from a lake, whether at the base or at an intermediate level of the ground-water system, have a significant effect on the interaction of lakes and ground water because under many conditions of high K_h/K_v and K_{aq}/K_t and low water-table configurations, a lake will have a weak ground-water divide or will lose water. In every simulation run for this study, the stagnation point associated with the ground-water divide is always under the downslope littoral or shoreline zone of a lake. This has particular significance when designing an observation-well program for studying the interaction of lakes and ground water because determining the position and head, or absence, of the stagnation point is the key to the relationship.

MULTIPLE-LAKE SYSTEM

In many geologic environments, lakes occur at different altitudes within major drainage basins. Although it is a common belief that water moves successively from higher lakes to lower lakes through the ground-water system within a major drainage basin—a situation where all the lakes would be the flow-through type, it is shown in the following discussion that this may not be the case. Digital simulations were run of a number of variations in the hydrogeologic setting of three lakes along a regional slope from a major divide to a major drain. The vertical exaggeration of the sections are the same as those in the one-lake system (80:1).

MODERATE REGIONAL SLOPE AND LOCAL RELIEF

The length and thickness dimensions of the multiple-lake system are different from those of the one-lake system, thus the proportions of the features are different. As before, the dimensions in parentheses are included as examples of realistic field situations.

A three-lake simulation set will be discussed later in which the models are of a system that has a water table with very low regional slope, a physiographic condition common in many geologic terranes.

One type of lake-ground water setting not simulated in this study is that of a straight-line, sloping water table between adjacent lakes. As will be apparent in the following sections of this report, the height of the water table mound on the downslope side of a lake relative to lake level is an important control on the interaction of lakes and ground water. Lakes in a setting of a straight-line water table simply would gain ground-water inflow on one side and lose water out the other.

The thickness of the ground-water reservoir of the three-lake system ranges from T (as much as 250 ft; 76 m) on the upslope end of the section to $0.40T$ (100 ft; 33 m) on the downslope end. The height of the water table above lake level on the regional upslope sides of the two lower lakes is $0.20T$ (50 ft; 15 m) and on the downslope side of all three lakes is $0.08T$ (20 ft; 6 m). The highest lake in the section has the water table $0.12T$ (30 ft; 9 m) above lake level on the upslope side. The difference between the level of the highest lake and the elevation of the water table on the upslope side of that lake was purposely made less than the two lower lakes because it is believed that lakes that occur high topographically are more likely to have lower water tables adjacent to them than the lower lakes. The water-table altitudes were varied in some of the simulations. The dimensions of the shallow lakes are about $0.1L$ wide and $0.20T$ deep. The aquifers are about $0.04T$ thick and those of limited areal extent are $0.15L$ long. As before, the datum for the head values is 100.

The positions of the three lakes are as follows: The surface of lake 1 is about $0.65T$ above the base and $0.32L$ from the left side of the section, lake 2 is at $0.75T$ and $0.60L$, and lake 3 is at $0.88T$ and $0.85L$. The aquifers are positioned at the base and, if at an intermediate level, at $0.30T$ above the base. The lateral position of the limited aquifers varies as noted in the text.

A simulation of a three-lake system in which each lake is shallow, is underlain by sediment, has a $0.08T$ (20 ft; 6 m) water-table mound on the downslope side of each, has a ground-water system whose K_h/K_v is 1,000, and contains no aquifers, is shown in figure 6. The position and head of the stagnation point on the ground-water divide beneath each lake is shown as in the discussion of the one-lake simulations. Under the given conditions, each lake gains ground-water discharge from its own local ground-water flow system, and each is completely isolated from the others.

For the three-lake system, comparison of all possible combinations of different water-table altitudes, lake depths, hydraulic conductivity ratios, and size and position of aquifers, as was done for the one-lake system, would lead to a far more complex summary table. The basic goal of simulating the multiple-lake system is to determine if the lakes have interrelationships with each other that would not be evident in simulations of the one-lake system. The results of the multiple-lake simulations in which the water table has moderate regional slope and local relief are summarized in table 3.

The effect on the interaction of lakes and ground water of an extensive aquifer at the base of the system can be seen by comparing row 1 with rows 2 and 3 of table 3. If an extensive aquifer at the base of the system has a hydraulic conductivity 1,000 times greater than till, and the K_h/K_v of the ground-water system is 100, the difference in head between the lake and the stagnation point beneath lake 2 is very small. In this simulation, there is very little change in the head at the stagnation point for lake 1 compared to the simulation listed in row 1, but there is water loss through the bottom of lake 3. If K_h/K_v is increased to 1,000 (row 3, table 3), holding all other parameters as in row 2 of table 3, a very strong divide is established beneath lake 1, and lakes 2 and 3 lose water through most, or all, of their bed (fig. 20).

Evidence that the lakes are independent of each other can be seen by comparing rows 6 and 7 of table 3. In these simulations, K_h/K_v and K_{aq}/K_t are both 1,000 and two limited aquifers are at the base of the ground-water system at the $0.45L$ and $0.75L$ positions. The only difference between the two is that the water-table mound between lakes 2 and 3 was decreased to only $0.04T$ (10 ft; 3 m) above the level of lake 3, and the upslope side of lake 3 was decreased to $0.08T$ (20 ft; 6 m) higher than lake level for the latter simulation (row 7). The effect of this change in the water-table near lake 3 on lakes 1 and 2 is very little, whereas the head at the stagnation point beneath lake 3 decreases $0.003T$ (0.8 ft; 0.2 m). If a limited aquifer is added at the $0.15L$ position, and all other parameters are as in the simulation listed in row 7 (table 3), the head at the stagnation point on the ground-water divide beneath lake 1 decreases considerably, and there is little effect on lakes 2 and 3 (compare rows 8 and 7).

The effect on the interaction of lakes and ground water of moving the position of limited aquifers laterally can be seen by comparing rows 14 and 15 of table 3. In the simulation listed in row 14, the aquifer at the $0.15L$ position is downslope from the edge of lake 1 (fig. 5). In the simulation listed in row 15 (fig. 21), this aquifer is shifted slightly in the upslope direction (to $0.22L$), so that the upslope part of the aquifer is partially beneath the downslope side of lake 1. All other parameters for these two simulations are held constant. This change lowers the head at the stagnation point near lake 1 by $0.002T$ (0.5 ft; 0.2 m). Thus, it is evident that the interaction of lakes and ground water is sensitive to the lateral position of limited aquifers downslope from a lake. The maximum effect is felt if the upslope part of an aquifer is beneath the downslope side of a lake, and the aquifer underlies the water-table mound downslope from a lake.

The effect on the interaction of lakes and ground water of moving the limited aquifers vertically from the base of the system to a middle position is similar to the one-lake situation; that is, the head at the stagnation point is lowered. (Compare rows 6 and 12, and rows 11 and 19 of table 3, and see also figs. 22 and 23.) Note that the middle aquifer in these two simulations is shifted to the right, from the $0.45L$ to about the $0.53L$ position, compared to the other simulations discussed to this point. This was done for most of the multiple-lake simulations because of the findings mentioned in the previous paragraph.

The effect of deep lakes compared to shallow lakes is also similar to the simulations of the one-lake system. Comparing rows 9 and 22 of table 3, in which all parameters are similar except lake depth, shows the relatively greater influence on the ground-water flow systems near deep lakes compared to shallow lakes. The ground-water divide beneath lake 1 in the simulation of shallow lakes (fig. 24) has a head at the stagnation point $0.004T$ (1 ft; 0.3 m) greater than lake level, whereas in the simulation of deep lakes (fig. 25), the lake loses water through two-eighths of its bed. Beneath lake 2, the head at the stagnation point decreases from $0.014T$ (3.4 ft; 1.0 m) greater than lake level in the shallow-lake simulation to $0.008T$ (2.1 ft; 0.6 m) in the deep-lake simulation. Beneath lake 3, the difference in head between the lake and the stagnation point of $0.004T$ (0.9 ft; 0.3 m) for the shallow lake, can be compared to the deep lake which loses water through three-eighths of its bed.

In most of the simulations of three-lake systems discussed thus far, K_{aq}/K_t and K_h/K_v are 1,000. These values were chosen because, as shown in the one-lake-system simulations, they tend to create conditions for maximum water loss from the lake to the ground-water system. It is of interest, therefore, to compare rows 21 and 22 (table 3) and figures 25 and 26. The simulation summarized in row 21 has K_h/K_v=100 (fig. 26), whereas in the latter this ratio is 1,000 (fig. 25). The stagnation points occur very deep in the system in the former and, in fact, the local flow cells around each of the lakes extend nearly the full thickness of the ground-water system and little ground water flows past the middle lake.

It is evident from the above discussion that, in most cases, lakes in a multiple-lake system act essentially independently. Changing the height of a water-table mound or the position of aquifers by one lake and not by the others has a considerable effect on that one lake that is similar to the equivalent one-lake simulation. The change may have a minor effect on an adjacent lake, changing the head at the stagnation point, for example, by perhaps $0.0004T$ to $0.0008T$ (0.1 to 0.2 ft; 0.03 to 0.06 m).

The only situation where a considerable effect is felt on the lakes is in the case of extensive aquifers within the ground-water system, and where K_h/K_v and K_{aq}/K_t are large (row 3 of table 3) (fig. 20). In this case, and there are similar cases in the one-lake settings, there is massive downward movement of water in the upper region of the ground-water basin and massive upward movement in the lower region. The great difference in head between the lake and the stagnation point associated with the lowest lake seems to be established because of the large influence of the water-table mound on the downslope side of that lake. If the water-table mound were not there, there would be massive upward movement on the lower side of the diagram and the hinge line (the point at the water table separating regional recharge from regional discharge) would be near the middle of the diagram. Apparently the mound is sufficiently strong to cause downward movement that will not be overcome, but instead, will be responsible for a strong ground-water divide that has a head at the stagnation point of very large magnitude. It is interesting to note in this case that the stagnation point is not beneath the lake. Rather, it is downslope from the lake and is nearly directly beneath the highest part of the water-table mound.

LOW REGIONAL SLOPE AND LOCAL RELIEF

A series of simulations were run of a multiple-lake system in which regional slope and local relief were kept relatively low (summarized in table 4). The length and thickness dimensions of the multiple-lake system that has low regional slope and local relief are unlike those for the system of moderate slope and relief, thus the proportions of the features again are different. The thickness of the system ranges from T (160 ft; 49 m) on the upslope end to $0.60T$ (100 ft; 30 m) on the downslope end of the section.

The water table on the upslope side of all the lakes is $0.13T$ (20 ft; 6 m) higher than the adjacent lake level, and on the downslope side is $0.06T$ (10 ft; 3 m) higher. The difference in altitude between the lakes is $0.06T$ (10 ft; 3 m). Only shallow lakes $0.06T$ (10 ft; 3 m) deep are simulated. The aquifers are $0.06T$ (10 ft; 3 m) thick, and the limited aquifers are $0.13L$ long.

A ground-water system that has no aquifers is shown in figure 27. Ground-water divides of equal size and strength (the difference in head between the lake and the stagnation point is $0.02T$ (3.0 ft; 0.9 m) by each lake) occur beneath each lake. It should be noted that simulations of this system of lower slope and relief differ somewhat from the other three-lake system discussed previously in that the water table relative to lake level by the highest lake is the same as by the two lower lakes.

Simulations that have extensive aquifers at the base of the system, K_{aq}/K_t=100, and K_h/K_v=1,000 (row 27, table 4), show no water loss from any of the lakes for any of the simulations. This is true also if the hydraulic conductivity ratios are reversed; that is, K_{aq}/K_t=1,000 and K_h/K_v=100 (row 28, table 4). In simulations that have both ratios at 1,000, a ground-water-flow pattern similar to the other three-lake system occurs—there is water loss through the entire bed of the higher two lakes and a divide established beneath the lowest lake (row 29, table 4).

In simulations that have limited aquifers beneath the water-table mounds between the lakes, and the up-slope edge of the aquifers are partly beneath the lake, a ground-water divide occurs beneath the lake, although the difference in head between the lake and the stagnation point of each is rather small (fig. 28). This result holds even when the limited aquifer is moved to about $0.13T$ (20 ft; 6 m) below the bed of the lower lake.

In the three-lake system that has low regional slope and local relief, it appears that the ground-water divides tend to be slightly stronger in most cases than where a higher regional slope is simulated. The slope of the water table from the lowermost water-table mound to the left edge of the hydrologic sections in the simulation of moderate regional slope, shows a drop of several tens of feet. The water-table slope in this same part of the section, in the simulations of low regional slope, is essentially flat, resulting in very slow ground-water movement. This very flat water table near the valley of the major drain on the system acts as a "check valve" on the entire system and tends to increase the tendency of the lakes to have stronger local ground-water-flow systems than in conditions of a higher-sloping water table.

In none of the simulations does water move from one lake to the next downslope if there is a water-table mound between the two lakes. Even if an upper lake loses water to the ground-water system, the movement generally is deep to the system and the water moves beneath the local flow systems associated with lower lakes. Thus, even in settings where lakes occur at various altitudes down a sloping valley side, each of the lakes, for most settings, acts as an independent entity and has little relationship to lakes either upslope or downslope from it. This conclusion gives increased importance to the summary table (table 1) of the one-lake system.

The effect of reservoir thickness on ground-water-flow systems is extensively discussed by Tóth (1963), and to a lesser extent by Freeze (1969b). The general effect of a thin ground-water reservoir is that regional flow does not occur for many settings, especially if regional slope is low. To check the effect of a thin ground-water system on the interaction of lakes and ground water, a setting was simulated that was 100 feet (30 m) thick on the upper end of the section and 50 feet (15 m) thick on the lower end. The difference between the section and figure 29 is that the local flow systems associated with each lake extend to the base of the ground-water reservoir, and regional flow does not occur (row 33, table 4).

TABLE 3.—*Summary of simulations of multiple-lake system whose water table has moderate regional slope and local relief*

Row Number	Simulation identification number	Lake depth: Shallow	Lake depth: Deep	Kh/Kv: 10^2	Kh/Kv: 10^3	Kaq/Kt: 10^2	Kaq/Kt: 10^3	Aquifer position: Full[1]: None	Full[1]: Base	Full[1]: 0.30T	Partial[2]: Base: 0.15L	Base: 0.45L	Base: 0.75L	0.30T: 0.15L	0.30T: 0.45L	0.30T: 0.75L	Height of water table above lake level (relative to total system thickness): Lake 1: Upslope: 0.20	0.16	0.12	0.08	Lake 1: downslope: 0.08	0.04	Lake 2: Upslope: 0.20	0.16	0.12	0.08	Lake 2: downslope: 0.08	0.04	Lake 3: Upslope: 0.20	0.16	0.12	0.08	Lake 3: downslope: 0.08	0.04	Results: Lake 1: Height of head of stagnation point above lake level (in feet)	Lake 1: Percent of bed that loses water	Lake 2: Height of head of stagnation point above lake level (in feet)	Lake 2: Percent of bed that loses water	Lake 3: Height of head of stagnation point above lake level (in feet)	Lake 3: Percent of bed that loses water
1	4-22:28.67	X			X		X	X									X				X		X				X				X		3.1		3.8		2.2	
2	4-23: 5.70	X		X		X			X								X				X		X				X				X		3.4		0.2			6/6
3	4-25:14.96	X			X	X			X								X				X		X				X				X		8.3			5/6		6/6
4	4-24: 5.74	X		X		X							([3])				X				X		X				X				X		RF(8.9)		RF(6.4)		RF(0.8)	
5	4-25:10.08	X		X		X						X	X				X				X		X				X				X		RF(6.7)		1.4		0.9	
6	4-24:10.95	X			X	X						X	X				X				X		X				X				X		4.2		2.8		1.1	
7	5-1:21.20	X			X	X						X	X				X				X			X			X				X		4.0		2.7		0.3	
8	5-2:10.85	X			X	X					X	X	X				X				X			X			X				X		1.7		2.5		0.3	
9	5-22:20-95	X			X	X					XS[4]	XR[5]	X				X				X		X				X				X		1.0		3.4		0.9	
10	5-16:6.77	X		X		X					XS	XR	X					X				X			X			X				X	1.0		3.2		0.2	
11	5-14:10.51	X			X	X					XS	XR	X				X				X			X			X				X	0.6		2.7		0.1	
12	4-25:20.58	X			X	X								X	X		X				X		X				X				X	4.4		1.8		0.1	
13	5-7:19.57	X			X	X								X	X		X				X			X			X				X	4.5		1.7			3/6
14	5-5:4.99	X			X	X								X	X	X	X				X			X			X				X	0.7		1.5			3/6
15	5-8:11.22	X			X	X								XS	X	X	X				X			X			X				X	0.1		1.5			3/6
16	5-12:5.60	X			X	X								XS	X	X		X				X				X			X			X		1.1			3/6
17	5-22:18.29	X			X	X								XS	XR	X	X				X		X				X				X			2/6	2.4			
18	5-15:6.70	X		X		X								XS	XR	X		X				X			X			X				X	1.3		3.4			2/6
19	5-13:10.17	X			X	X								XS	XR	X		X				X			X			X				X			2/6	1.8			3/6
20	5-19:7.43		X		X		X	X									X				X		X				X				X	2.2		2.7		0.8	
21	5-22:11.13		X	X		X					XS	XR	X				X				X			X			X				X	1.6		4.2(RF)		0.1	
22	5-21:13.49		X		X	X					XS	XR	X				X				X			X			X				X			2/8	2.1			3/8
23	5-28:8.05		X	X		X								XS	XR	X	X				X			X			X				X	2.0		RF(0.1)			3/8
24	5-23:26.79		X		X	X								XS	XR	X	X				X			X			X				X			4/8	1.0			5/8

[1]Aquifer extends full length of the basin.
[2]Aquifer does not extend full length of the basin.
[3]Partial aquifer at base upslope from lake 3.
[4]XS, aquifer shifted from 0.15L to 0.22L.
[5]XR, aquifer shifted from 0.45L to 0.53L.

TABLE 4.—*Summary of simulations of multiple-lake system whose water table has low regional slope and local relief*

Row Number	Simulation identification number	Lake depth: Shallow	Lake depth: Deep	Kh/Kv: 10^2	Kh/Kv: 10^3	Kaq/Kt: 10^2	Kaq/Kt: 10^3	Aquifer position: Full[1]: None	Full[1]: Base	Partial[2]: Base: 0.35L	Base: 0.55L	Base: 0.82L	0.45T: 0.35L	0.45T: 0.55L	0.45T: 0.82L	Height of water table above lake level (relative to total system thickness): Lake 1: Upslope: 0.13	Lake 1: downslope: 0.06	Lake 2: Upslope: 0.13	Lake 2: downslope: 0.06	Lake 3: Upslope: 0.13	Lake 3: downslope: 0.06	Results: Lake 1: Height of head of stagnation point above lake level (in feet)	Lake 1: Percent of bed that loses water	Lake 2: Height of head of stagnation point above lake level (in feet)	Lake 2: Percent of bed that loses water	Lake 3: Height of head of stagnation point above lake level (in feet)	Lake 3: Percent of bed that loses water
25	6-4:5.31[2]	X			X			X								X	X	X	X	X	X	3.0		3.0		3.0	
26	6-17:9.36[4]	X			X			X								X	X	X	X	X	X	3.0		3.0		3.0	
27	6-5:7.56	X				X			X							X	X	X	X	X	X	2.7		1.9		0.4	
28	6-9:2.38	X		X			X		X							X	X	X	X	X	X	2.8		1.8			
29	6-11:5.14	X			X		X		X							X	X	X	X	X	X	3.9			7/8		8/8
30	6-11:6.92	X			X		X			X	X	X				X	X	X	X	X	X	1.6		1.9		1.7	
31	6-16:25.29	X		X			X						X	X	X	X	X	X	X	X	X	2.1		2.2		RF(2.1)	
32	6-16:26.10	X			X		X						X	X	X	X	X	X	X	X	X	0.4		0.8		0.7	
33	6-18:6.49[5]	X			X			X								X	X	X	X	X	X	RF(4)		RF(3)		RF(1)	

[1]Aquifer extends full length of the basin.
[2]Aquifer does not extend full length of the basin.
[3]K aystem=0.2 ft/day.
[4]K system=200.0 ft/day.
[5]Shallow ground-water system.

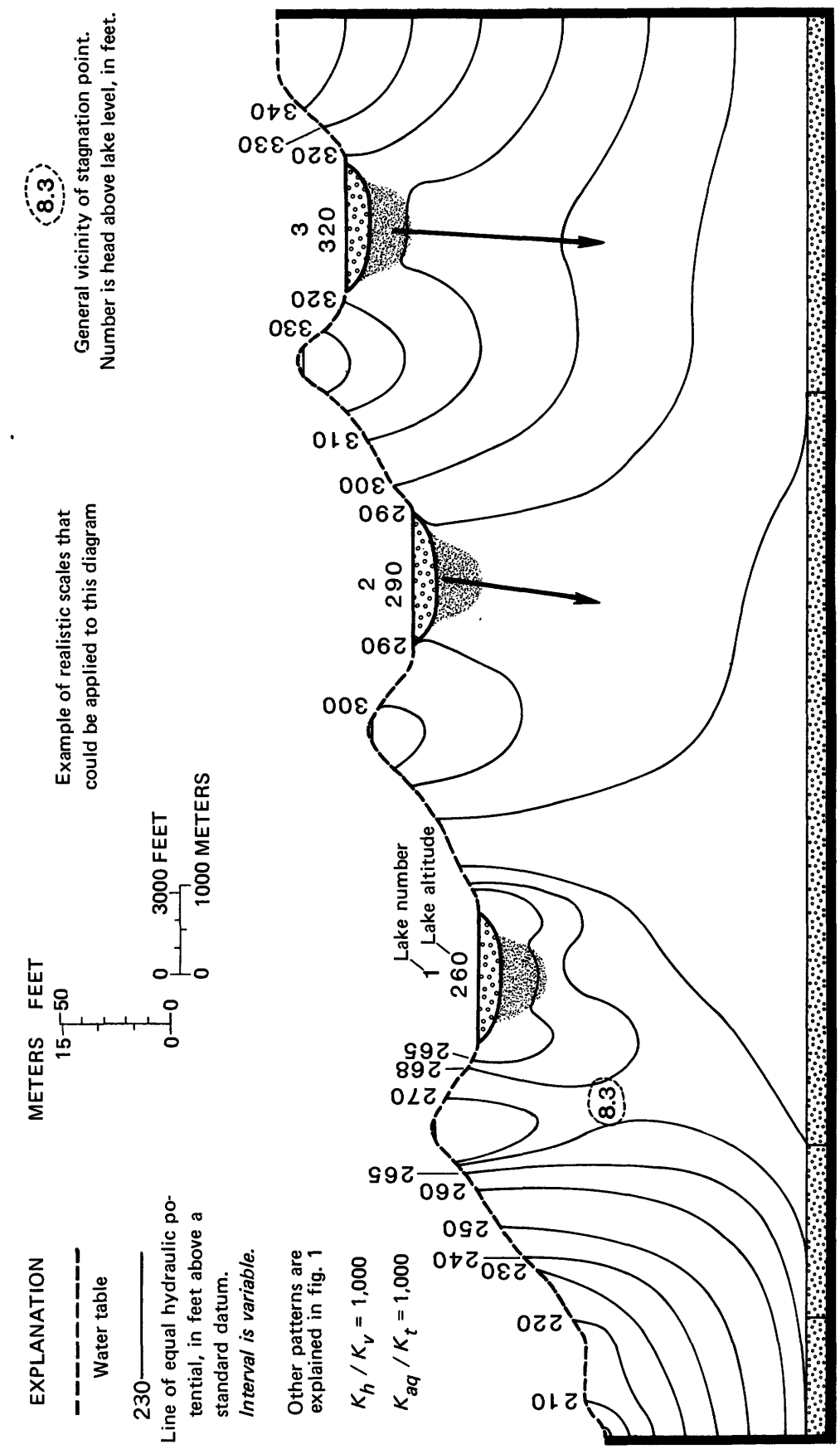


FIGURE 20.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has an extensive aquifer of relatively high hydraulic conductivity at the base of the system.

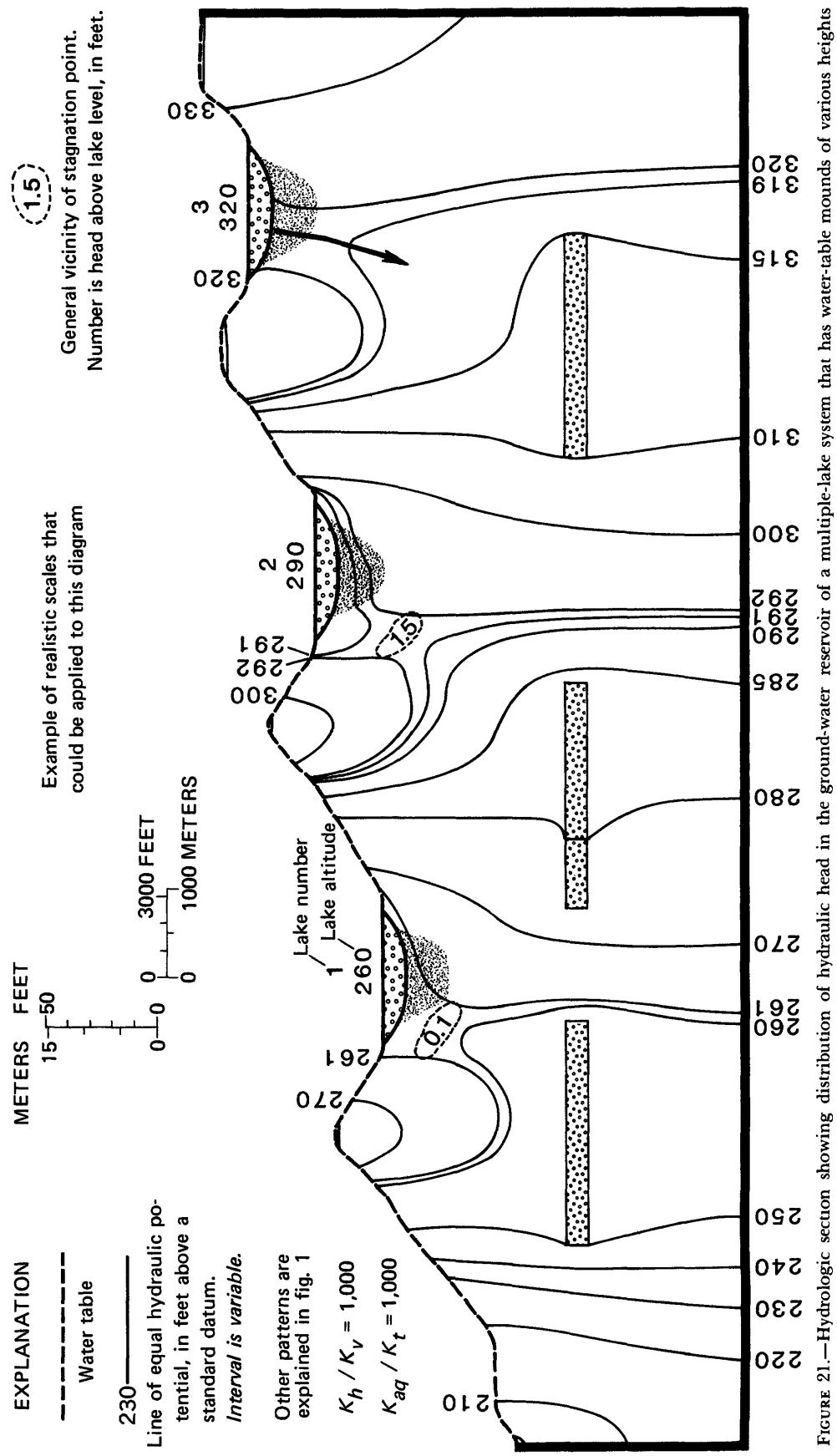


FIGURE 21.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has water-table mounds of various heights and aquifers of limited extent in the middle of the system.

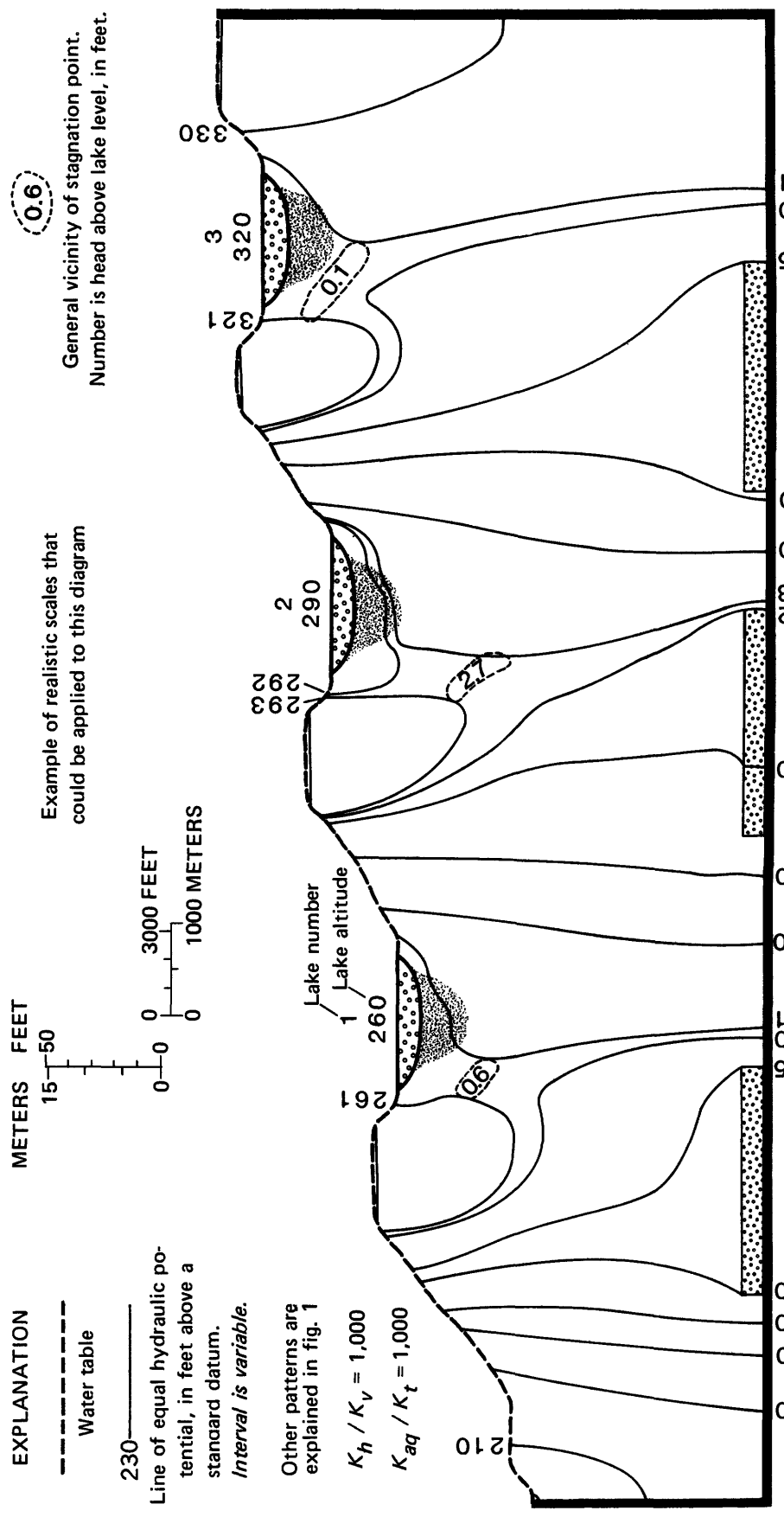


FIGURE 22.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has low water-table mounds and aquifers of limited extent at the base of the system.

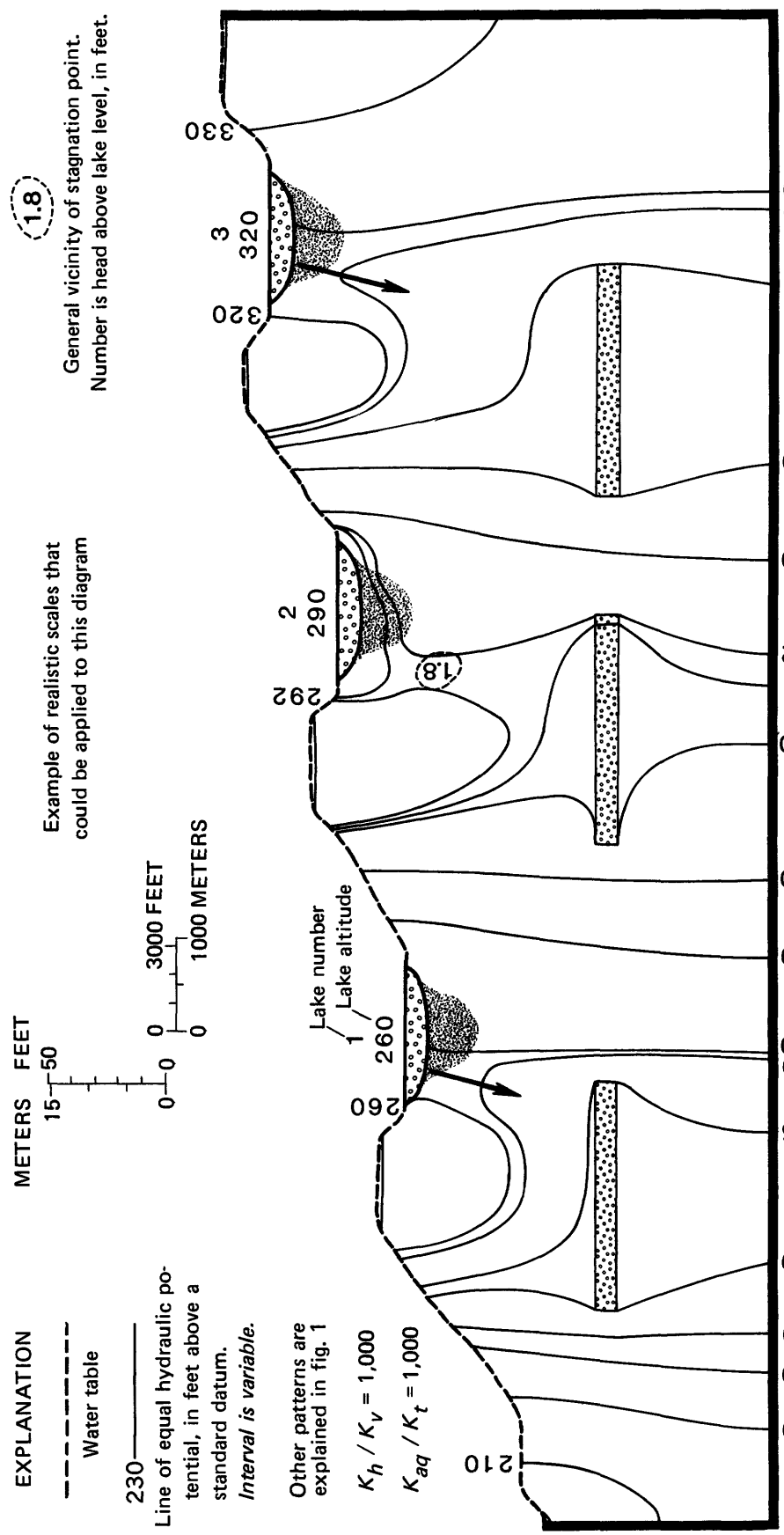


FIGURE 23.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has low water-table mounds and aquifers of limited extent in the middle of the system.

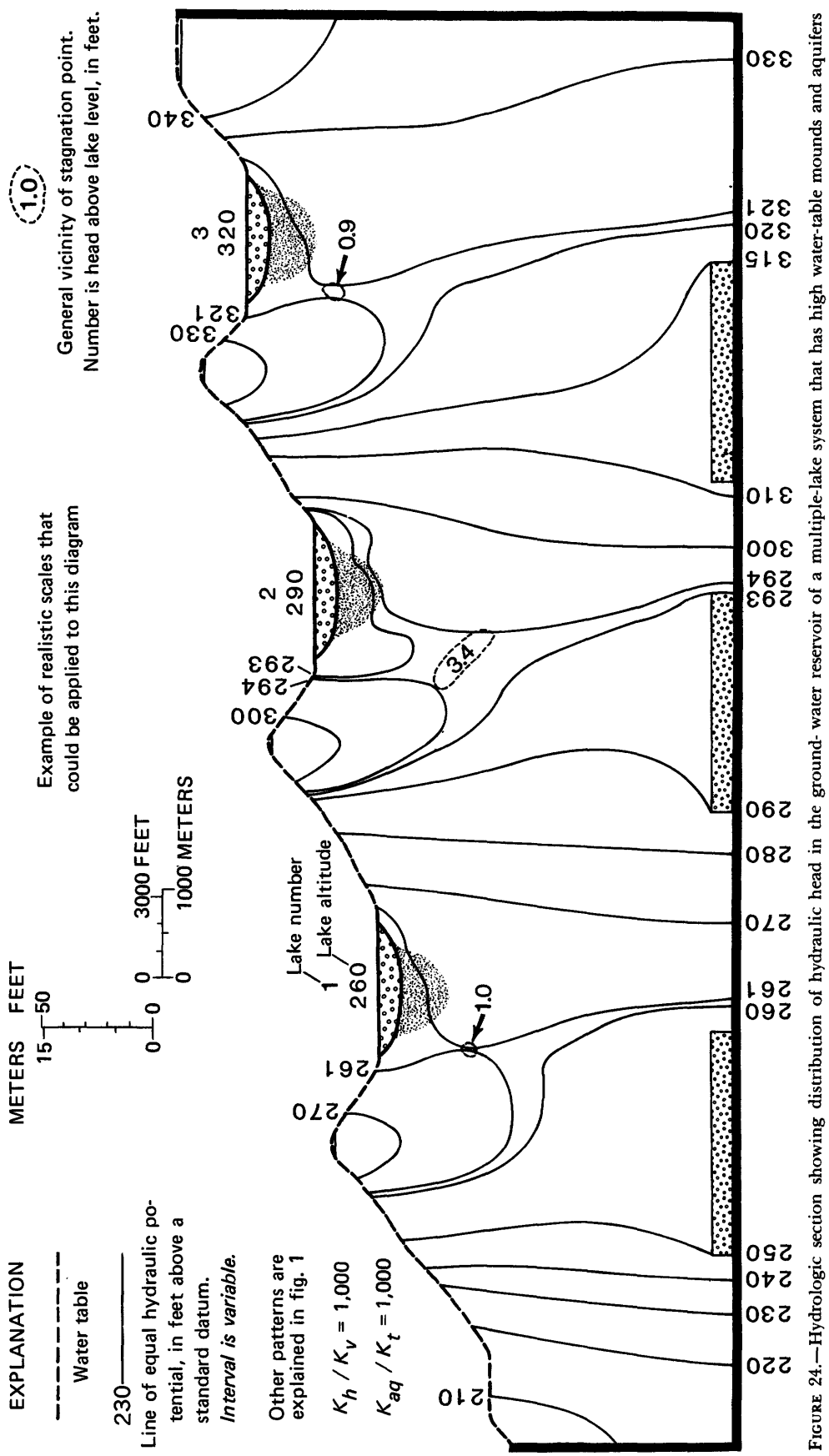


FIGURE 24.—Hydrologic section showing distribution of hydraulic head in the ground- water reservoir of a multiple-lake system that has high water-table mounds and aquifers of limited extent at the base of the system.

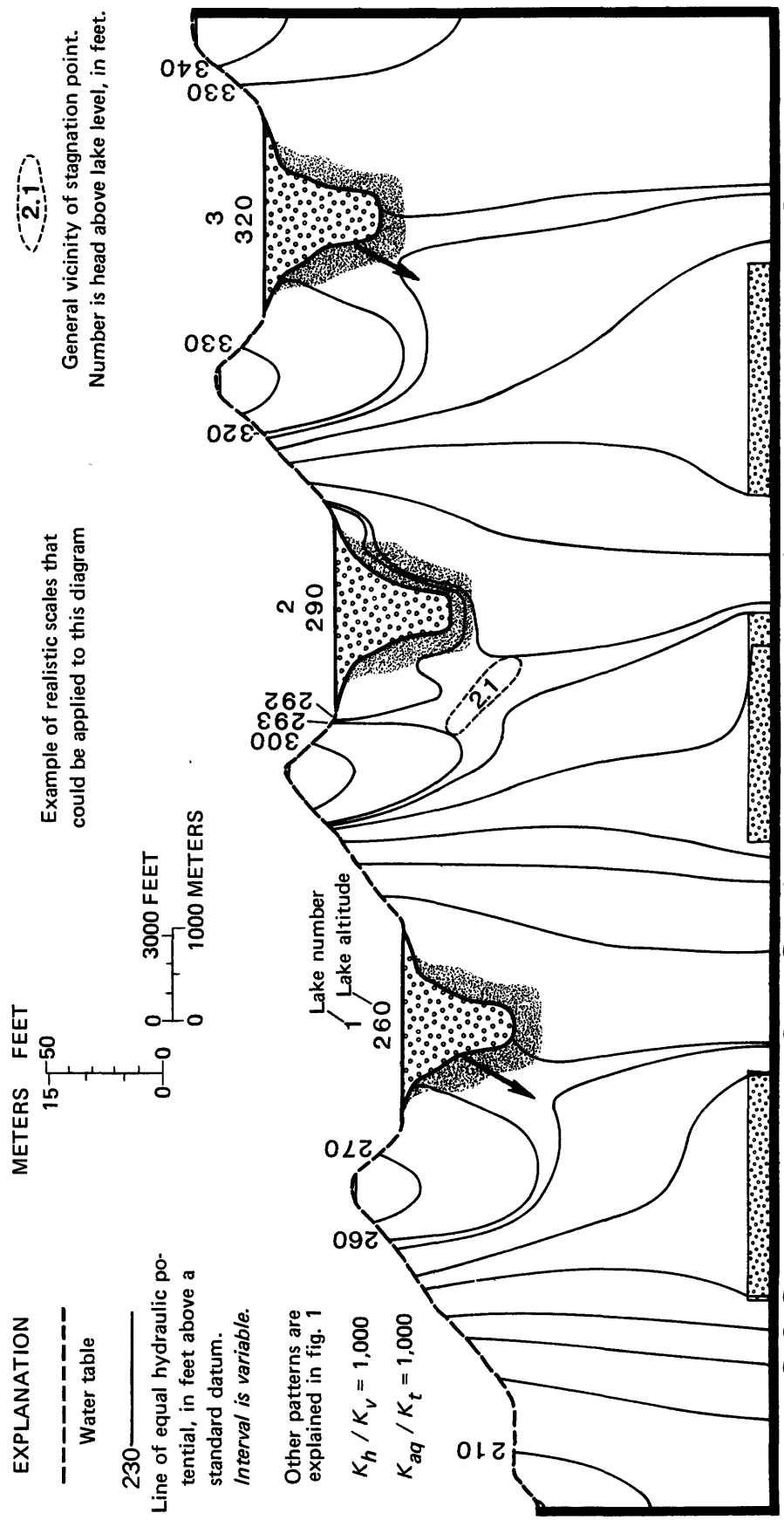


FIGURE 25.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has deep lakes, high water-table mounds, aquifers of limited extent at the base of the system, and K_h/K_v=1,000.

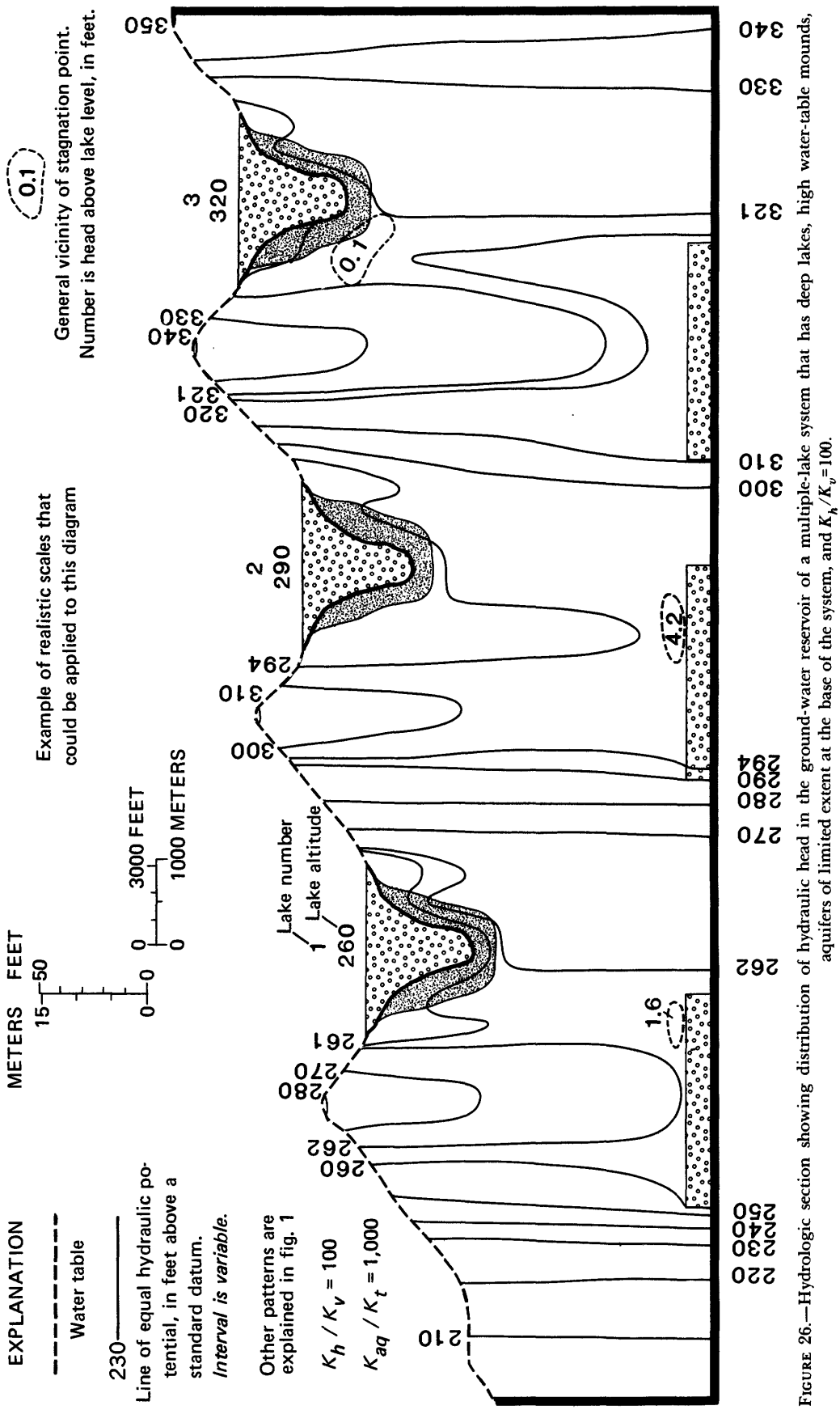


FIGURE 26.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has deep lakes, high water-table mounds, aquifers of limited extent at the base of the system, and $K_h/K_v = 100$.

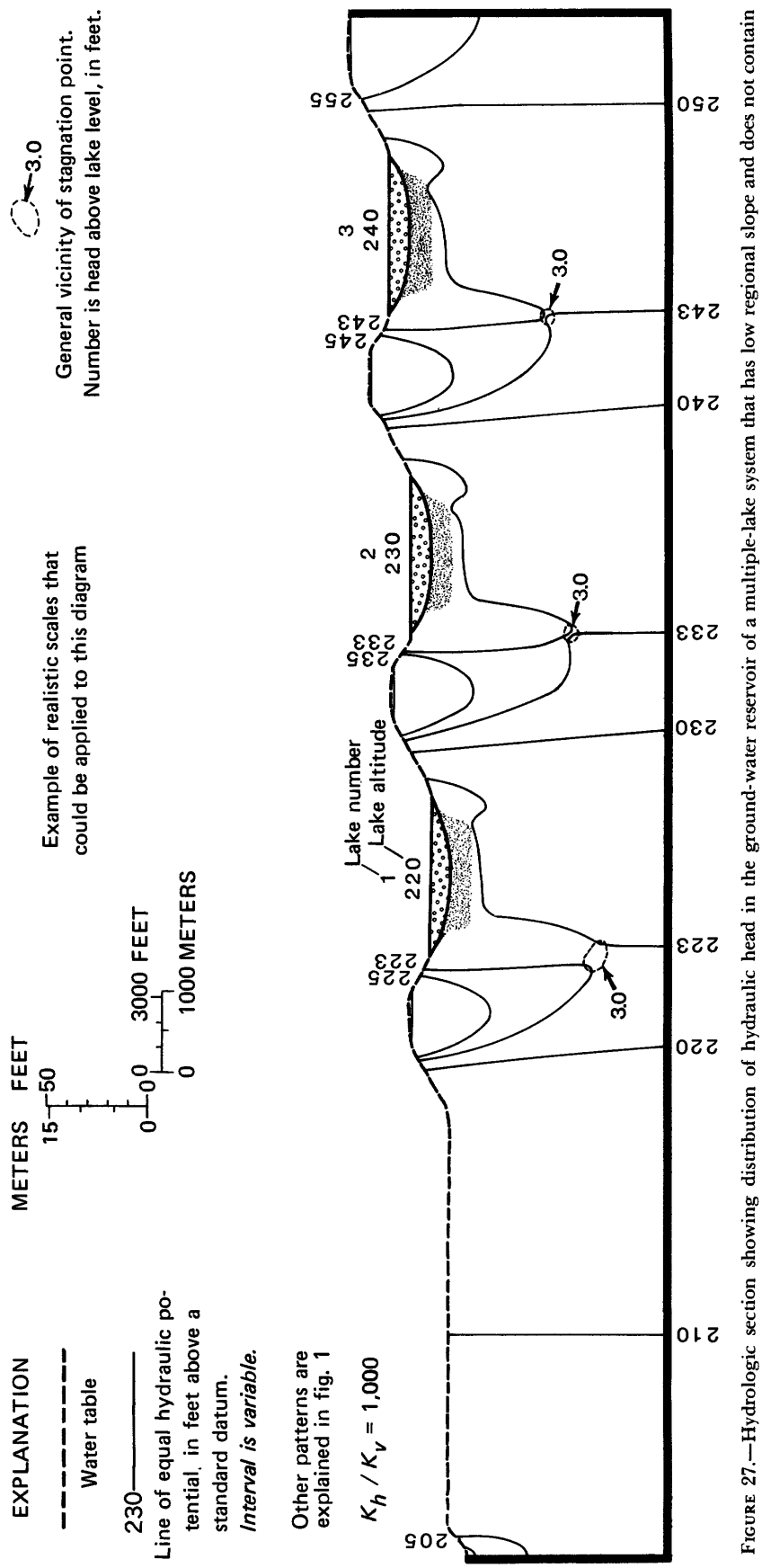


FIGURE 27.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has low regional slope and does not contain aquifers.

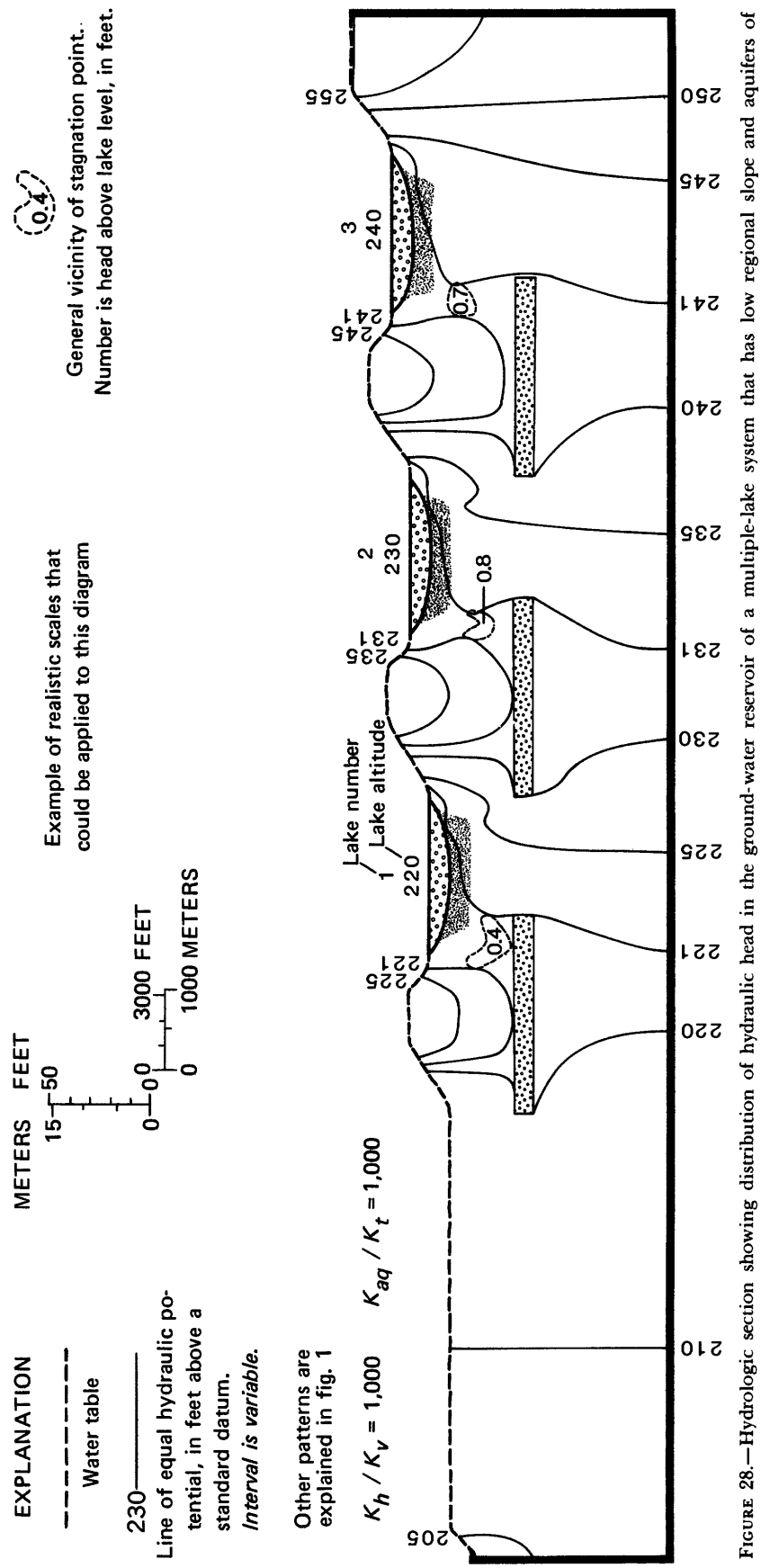


FIGURE 28.—Hydrologic section showing distribution of hydraulic head in the ground-water reservoir of a multiple-lake system that has low regional slope and aquifers of limited extent in the middle of the system.

QUANTITATIVE ASPECTS OF GROUND-WATER INTERCHANGE WITH LAKES

Most of the discussion to this point is concerned with the qualitative aspects of the relationship of ground water to lakes. Attention is focused on factors that control the presence and strength, or the absence of a ground-water divide beneath a lake. The importance of the position and head relative to lake level of the stagnation point of a ground-water divide, if present, is stressed. Not only is the basic presence or absence of a divide of interest to those concerned with lake hydrology, but the quantities of water involved are also of great interest.

The basic concept of a flow net is presented in the discussion of ground-water-flow diagrams. It is pointed out in that section that figures 4 and 5 are not quantitative flow nets in the precise meaning of the term, because the ground-water reservoirs they illustrate are considerably anisotropic and vertical exaggeration is great.

A quantitative flow net can be used to calculate ground-water discharge through an isotropic medium using the following form of Darcy's Law (Freeze, 1969b):

$$Q=K\frac{\Delta\phi}{\Delta s}w\Delta m, \qquad (2)$$

where Q =discharge through a segment of the flow net,
K =hydraulic conductivity,
$\Delta\phi$ =drop in hydraulic potential between equipotential surfaces,
Δs length of flow path in the segment of the flow net,
Δm=width of the segment of the flow net perpendicular to the flow direction, and
Δw =thickness of the flow system perpendicular to the plane of the diagram.

Taking a unit thickness of the system (w=1), and considering that for the squares of the net $\Delta s=\Delta m$, equation 2 reduces to

$$Q=K\Delta\phi. \qquad (3)$$

Useful properties of a flow net are that discharge in each flow channel (zone located between two adjacent flow lines) remains constant throughout its length, and equal quantities of water move through each flow channel. In spite of the fact that figures 4 and 5 cannot be used to accurately calculate discharge, they are useful in estimating relative quantities because the proportions of flow between the various flow systems (local, intermediate, and regional) remain constant.

Referring to figure 4, it is shown by relative spacing of stream lines that much more water moves through the local flow systems than the intermediate or regional systems. The difference in quantities of flow between the various flow systems is not as great in the situation represented by figure 5, partly because of the relatively weak local flow near, and the leakage from, lake 3.

The relationship of ground water to lake 3 of figure 5 is of interest when considering quantities of flow into and out of the lake. Despite the fact that the lake loses water through at least half of its bed, the flow net indicates more ground-water gain into the lake than loss out of it. Not only is the loss relatively low when considering only the hydraulic potential distribution, but most of the outflow must be through the bottom sediments rather than through the littoral zone, which is true of nearly all situations where lakes lose water to the ground-water system. From equation 3, it is clear that Q must be rather low if both K and $\Delta\phi$ are low. This pattern of inflow in the littoral zone of a lake, even on the downslope side, and loss, if present, through the lake sediments is a common phenomenon in nearly all the simulations in which loss occurs.

McBride (1969) found that the inflow to Lake Sallie, Minnesota, is greatest in the shallows near the shoreline and decreases logarithmically toward the deeper part of the lake. He later showed, through a modeling approach (McBride and Pfannkuch, 1975), that this is a general phenomenon. It can also be corroborated by a detailed flow net analysis.

The results of this study and those of McBride are important to the calculation of water budgets for lakes. Because even if a lake loses water through much of its bed, the quantity of ground-water gain in the littoral zone may be considerably greater than loss through the sediments of the lake.

The other important factor in calculating the quantities of ground-water interchange with a lake is the hydraulic conductivity (K) of the ground-water system. Specific values of hydraulic conductivity have been mentioned little in the discussion up to this point, because in the models all K values are relative. If hydraulic conductivity is changed from 0.2 ft/day (0.06 m/day) to 200.0 ft/day (61 m/day), but all the other K values in each simulation are changed accordingly, the resulting head configurations are identical. (Compare rows 25 and 26 of table 4.)

If interest is in quantities of ground-water discharge, for use in determining water budgets for example, specific values of K are extremely important. (See equation 3.) Obviously, far more ground water will interact with a lake situated in highly conductive rock material such as sand and gravel than a lake situated in silty till, provided the hydraulic gradients ($\Delta\phi$) are similar.

AREAL AND TEMPORAL VARIATIONS

The hydrologic sections discussed in this report represent a two-dimensional vertical view of the ground-water system. By carefully selecting the line of section on a map, the general qualitative interrelationship of lakes and ground water can be adequately determined. To assure areal coverage of the lake's entire ground-water basin, however, a more accurate analysis of the entire drainage

basin of a lake would have to consider radial flow. Perhaps the best approach would be to use three-dimensional modeling techniques which have recently received much research attention and are becoming available for general use. Until three-dimensional models of ground water flow near lakes are operational, an alternate approach to providing areal coverage is to run two-dimensional models of selected lines of section. (The lines of section must be chosen so they radiate from a lake and are representative of a pie-shaped part of the ground-water system near a lake.)

Because the ground-water system is dynamic, a steady-state hydrologic section can be representative of a system in which changes occur very slowly over a period of time. If lake and water-table altitudes change rapidly, the most accurate analysis would be to solve the equations of transient ground-water flow. Examples are lakes in a setting of widely fluctuating water-table and lake levels, especially if the changes are out of phase with one another, or are much greater in one than the other. Not only would flow nets be needed to calculate the changed rates of ground-water discharge but the basic relationship of a losing versus a gaining lake might be changed. An example of this is given by Meyboom (1967), who found that some lakes in the prairie provinces of Canada are underlain by ground-water divides for part of the year (spring and summer), but lose water to the ground-water system for the remainder of the year (fall and winter). Depending on the accuracy needed for calculation of ground-water discharge, sections would have to be drawn to reflect the changing conditions.

There are probably many lakes in hydrogeologic settings where the trends in lake levels and water-table levels are essentially parallel for most of the year (Winter and Pfannkuch, 1976; McBride, 1969). In such situations, hydrologic sections would be needed for one time or only a few times during the year. Freeze (1969b) argues, in considering large basins, that the effect of small-scale cycles of wetting and drying during the year can be approximated by a steady-state average.

The most likely situations where hydrologic sections would be needed for more than one or two times during a year would be if: (1) A large rise in lake level would not be accompanied by a similar rise in the water table—for example, a flood wave passing through a lake that has streamflow in and out or a large drop in lake level caused by release of water through a dam, or (2) a large drop in the water table were caused by discharge of ground water by phreatophytes, or by dissipation of water-table mounds because of lack of rainfall. Both latter conditions had a bearing on the results of Meyboom's study.

IMPLICATIONS FOR FIELD STUDIES OF THE INTERACTION OF LAKES AND GROUND WATER

It was pointed out in the introductory paragraphs of this report that a number of different approaches to studying the relationship of ground water to lakes have been tried. Some workers have thought that a single piezometer (observation well) beside a lake would adequately define the relationship, while others have placed large numbers of piezometers near a lake. Knowledge of the possible variations of ground-water flow systems near lakes, as demonstrated in the simulations of this study, suggest placement of piezometers that would optimize information on the interaction of lakes and ground water using a minimum number of piezometers.

Rather than place piezometers within the drainage basin of a lake, most effort should be on finding the maximum altitude of the water-table along the areal ground-water divide around a lake where such a divide exists. For flow-net analysis it is necessary to find this water-table-mound maximum and to place a piezometer on it for each segment of the lake's drainage basin where different ground-water-flow patterns are suspected. As seen from the simulations, one of the most important locations is the height of the water table above lake level on the downslope side of a lake.

Finding the maximum height of a water-table mound can be difficult. It has been demonstrated a number of times in the field that water-table mounds do not underlie directly topographic highs. Topography is not shown on the hydrologic sections—one can visualize topographic highs anywhere along the sections. In addition, the accessibility of roads and the need to obtain the land owner's permission is an important constraint in locating drilling sites and observation wells. It is easily demonstrated in any of the simulations of a three-lake system (fig. 4, for example) that a piezometer placed closer to lake 2 than lake 3 along the water-table profile between lakes 2 and 3 would record water-table altitudes lower than the level of lake 3. One would conclude in this case that, since the water table at that point is at an intermediate altitude between the two lakes, water flows from lake 3 to lake 2, an erroneous conclusion reached in many studies of lake-ground water interaction in which few wells are placed and the principles of ground-water flow near lakes are not understood.

In addition to locating key points along the water-table divide around a lake, it is important to know the location and head relative to lake level of the stagnation point on the ground-water divide beneath the lake, if such a point exists. This is best accomplished by placing a nest of closely spaced piezometers, each completed at a different depth, in the most appropriate location. As suggested by the simulations of this study, the most appropriate location to look for the stagnation point is beneath the shoreline on the downslope side of the lake.

Data on the other factors that control ground-water flow (hydraulic conductivity of the various geologic units, hydrogeologic boundaries, location of aquifers) are not easily obtained, but there are accepted methods for acquiring them.

Field determination of the critical K_h/K_v ratio, on the other hand, is a serious problem. Although it has not been field tested, the method of determining K_h/K_v from measured head values proposed by Gillham and Farvolden (1974) may prove useful.

SUMMARY

The relationship of ground water to lakes is the least well known aspect of lake hydrology. This report discusses steady-state digital-model simulations of ground-water flow near lakes as a first step toward a general theoretical understanding of the interaction of lakes and ground water. Numerical-model simulations were run to define the principles of the interaction of lakes and ground water, and to evaluate parameters that control ground-water flow near lakes.

The numerical models, using the alternating-direction-implicit (ADI) and strongly implicit procedure (SIP) methods to solve the steady-state ground-water-flow equation for vertical sections, were used to simulate one-lake and multiple-lake systems.

The report demonstrates by analysis of ground-water flow in vertical sections that the existence, position, and head value at the stagnation point of the ground-water-flow field, relative to the head represented by lake level, is the key to understanding the interaction of lakes and ground water. The stagnation point is the point of least head along the divide between ground-water-flow cells beneath a lake. Therefore, if a stagnation point exists, the divide is continuous, the lake cannot leak, and it is the discharge point of the ground-water flow system. If there is no stagnation point, the ground-water divide related to the lake is not continuous, and the lake can leak through part or all of its bed.

Factors that strongly influence the interaction of lakes and ground water are height of the water table on the downslope side of the lake relative to lake level, position and relative hydraulic conductivity of aquifers within the ground-water reservoir, ratio of horizontal to vertical hydraulic conductivity of the ground-water system, regional slope, and lake depth. Of lesser significance to lake-ground water interaction are height of the water table on the upslope side of a lake relative to lake level, ground-water reservoir thickness, and presence of lake sediments.

The models are believed to be the first to show the detailed patterns of ground-water flow beside and beneath lakes in a wide variety of hydrogeologic settings. They are unique because they show ground-water-flow patterns beneath and between a series of lakes, each at a different altitude, along a valley side. A significant finding is that, for most settings, water does not move from higher lakes through the ground to lower lakes if a water-table mound exists between the lakes. This can happen only if one presumes a straight-line water-table profile connects the lakes.

In field studies of the interaction of lakes and ground water it is especially important to define the geologic framework including the hydraulic conductivities of the geologic units—the boundaries of the system, the ratio of horizontal to vertical hydraulic conductivity, the height of the ground-water watershed relative to lake level, and the strength (head at the stagnation point relative to that represented by lake level) and position of the stagnation point.

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Outlook

[EXTERNAL] Copper Flat Mine

From Robert <byrd.bob@gmail.com>
Date Thu 10/15/2026 4:33 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

[You don't often get email from byrd.bob@gmail.com. Learn why this is important at https://aka.ms/LearnAboutSenderIdentification]

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Dear Director Aguilera,

My family has deep roots in Sierra County, my Great Grandfather coming to then-Hot Springs in the early 1900s to work at the Dam, and planting roots for generations to come. SW New Mexico is in need of good jobs that are independent of seasonal tourism the water level at Elephant Butte and competition for space launches. Large landowners cater to the few wealthy tourists, and our youth seemingly only have service jobs to keep them here.

I have spoken in favor of the mine back when the project was under previous management- and Hillsboro is a sad place. While waiting for the event to begin in the community center I discovered the only restaurant was only open for lunch (which I missed), the nearest gas was off the interstate near the lake (Caballo) and the school bus came by with exactly one student. A handful of retirees with state pensions were upset about the mine, unaware that they'll only notice it when they drive up past it from the interstate- but with the mine there will be more families in the community, and support economic investment in local businesses and activities.

Mining is in our heritage here. I'm a retired miner, and it is a fascinating field to work in, paying great wages, and could help improve the tax base necessary to maintain infrastructure, support schools, and attract additional investment, as business that complements the mine moves in, giving young families a reason to stay. The mining potential of our state, and in particular the Southwest corner is excellent- and totally compatible with tourism and agriculture.

Modern mining is very different from what most people expect it to be. I agree that our water resources are important, and need to be properly valued when allocating. I invite you to consider how much water is actually used in producing a pound of copper and the value of that copper at Copper Flat, compared to any agricultural use, which unfortunately is particularly wasteful by choice in this state.

Sincerely,

Robert Byrd
Las Cruces
[redacted]

Sent via mobile

Outlook

[EXTERNAL] Copper flat mine

From Hunter White <rhwhite222@gmail.com>
Date Thu 10/15/2026 10:38 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from rhwhite222@gmail.com. Learn why this is important

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

I fully support the Copper flat mine.
The companies proposed use of dry stack tailings is state of the art and does in fact tremendously reduce water usage. The science is solid. Let the permitting process follow its course of due diligence..
Mining today is one of the most regulated business activities and the NEPA permitting process is exhaustive. The process ensures that the science and engineering are sound and the regulations outline approval processes. Please just follow the law.
The oncoming AI revolution will require tremendous amounts of copper. The current copper industry simply cannot provide this vital material without bringing on significant new mine capacity. In New Mexico this can be done responsibly and provide needed local, state and federal taxes while also provided good high paying jobs.
Follow the process and approve this mine.

Sincerely
Robert White

Outlook

[EXTERNAL] Re: Copper Flat Mine Revised Application, permit no SI027RN

From John Wall <john.d.x.wall@gmail.com>
Date Fri 10/16/2026 11:58 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from john.d.x.wall@gmail.com. Learn why this is important

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Dear Director Aguilera,

Good afternoon! I'm writing you in reference to the application for the Copper Flat Mine. I respectfully urge the New Mexico MMD not to approve New Mexico Copper Corporation's revised application for the Copper Flat Mine. As the revised proposal submitted still offers insufficient clarity on identifying sufficient water for mine operations and reclamation, protecting those using water sources further downstream, demonstrating a meaningful safety plan for longterm storage at the proposed Tailings Storage Facility, and explaining a meaningful or appropriate plan for reclamation of the open pit.

There are updates in the revised proposal specific to reducing water use from the previous proposal (i.e. filtered tailings to replace more common wet tailings), but the fundamental concerns originally aired on this project do not feel meaningfully acknowledged and addressed in this revision.

We don't clearly see if an adequate amount of water not only for mine operations but also reclamation at proposed production rates is even legally and physically possible. While projected water savings associated with filtered tailings are considered in the revision, there seems to be little assurance that such a heavy reliance on recycling water throughout mine operations will be completely managed mainly through this adjustment. Any company cannot stop their consideration of water consumption only at the start of their project. It is imperative that NMCC ensures not only that the water for this project is legally available for the mine to operate but also that sufficient water will remain available to those that rely on it during operations and through the reclamation process.

Related to water consumption, nearby wells and springs are susceptible to depletion from groundwater pumping and mine-related depletion. That leaves Las Animas Creek, downstream water users, and ultimately the Lower Rio Grande with question about their water availability that are still not accounted for. The adequacy of the mine's water supply cannot be evaluated separately from its effects on people and ecosystems that depend on the same water resources. This is a similar concern for other proposed projects in the area; some of them with more robust answers on their first presentation compared to NMCC's revised application.

In regards to the long-term stability and safety of the proposed TSF. Clear information about issues evaluated, like subsurface conditions and seismic hazards necessary to evaluate slope

stability, was found to still be missing after technical review. Before approving a facility intended to permanently contain mine waste, I urge MMD to please ask for meaningful analysis to determine how the TSF will perform during operations, closure, and long-term reclamation. What are the implications and consequences of a potential catastrophic failure.

In the revision, the proposed pit would ultimately be approximately 1,000 feet deep and 2,800 feet wide. The reclamation plan relies on rapidly filling the pit with groundwater to limit acid formation. Under the revised proposal, however, filling the pit is expected to take more than 2.5 years rather than approximately six months as previously proposed. This undermines a central assumption of the company's plan for reclamation of the open pit. Rather than alleviating concerns, this point in the revision now raises serious concerns about the likelihood of an acidic pit lake as well as the adequacy of the proposed reclamation plan.

If the proposed reclamation strategy depends on rapid pit filling when the revised water supply no longer allows the pit to be filled rapidly, MMD should not accept this incongruence. Additionally, backfilling the open pit needs to be considered as an alternative to the proposal, at this point.

None of these issues will be resolvable after a permit is issued. These will continued whether or not this project has secured the resources necessary to operate and reclaim the site, safely construct a permanent mine waste facility, and protect water users and groundwater for years to come.

Based on this, **I must urge MMD not to approve the revised Copper Flat application unless and until the applicant**:

- Demonstrates that its projected water savings from switching to filtered tailings are realistic and sufficient;
- Demonstrates that an adequate amount of water is legally available for the full needs of mine operations, closure, and reclamation;
- Fully evaluates the effects of groundwater pumping and other mine-related depletion on wells, springs, Las Animas Creek, downstream water users, and the Lower Rio Grande;
- Provides the site-specific geotechnical and seismic analysis necessary to demonstrate the stability and long-term safety of the proposed Tailings Storage Facility;
- Adequately evaluates the consequences of a potential TSF failure;
- Demonstrates that its revised pit reclamation strategy can prevent the formation of an acidic pit lake despite the substantially longer proposed filling period; and
- Fully evaluates backfilling the open pit as an alternative reclamation approach.

The communities surrounding Copper Flat bear any consequences of this project long after mining ends. MMD has a responsibility to ensure these fundamental questions are resolved before, not after, a decision is made.

I urge the Division to require the information and analysis necessary to address these concerns and not approve the revised application as currently proposed.

Sincerely,

John Wall Silver City, NM Grant County

Outlook

[EXTERNAL] Copper Flat Mine

From Kate Gibbons <kate@stargroup.live>
Date Fri 10/16/2026 10:55 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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To whom it may concern,
I am writing to express my strong opposition to the opening of the Copper Flat Mine in Sierra County, outside of Hillsboro.
I live directly down stream from the mine on Animas Creek Rd; eleven miles from the site.
I am concerned about pollution and runoff affecting the viability of my well, which is my only source of drinking water.
I am also concerned about how the water use and water quality downstream and adjacent to the site will be monitored and ensured, including the frequency, method, and entity responsible for monitoring.
Lastly, I am concerned about noise, light pollution, hours of operation, and the inadequacy of hwy 152 for constant use by vehicles for hauling.
Thank you for this consideration.
--

Kate Gibbons, Ph.D., LISW, LCSW
Janus, LLC Consulting and Co-Creating
https://calendly.com/kateg-808/meeting-with-kate-gibbons-janusllc
[redacted]
w: www.stargroup.live
https://www.linkedin.com/in/kate-gibbons-4a876319/

Outlook

[EXTERNAL] Opposition to the copper flat mine.

From Haynes, Lisa - (lynx) <lynx@arizona.edu>
Date Fri 10/16/2026 4:52 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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To: the Director of Mining and Minerals Division, state of New Mexico.
From: Lisa (Elizabeth) Haynes, resident of Hillsboro, New Mexico
Subject: opposition to the Copper Flat mine.

In one short sentence, I am vehemently opposed to the Copper Flat mine, and therefore the permit to allow the mine.

However, my rationale is expressed in these points:

First is water. It is absolutely unbelievable that the state is considering permitting this mine, given the extreme water concerns that we have in this region. It is mind-boggling when one considers the state of the drying (and I would say dying) Rio Grande River as evidenced by the extreme low level of water in the Elephant Butte Reservoir this summer. As a biologist and ecologist, I have been focusing on water restoration and watershed health and just cannot believe that there are proposals for this horrendous project to move forward. I just can't come up with enough superlatives to express my disbelief and horror that it is being considered. We are now completely in the watershed death cycle in this region (https://www.waterstories.com/story/the-watershed-death-spiral) , particularly on this east face of the Black Range after the two huge forest fires (the Silver and Black fires) in the range which precipitated and aggravates the deterioration of landscape ecology, and therefore water cycling. In Hillsboro, this is evidenced by many of the dead and dying cottonwoods as well as other trees, because the water table has dropped below the 10-foot level that they require to have their roots in the groundwater, combined with record high temperatures and long-term drought. As we are going into hotter and dryer periods in the future, how could **anyone** conceive of such an ill-considered proposal as this mine.
Also, this gets close to home, as my property boundary … and well…is fairly close to the Pitchfork Ranch boundary, which has been listed as one of the land owners that may very well be impacted by the water withdrawal for the mine.

I agree with all of the other residents and experts opposing this mine on many other counts, such as the rosy projections of jobs. Having worked in several US regions during my lifetime that were highly impacted by mines and oil and gas development, those projections do not manifest with locals getting very many of the jobs. It's usually outsiders and mostly those who have experience and expertise and who mostly leave when the project timeline is over. All of the promises of high-quality jobs, "state-of-the-art" mitigation, etc., etc. etc., in my experience have not been met, and locals and taxpayers are left with the mess both environmentally and culturally while some big corporation, CEOs, etc. take home big checks usually to another country, as will be the case with this Australian outfit.

The impact to Animas Creek is something I just can't contemplate. I have worked in the creek and have been to its headwaters, and it is by far one of the most sublime and biologically rich places I've ever experienced in the southwestern United States. Those sycamores are absolutely magnificent, precious and irreplaceable as we go

into a hotter future, plus, there is so much deep historical and cultural history there. You may not know that the book has been written about the specialness of that drainage, even relative to surrounding ones: *River of Spirits: A Natural History of New Mexico's Las Animas Creek*, written by Hillsboro locals. Impacting that drainage is incomprehensible to me.

I suspect moving forward with this project at this particular moment in time to obtain ridiculously low ore concentrations is due to the demand mostly for data centers, which are equally egregious, given the future we are moving into with respect to already stressed water and natural resources. How can human beings be so **inordinately blind to the current and future realities**?

In my mind, this project is analogous to arson… lighting fires of destruction, deliberately and knowingly, ignoring the obviously extremely detrimental impacts to our communities, both human and natural, and especially to the life giving waters of our beautiful New Mexico landscape here in Sierra County. Please reconsider this proposal and deny it.
Sincerely,
Lisa Haynes

Outlook

[EXTERNAL] Copper Flat Mine water consideration

From Michael Hill <dragonmotors@gmail.com>
Date Fri 10/16/2026 9:39 AM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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Hello,

This is just a consideration about the water resources that Copper Flat Mine will need to draw from. The water shed that will be drawn from for the Copper Flat Mine seems to me to obviously drain into the Rio Grande. If the ground water is taken from drainage that ends up in the Rio Grande, then there is going to be an issue that has to be addressed about water delivery to Texas. As I am sure you all know, Texas sued New Mexico for ground water usage and New Mexico had to settle and admit that the ground water usage in New Mexico had some effect on the down stream water delivery to Texas. I see no reason to believe that the Copper Flat Mine usage would not affect our water delivery volume to Texas as well, and Texas certainly will be concerned and has been historically litigious. I think the state really needs to take that into consideration when looking at this project.

Thank you

Michael Hill
[redacted]

Outlook

[EXTERNAL] Public Comment Submission – Copper Flat Mine SI027RN

From Liliana Castillo <liliana@singlespacestrategies.com>
Date Fri 10/16/2026 1:28 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>
Cc allysonsiwik <allysonsiwik@gmail.com>; Ava Curtis <acurtis@swuraniumimpacts.org>; Sarah Knopp <sknopp@amigosbravos.org>; Wendy Attcity <sricwendy@gmail.com>; Ann McCartney <amccartney@nmelc.org>; ejantz@nmelc.org <ejantz@nmelc.org>; Susan Gordon <susangordon@earthlink.net>; Chris Shuey <sric.chris@gmail.com>; Rachel Conn <rconn@amigosbravos.org>

1 attachment (241 KB)
Copper Flat Sign On Letter SI027RN NM Mining Watch.pdf;

You don't often get email from liliana@singlespacestrategies.com. Learn why this is important

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Hello Director Aguilera,

On behalf of New Mexico Mining Watch, I'm submitting the attached letter and 85 accompanying signatures for consideration during the public comment period for the proposed Copper Flat Mine (SI027RN).

Please include the letter and signatures in the official public comment record.

We appreciate the opportunity to provide input and request confirmation that these materials have been received.

Thank you,

Liliana Castillo
On behalf of New Mexico Mining Watch

New Mexico MINING WATCH

We, the undersigned, urge the New Mexico Mining and Minerals Division (MMD) not to approve New Mexico Copper Corporation's revised application for the Copper Flat Mine (SI027RN). Significant questions remain about whether the revised proposal has sufficient water for mine operations and reclamation, adequately protects downstream water users, demonstrates the long-term safety of the proposed Tailings Storage Facility, and provides an adequate plan for reclamation of the open pit.

The company's revised proposal changes how mine waste would be managed, replacing conventional wet tailings with filtered tailings and projecting significantly lower water use. But changing the proposal has not resolved the fundamental concerns surrounding the project.

The revised proposal has not demonstrated that sufficient water is legally and physically available for both mine operations and reclamation at proposed production rates. The project would rely heavily on recycling water throughout mine operations, and questions remain about whether the projected water savings associated with filtered tailings are realistic and adequately supported. The company must demonstrate that the water sources it relies upon are legally available for mine operations and that sufficient water will remain available throughout the life of the project and through reclamation.

MMD must also fully account for the effects of the project's water use beyond the mine boundary. Groundwater pumping and other mine-related depletion could affect nearby wells and springs, Las Animas Creek, downstream water users, and ultimately the Lower Rio Grande. The adequacy of the mine's water supply cannot be evaluated separately from its effects on people and ecosystems that depend on the same water resources.

The revised application has also not adequately demonstrated the long-term stability and safety of the proposed filtered Tailings Storage Facility (TSF). Technical review has identified the need for additional site-specific information and analysis, including information about subsurface conditions and seismic hazards necessary to evaluate slope stability. Before approving a facility intended to permanently contain mine waste, MMD should require sufficient analysis to determine how the TSF will perform during operations, closure, and long-term reclamation, including the consequences of a potential catastrophic failure.

The revised proposal also undermines a central assumption of the company's plan for reclamation of the open pit. The proposed pit would ultimately be approximately 1,000 feet deep

and 2,800 feet wide. The reclamation plan relies on rapidly filling the pit with groundwater to limit acid formation. Under the revised proposal, however, filling the pit is expected to take more than 2.5 years rather than approximately six months as previously proposed. That substantial change raises serious concerns about the likelihood of an acidic pit lake and the adequacy of the proposed reclamation plan.

MMD should not accept a reclamation strategy that depends on rapid pit filling when the revised water supply no longer allows the pit to be filled rapidly. Backfilling the open pit should be fully evaluated as an alternative to the current proposal.

Taken together, these are not minor details that can be resolved after a permit is issued. They go to whether the proposed mine has the resources necessary to operate and reclaim the site, whether its permanent mine waste facility can be safely constructed and maintained, and whether surrounding water users and groundwater can be protected over the long term.

We therefore urge MMD not to approve the revised Copper Flat application unless and until the applicant:

- Demonstrates that its projected water savings from filtered tailings are realistic and adequately supported;
- Demonstrates that sufficient and legally available water exists for the full needs of mine operations, closure, and reclamation;
- Fully evaluates the effects of groundwater pumping and other mine-related depletion on wells, springs, Las Animas Creek, downstream water users, and the Lower Rio Grande;
- Provides the site-specific geotechnical and seismic analysis necessary to demonstrate the stability and long-term safety of the proposed Tailings Storage Facility;
- Adequately evaluates the consequences of a potential TSF failure;
- Demonstrates that its revised pit reclamation strategy can prevent the formation of an acidic pit lake despite the substantially longer proposed filling period; and
- Fully evaluates backfilling the open pit as an alternative reclamation approach.

The communities surrounding Copper Flat would live with the consequences of this project long after mining ends. MMD has a responsibility to ensure these fundamental questions are resolved before, not after, a decision is made.

We urge the Division to require the information and analysis necessary to address these concerns and not approve the revised application as currently proposed.

Sincerely,

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
John Maddaus			
Dyas Lawson	First Congregational United Church of Christ, Albuquerque	Albuquerque	New Mexico has been raped and pillaged by mining companies for far too long. Please don't let them destroy any more of our beautiful state.
Maura Ciccarelli		Caballo	
Matt Jones		Santa Fe	
Linda Hale	retired	Truth or Consequences NM	Do not approve any Copper Flat application: "mines" are "Corporations" and will not do anything that is said on paper: they will abandon the problem with the people who live here affected for generations: it's what "mines" have done forever. There are no "regulations, laws, rules" that will not have ""loopholes built into the regulations, laws, rules"" including "taking it to court" to avoid doing whatever they lie in the ""agreement"". Corporations as defined in this country have no accountability. Tell this "Corporation" to develop wind and solar as it has been done for decades in ""progressive countries"" that tax and regulate ""businesses"" for the good of the people and those countries.
Kahlan Thompson		Caballo	
Ronald Coleman		Truth or Consequences	

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
John E Arguello cu	Self	Santa Clara, N M	Water is our most precious resource, that we cannot live without. Depleting or polluting our watertable will have dire consequences for future generations...
Deborah Snider		Silver City	
Deborah Snider Snider		Silver City	
J. Edward Arguello	Self and GRIP	Santa Clara NM	Once polluted, our precious water is hard to reclaim. Please help to protect our low water resources..
Elizabeth Tudor	N/a	Kingston	Water it's a no brainer . We do not have the water to support mining here in Sierra County .
Duke Sheppard		Hillsboro NM, 88042	I live in Hillsboro, the nearest town to Copper Flat Mine. I am an avid outdoorsman and use the surrounding area MULTIPLE times a week. There are many springs that are likely to be affected in the area, and that are CRITICAL for wildlife. I am also very concerned about the traffic impacts; most of us in this quiet village use this stretch of 152 many times a week. It cannot handle tons of truck traffic. We live here BECAUSE it is a quiet community; we will be effected by additional traffic AND we will definitely hear blasting and likely have dust.

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
			The fact that this is even being discussed during a record breaking drought is asinine. By their own estimates, 1 million gallons or more a day?!!! Absolutely should not even be on the table. "Dry Stack" isn't so dry, is it? Please stop this ridiculous plan.
Elizabeth Tudor		Kingston	No Copper Flats Mine
Linda Sweanor		Kingston	I strongly oppose the reopening of the Copper Flats Mine unless the company can show that there is adequate, legally available water for operation and reclamation, that it will not result in contamination and depletion of critical groundwater by other users and wildlife (we are in a serious drought!!), that it has a solid plan for sound reclamation of the site (including evaluating backfilling as an alternative approach), and that we can trust that the company will follow-through with the full reclamation of the site (without relying on taxpayers to help foot the bill).
Rebecca Hallgarth	n/a	Hillsboro, NM	I submitted brief written comments for the record in July 2026, but this letter is broader in scope and describes my concerns more fully.
Katherine Nelson	Tripping Sierra Productions	Alto, NM	Preserving our water resources in New Mexico is vital to our flora & fauna, our agriculture, our people, our lakes rivers & streams. No to this data center! There is a mega data center being built in Dona Ana County, enough is enough!

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
Desiree Bernard	NM Interfaith Power and Light	Santa Fe	
Nell Burrus		Albuquerque	
Suzanne Dulle		SILVER CITY	
Anita Amstutz		Taos, NM	Please stop this horrific destruction to our river and watersheds
Patricia Sheely	NMIPL	Gallup, NM	
Chris Harritt		Silver City	
Martha Phillips		Rio Rancho	
Laura Pugatch	First Congregational United Church of Christ	Albuquerque	
Mark Nolan	FCUCC Albuquerque	Albuquerque	We don't have enough water with climate change to support it's use in a copper mine, nor does this proposal deliver effective reclamation results.
Martha Phillips	First Congregational United Church of Christ, Albuquerque	Rio Rancho	
Virginia Myers	concerned citizen of New Mexico	Albuquerque	Our land in New Mexico is precious to all of us. We must preserve it for the next generations. If we continue to extract

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
			every mineral from this land for pure profit, then we will be left with an environment that is uninhabitable for any of us.
Barb O'Connor		Santa Fe	ofs
Bonney Hughes	Interfaith Power and Light	Santa Fe	I have a Master of Science in Environmental Toxicology and 20 years' experience, 19 of them with NMED
Karen Mock	None	Hillsboro NM (seasonally)	There are too many unknowns about the dry stacking technology proposed. Specifically, the impacts of this approach on water quality and quantity, seismic impacts, dust control, noise levels, and long term stability of the stacks.
Karen Smith		Rio Rancho	
Bonny Hennigan	Interfaith Power & Light	Albuquerque	
Blaine Wimberly		Cedar Crest	
Becky Glenn		Silver City	
Karen Boehler		Roswell	
Sharon Cordova	First Congregational UCC	Albuquerque	

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
Candace Browne	PAWA	Truth or Consequences, NM	Communities surrounding Copper Flat (and even potentially communities who receive water from the Rio Grande Water Compact via water released from the Caballo Reservoir downhill from the Copper Flat mine site) will live with the consequences of this project and specifically because the dry stack tailings pile (DST) covering 500 acres and being 200 feet in height can pose a threat of acid drainage and fugitive toxic dust pollution indefinitely, often lasting for decades, hundreds of years, or even in perpetuity if they are not effectively "capped" and managed. I ask the NM Mining and Minerals Division (NM MMD) to require the mining company to provide the information and analysis necessary to address these concerns and and require a detailed proven plan for effectively "capping" and managing (including how many AF of water this would be required over 500 acres and for how many years?) this huge dry stack tailings in arid desert conditions similar to those in Sierra County, NM and I ask the MMD to not approve the revised application as currently proposed until all new Plans are approved.
Mary Barrett		Silver City	
Chris Harritt			
Sara Keeney		Albuquerque	

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
Danny Ruppert		Las Vegas N.M.	This project needs extensive environmental review
Philip Taccetta	Microflora Farm Animas Creek	Caballo	Area residents and future generations deserve diligence from MMD. We all deserve careful assurance that livelihoods, homes and environment will not be irreparably damaged by the proposed mine.
Gwenyth Lewis	First Congregational Church Albuquerque	Albuquerque	Again -- Copper Flat Mine proposal endangers the very scarce water supply in the area, and those who will pay the biggest price if it passes will be people who are already struggling economically. Please do NOT allow this to pass!
Ruth Randall	First Congregational Church Albuqueque	Albuquerque	
Elizabeth Johns		Albuquerque, NM	
Wesley Sisson	New Mexico Environmental Justice Caucus of the Democratic Party	Santa Fe	
Margaret Hadderman	GRIP	Silver City	In the southwest it's almost always a question of water; our local resources are FAR too precious to waste on this Copper Flat Mine proposal.
Becky Glenn		Silver City	

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
Ruth Striegel	First Congregational United Church of Christ	Albuquerque	
Mary Barrett		Silver City	
Betsy Holdsworth	SSH Farms	MIMBRES	
Lore Lawrence		Caballo, New Mexico	We live on Animas Creek. Our life will be negatively impacted, if not obliterated by this mine. Our ten acres is home to donkeys, sheep, Mexican Red Wolves, and humans. Wild Life Way Animal Sanctuary is an asset to this community. Not a week goes by that folks visit, meeting wolves up close and personal for the first time in their lives. We also have a small regenerative farm, providing food to our family, our neighbors, and others in need. The potential infiltrates from The mine will destroy our groundwater, regardless of the new “treatment” plan. This proposed mine is directly upstream of Caballo Lake and the Rio Grande. More water usage is the last thing this county, state, and nation needs. Thank you for listening to the many of us with significant concerns about our precious water and the future inhabitants of this glorious area of Animas Creek.

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
			We need water for life, not noise, pollution, decimation of wild land. This is a very poor location for a mine. Thank you. Lore Lawrence.
Kristin Boren		Hillsboro	I am a property owner and business owner in Hillsboro. The mine would greatly affect the quality my life through water use and reduction of water available to support our community, cancer causing toxins, road use, noise, and environmental destruction of all I value of my life here. Please do not allow this travesty to happen.
Mary Doeffinger		T or C	We need all the water for citizens to drink and use 1,000,000 gallons a day or even half 1,000,000 gallons a day even 200,000 gallons a day is far too much for us to give up with this precious resource
Mary Nolan-Winkler	Hillsboro resident	Hillsboro	I am one of the original compaintants via a lawsuit against the reopening of this mine and that was about a decade or more ago. Then it was the WATER as we were already in a drought. Now? It's still the WATER and with dry stacking, the pollutants that will be carried in the VERY windy months here in SW NM. Still, the drought continues. Quality of life is one of the reasons people relocate to New Mexico. Reopening the mine won't

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
			enhance that aspect. And if it comes to JOBS, I am thinking that with the debt the mining company is in, it will only reopen long enough to sell it off. I obviously am totally against the reopening of this mine. Already the thought of it has one business getting ready to move out of Animas Canyon.
Lara Clement		Caballo, NM	My message is simple, as a land owner of 58 acres in the Animas Creek canyon of Caballo, NM, I urge you to oppose this mine reopening bid. We are in a historic drought, as noted by multiple agencies and studies, and our unique riparian area, with it's giant, old-growth sycamore forest, simply cannot support the ground water loss that will occur if this mine is to be opened, even at their estimate of using "less" water. The wildlife and environment may never recover, much less the domestic and agricultural wells of the population of the surrounding areas. What of their water rights? Our right as citizens to live on our property and pursue life, liberty, and happiness cannot be sustained without water. Water is life, and should not be bartered away for a corporation and a few rich "shareholders" to make a quick buck, leaving the rest of us who have lived here high and literally dry.
Heather Rische		Monticello	Please shift to non extractive industries and protect our children's futures!
Roxanne VanWormer		Truth or Consequences	

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
Rosaura Mota		Sierra County	
Bob Brandis		Williamsburg	The Hillsboro and Kingston communities and all the small farms and ranches, no to heavy equipment and trucks and diesel. Low grade ore requiring massive amounts of earth dug up. The area is calm and peaceful and full of beautiful scenery. This is a local treasure. Considering the track record of corporations on this kind of thing it is hard to believe the propaganda put forth by the corporation. especially in this time of the current presidential administration's gutting of the EPA and promotion of exploitation of protected sacred lands for mining and oil extraction. This is a part of that, and I am greatly opposed to this kind of exploitation for profit as it potentially can ruin wonderful natural recreational areas.
Virginia Necochea, Executive Director	New Mexico Environmental Law Center	Albuquerque	
Lynn Curt		Hillsboro	
Shirley Pevarnik		Silver city, NM	I want to urge MMD to protect our precious resources and our beautiful natural lands.
Paul Oostenbrug	First Congregational UCC Albuquerque	Albuquerque	

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
Karen Smith	FIrst Congregational UCC	Rio Rancho	
Penni Sears		TorC	Protect our precious resources!
Ben Foerstner		TorC	Protect our land and resources. We don't want this
Shirley Pevarnik	Concerned citizen	Silver City	Is there enough water? Will there be more pollution? How will down stream pollution be affected? How will the wildlife and birds be harmed?
Shirley Pevarnik	Concerned citizen	Silver City	Is there enough water? Will there be more pollution? How will down stream pollution be affected? How will the wildlife and birds be harmed?
Melissa Amarello	Advocates for Snake Preservation	Silver City	
Becky Glenn		Silver City	
Patrice Mutchnick	Heart of the Gila	Mimbres, NM	
L. Watchempino		Pueblo of Acoma	MMD should not accept the New Mexico Copper Corporation's revised Copper Flat Mine application for review until the company can demonstrate that it possesses sufficient water rights for its mine operations, closure, and reclamation; that its groundwater

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
			pumping will not impair the rights of other water rights holders in the basin; or adversely impact Las Animas Creek and hydrologically related springs, or the Lower Rio Grande.
DeAnna Mooney		Silver City	
Melissa Amarello		Silver City	
Kathleen Gibbons		Animas Creek Caballo	I strongly opposed based on the imminent negative impact on Animas Creek Valley and my well, which is our only source of water for household and farming.
Lynn Curt		Hillsboro	I am also very concerned with the fact that the existing roadway (State Road 152) between the proposed mine and I-25 has not been fully addressed in this permitting process. The New Mexico tax payer absolutely should not be responsible for the reconstruction because of damage and wear as a result of mining operations it was not intended for.
Ronald Coleman		Lafayette	
L. Watchempino		Pueblo of Acoma	It is unlikely that sufficient water is legally or physically available for both mine operations and long-term reclamation at proposed production rates when New Mexico‘s 50-Year Water Plan has

Name	Organization or Affiliation (if applicable)	City, town, or Pueblo of residence	Additional comments
			projected 25% to 40% less water availability in our state due to climate changes.
Carol Morrison		Silver city	
Bo Bergstrom		Silver City	
Michael Hill		Silver City	
Pat Mutchnick		Mimbres	
Denise Evans		Grant	Do not reopen the mine.

Outlook

[EXTERNAL] Copper Flat Public Comment, Permit No. SI027RN

From Timur Kuru <tkuru@stealthcriticalmetals.com>
Date Fri 10/16/2026 4:34 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

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Director, Mining and Minerals Division
New Mexico Energy, Minerals and Natural Resources Department

Dear Director,

On behalf of Stealth Critical Metals Inc (stealth.earth), I am writing to support New Mexico Copper Corporation's amended application and the responsible reactivation of the Copper Flat Mine.

Stealth develops mining technology that adapts oil and gas drilling methods to access deeper mineral resources with the aim of reducing surface disturbance and development costs. We have worked with the New Mexico Copper team, and our support reflects both that experience and our interest in strengthening domestic critical mineral production through responsible mining and technological innovation.

Reactivating Copper Flat would create jobs, generate tax revenue, support local businesses, and contribute to the domestic copper supply.

We particularly welcome the amended application's proposed replacement of the wet tailings impoundment with a dry stack tailings facility. The planned recovery and reuse of water from tailings is a concrete example of the team's attention to water conservation. In a water-constrained region, we believe that focus is essential to responsible mine development.

We support approval of the amended application, subject to the Division's determination that applicable environmental, water protection, and reclamation requirements are satisfied.

Thank you for considering our comments.

Respectfully,

Timur Kuru, PhD
Chief Executive Officer
Stealth Critical Metals Inc

Outlook

[EXTERNAL] Copper Flat Mine Permit Comments

From ericson.wayne@yahoo.com <ericson.wayne@yahoo.com>
Date Fri 10/16/2026 1:49 PM
To MARP, MMD, EMNRD <MMD.MARP@emnrd.nm.gov>

You don't often get email from ericson.wayne@yahoo.com. Learn why this is important

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Gentlemen: In reviewing available documents and listening to discussions at the Sept. 17, 2026 hearing in Hillsboro, there appears to be a lack of information and analysis of the long-term (post-mining) hydrology of the mine pit and downgradient areas.

Has New Mexico Copper or its consultants done a current detailed water balance of the pit after mining to determine if it will be a sink or a groundwater recharge source, or both based on various precipitation amounts? The igneous rocks of the mine area are highly fractured and will likely have irregular flow properties with some high flow characteristics in fractured zones to no flow from intact igneous rock masses. If the post-mining hydrologic setting causes the pit to fill with groundwater and surface water after pit dewatering stops then contaminants associated with the mine could be released to the regional aquifer. What is the monitoring and action plan for the post-mining lake?

Surface inflows to the pit will vary with the precipitation amounts. Wet years could result in accretion of water in the pit to a level above the phreatic water levels around the pit and thus cause water to leave the pit. Pan evaporation rates of about 70 inches and a corresponding 50 inch pond surface evaporation may not be sufficient to prevent outflow from the pit to the regional aquifer. Thus updated hydrology modeling of the pit area after closure needs to be done to determine if untreated, mineral contact water could reach the aquifer. The updated modeling and understanding of the interaction of the pit lake and the groundwater system needs to be completed prior to a new or updated state discharge permit is issued. The state should also require that a monitoring and mitigation plan for offsite impacted water discharge into the aquifer system needs to be provided based on new numerical analyses of the mine setting.

If further analyses of the pit lake impacts indicate that outflow may occur under historical precipitation ranges, then the MMD should consider having New Mexico Copper backfill the pit as part of it reclamation activities.

Respectfully,

Wayne Ericson PE, (NM 7870)

To: Anna Aguilera, Director
Mining and Minerals Division, EMNRD
James Kenney, Secretary
Environment Department
From: Max Yeh
Percha/Animas Watershed Association
Date: October 16, 2026
Re: SI027RN and DP-1840
Final Comment on Pitlake Reclamation: Fallacy of Averages

The simplest way to imagine whether the post-closure Copper Flat Mine pitlake will be an evaporative sink or a flow-through pit according to the Copper Rule is to consider what one might call the "fallacy of averages." The Copper Rule does not specify how to calculate when evaporation off the pitlake surface exceeds inflow, and NMCC seems to have done this by using average annual evaporation rates and average annual precipitation. See *Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico* (SRK, 2018).

But average figures for evaporation and for precipitation do not sufficiently desribe the water flow situation of the pitlake either on a day-to-day basis or on an annual basis. Even if a steady-state situation on the average results in a net annual inflow of groundwater into the pit, variations of actual annual evaporation and annual precipitation result in comparable annual variations in water flow. And since evaporation is inversely related to precipitation (more rain, less evaporation), the vast annual precipitation variations will cause equally vast changes in pitlake water flow. While one might calculate a net annual inflow of groundwater into the pit as a generalized, average situation, in fact, every year that sees a greater than average rainfall (with the resulting decline in evaporation) can see an outflow of water from the pitlake into groundwater in order for the whole system to return to steady state, or what the Copper Rule calls a "hydrologic balance."

This possibility is made more likely by the fact that in the steady state situation (outflow equals inflow), the groundwater inflow is very small. On the average, it is less than 0.17 inches/day (50 inches/year evaporation rate divided by 365 days).

Remember that in 2025, NMCC reported that the pitlake was dry. A dry pitlake can only mean that under the present drought situation, the groundwater inflow rate is less than the evaporative rate. The hydraulic pressure head which causes the seepage inflow must be very low since it is insufficient to overcome the effect of evaporative loss. Since there was no net inflow of water during the whole period when the pitlake was dry, one can assume that the hydraulic head of groundwater at the pitlake is less than the pressure needed to move 0.17 inches/day of water. The pitlake level does not have to rise very much to counter that pressure and to reverse it.

Historically, Hillsboro has seen a very wide lattitude of annual precipitation figures, from 3.35 inches in 1956 to 20.33 inches in 1941, so non-average situations are common and a flow-through pit would not be unusual.

If evaporation cannot offset all inflow into the pit from both groundwater inflow and from precipitation and runoff, then the OPSDA designation fails in closure, and that means reclamation of waste rock piles and coverage requirements within the OPSDA must be changed, and possible sources of

contamination must abide by slope gradients that minimize erosion. These considerations of slope gradients should also apply to the pit itself. Are pitwalls too steep to minimize erosion as is required – 19.10.6.603F(2)?

October 16, 2026

Anna Aguilera, Director
Mining and Minerals Division
Energy, Minerals and Natural Resources Department
1220 South St. Francis Drive
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Via email: MMD.MARP@emnrd.nm.gov

RE: Public Comments on Copper Flat Mine Permit SI027RN

Dear Ms. Aguilera:

We write on behalf of the undersigned organizations to provide you with public comments on the Copper Flat permit SI027RN under the NM Mining Act (NMSA 1978, Section 69-36-1 et. Seq.) and Part 6 New Mine regulations (NMAC 19.10.6).

These comments are submitted in addition to the public comments delivered in person by Gila Resources Information Project and Percha/Animas Watershed Association during the public hearing held on September 17, 2026 in Hillsboro, NM.

We urge the Mining and Minerals Division (MMD) to not approve the Copper Flat Mine Permit SI027RN because of the following deficiencies with its application:

1. New Mexico Copper Corporation (NMCC) has not provided to MMD and the public its revised water budget for review in a timely manner;
2. The Copper Flat Mine's water use likely exceeds its available water rights at the proposed production rate;
3. OSE has not provided its determination regarding water rights administration; The Office of the State Engineer (OSE) has not approved a change in Point of Diversion from NMCC's well(s) to the open pit for pit dewatering;
4. The filtered tailings storage facility design and operation must follow Global Industry Standard on Tailings Management.
5. The OSE has not provided review of the filtered tailings storage facility;
6. The Air Quality Bureau has not reviewed the changes in the revised Copper Flat Mine Operation and Reclamation Plan (MORP) and an air quality permit modification is required;
7. NMCC has not provided sufficient evidence that the Copper Flat Mine will not need perpetual care.

NMCC has not provided to MMD and the public its revised water budget for review in a timely manner

NMCC stated at the public hearing that it had a revised water budget and that the one that was made available in its application for agency and public review was not the most recent information. As of this writing, the company has still not provided its revised water budget to MMD. The water budget is a critical piece of information needed to evaluate water use at the mine and determine if the water usage estimates "pencil out" for the proposed production rate.

It is unfair to the public and a waste of agency and public resources to not provide this updated information in a timely manner. Because we have not had an opportunity to evaluate this new information, **we request an extension of the public comment period to allow for public review of the revised water budget once it is made available. Until this public review is completed, MMD should not approve the permit.**

The Copper Flat Mine's water use likely exceeds its available water rights at the proposed production rate. NMCC does not have sufficient water rights to operate and the permit cannot be approved.

NMCC has underestimated its water use in its revised application. The application asserts that the Copper Flat Mine can operate at 30,000 tons per day of production with its available water rights simply by switching from conventional wet tailings to filtered or dry stack tailings. As our technical expert Dr. Steven Emerman demonstrated in the public hearing, NMCC has overestimated the amount of water that can be saved by this change in technology and will require at a minimum 2,500 acre-feet of water in order to operate at this rate. But the company only has approximately 1,050 acre-feet of water rights. NMCC can't operate at the proposed production rate with the water rights it has.

The Office of the State Engineer (OSE) states in its July 15, 2026 letter to MMD:

> "…NMOSE appreciates the reduction in projected consumptive water use associated with the dry-stack tailings design and the corresponding reduction in predicted hydrologic impacts. Continued monitoring of groundwater levels, pumping, and project operations will remain important to verify that actual conditions remain consistent with those represented in the project analyses. Furthermore, the need for water beyond the stated adjudicated rights in the PHC [Probable Hydrologic Consequences] may require additional evaluation by the NMOSE."

This statement implies the uncertainty associated with NMCC's claim that it can operate within its available water rights and that it may need additional water rights that would be subject to evaluation by the OSE.

The risks associated with permitting a mine that doesn't have sufficient water rights to operate are significant to both MMD, adjacent water rights owners, and the public. Speculative permitting of NMCC's revised MORP – granting a permit with incomplete information on water use - risks giving the go ahead to a mine that may not be feasible within its available water rights. This potentially sets up a future situation where state regulatory agencies are forced to look the other way if the Copper Flat Mine doesn't have enough water to operate. This in turn increases the risk of illegal use of groundwater with impacts to adjacent water rights owners.

The OSE has stated that it will be monitoring NMCC's groundwater withdrawals from its wells and will shut down the operation if it exceeds its available water rights. How effective will that process be at halting a large-scale industrial operation with millions of dollars on the line? The politics of this situation will be enormous and should be avoided by the state at all cost.

<u>OSE has not provided its determination regarding water rights administration; The OSE has not approved a change in Point of Diversion from NMCC well(s) to the open pit for pit dewatering.</u>

The OSE states in its July 15, 2026 letter to MMD that NMCC's right to full use of its water rights may still be subject to water rights administration:

> "While NMOSE recognizes these reductions in projected hydrologic impacts, several aspects of the updated analysis warrant clarification or should not be interpreted as agency conclusions. First, the PHC [Probable Hydrologic Consequences] report appropriately evaluates the anticipated physical hydrologic consequences of the revised mining plan. However, NMOSE notes that the report does not evaluate matters related to water-right administration. Statements regarding the ability of New Mexico Copper Corporation to fully exercise its existing water rights should not be construed as a determination by the Office of the State Engineer regarding administration of those rights, priority administration, impairment, compliance with permit conditions, or any future administrative actions that may become necessary. Such matters remain subject to applicable statutes, regulations, permit conditions, and future factual circumstances."

For example, NMCC will be dewatering the pit at Copper Flat in order to mine. Similar to the proposed Emma Pit at the Tyrone Mine, NMCC will need to apply to the OSE for a change in the Point of Diversion from one of its wells to the open pit for pit dewatering. As far as we know, a permit for pit dewatering has not been applied for or granted.

There may be other water rights administration issues that still need to be resolved. As it states in the July 15, 2026 letter, OSE's communications to date do not constitute determination that all water rights issues have been resolved in order for operation of the Copper Flat Mine. Until MMD can be sure that all water rights issues have been addressed, the application should not be approved.

The filtered tailings storage facility design and operation must follow the Global Industry Standard on Tailings Management.

We strongly disagree with NMCC's assertion that filtered tailings storage facilities have "no failure mode" and that tailings storage facility failure is eliminated with use of filtered tailings. Technical testimony from our expert Dr. Dave Chambers at the September 17 public hearing described the possibility of filtered tailings storage facility failures due to re-saturation of the dry stacks after extreme precipitation events and then liquefaction of the filtered tailings causing a catastrophic failure. Technical modeling carried out for the filtered tailings storage facility must take into account the possibility of re-saturation especially given the increased frequency of extreme storm events due to climate change.

In the wake of several tragic tailing storage facility failures around the world, including the catastrophic failure of the Córrego de Feijão tailings dam at Vale's iron ore mine in Brumadinho, Brazil which killed nearly 300 people, the Global Industry Standard on Tailings Management (GISTM) was developed (https://www.unep.org/en/news-and-stories/press-release/new-global-industry-standard-tailings-management-aims-improve-safety)

According to the United Nations Environment Program (UNEP), the Global Industry Standard on Tailings Management will "prevent catastrophic tailings facility failures, improve mining safety, and achieve an ambition of zero harm to people and the environment. It requires Operators to take responsibility and prioritise the safety of tailings facilities, through all phases of a facility's lifecycle, including closure and post-closure. It also requires the disclosure of relevant information to support public accountability." (UNEP, 2020 https://wedocs.unep.org/items/32322ba2-ce3d-484d-9696-ea70cbbf24a3)

Mining Act requirements for new mines require that industry best practices are used in mine operations and reclamation:

> "Most Appropriate Technology and Best Management Practices The mining operation and the reclamation plan shall be designed and operated using the most appropriate technology and the best management practices." NMAC 19.10.6.603 A.

Because they reflect global industry best practice, it is critical that MMD require that GISTM standards are adhered to in the design, operation and reclamation of the Copper Flat Mine filtered tailings storage facility.

Due to several deficiencies in its slope stability analysis, we recommend that MMD require the company revise its tailings storage facility design to meet the GISTM standards, especially for seismic and flood design events for facility closure, and update the associated analyses to properly evaluate the probability of catastrophic failure of the filtered tailings storage facility.

Please refer to Dr. David Chambers' testimony for specific areas needing improvement, especially the need for a permit condition that requires that filtered tailings are compacted with specialized equipment rather than just haul truck traffic.

<u>The OSE has not provided review of the filtered tailings storage facility.</u>

Unfortunately, the OSE has determined that the Copper Flat filtered tailings storage facility is non-jurisdictional since it does not meet the legal definition of a dam. However, state law does allow the OSE to intervene if a non-jurisdictional dam becomes hazardous or creates an immediate danger to public safety or property (19.25.12 NMAC).

A jurisdictional dam under OSE regulations is 25 feet or greater in height and impounds more than 15 acre-feet of water or a dam that is 6 feet or greater in height and impounds 50 acre-feet or more of water. The filtered tailings storage facility will be 200 feet at its highest point at the downgradient end of the facility, and since the tailings will contain from 12 – 15% water by weight, the 500-acre facility will contain greater than 15 acre-feet of water. One could make the argument that the filtered tailings storage facility does meet the jurisdictional dam definition.

Because there is currently no OSE regulation specifically for filtered tailings storage facilities, we urge the MMD to ask the OSE to use existing state law to review and evaluate the filtered tailings storage facility design to ensure that it will not constitute a high risk for catastrophic failure.

<u>Air emissions from the Copper Flat filtered tailings storage facility are a significant change from the 2013 NSR Air Quality Permit and require a modification. Therefore, NMED cannot provide its determination that Copper Flat meets applicable air quality regulatory requirements.</u>

Filtered tailings storage facilities emit significantly more particulate matter into the ambient air than conventional wet tailings. This is due to at least two factors: 1) the method for conveyance and deposition of tailings and 2) the area of the tailings surface exposed to wind erosion.

Wet tailings convey and deposit tailings slurry through a pipeline and discharge the slurry into a tailings impoundment with minimal to no heavy equipment use. Dry stack tailings use trucks or conveyor belts to transport the filtered tailings to the storage facility, deposit the material, and then compact it. The materials handling specific for dry stack tailings has a significantly greater potential to emit dust than conventional wet tailings given the low moisture content of filtered tailings versus wet tailings and the methods used for handling the tailings, such as use of heavy equipment. In an arid environment like Sierra County, this is even more of an issue. The BHP/Rio Tinto filtered tailings guide explains that air emissions for dry stack tailings are dependent upon climate with arid environments leading to higher dust emissions. It also notes that equipment selection for depositing the dry stacks also influences dust emissions. (BHP, Rio Tinto/Tailings Management Consortium *Filtered Stack Tailings A Guide for Study Managers*. https://www.bhp.com/-/media/project/bhp1ip/bhp-com-en/documents/sustainability/tailings-storage-facilities/260508_filteredstacktailingshandbook.pdf)

Secondly, a large portion of the surface of a wet tailings storage facility is covered with water, reducing the amount of surface area exposed to the wind, therefore limiting fugitive emissions caused by wind erosion. In comparison, the surface of a filtered tailings storage facility is completely exposed to the wind and is subject to wind erosion and therefore has a greater potential to emit for particulate matter relative to wet tailings.

Because of these two factors, the potential to emit for fugitive dust emissions from the Copper Flat filtered tailings storage facility is likely to be significantly greater than the conventional wet tailings storage facility proposed in NMCC's initial application.

A filtered tailings storage facility has never been permitted in New Mexico. Arizona has permitted at least three filtered/dry stack tailings facilities - South32 Hermosa, Antler Copper Project and Rosemont Copper Project. We can look to these projects for guidance on air emissions permitting under the federal Clean Air Act. Like New Mexico, Arizona Department of Environmental Quality (ADEQ) has delegated authority for permitting of major and minor sources of air pollution. Examining the air quality permit application submitted to ADEQ for the Antler Copper Project in Mohave County, we see that EPA's AP-42 emissions factors for "Unpaved Roads" for haul trucks and support vehicles in Chapter 13.2.2 and for "Aggregate Handling and Storage Piles" for continuous truck loading and unloading in Chapter 13.2.4 were used to evaluate the fugitive dust emissions unique to filtered tailings operations. (ADEQ Technical Review and Evaluation of Application for Air Quality Permit No. 105543 Antler Copper Project https://static.azdeq.gov/pn/%E2%80%A2%20Old%20-%20Check%20then%20remove/aq_amp_tsd.pdf)

The New Source Review (NSR) Air Quality Permit #0365-M3 issued by the NM Environment Department's Air Quality Bureau in June 2013 for Copper Flat (https://cloud.env.nm.gov/resources/_translator.php/YWZmNTY0ODY3ZWRkZjBjN2NhZThmZWM5Nl8xMjE1OA~~.pdf) does not apply to NMCC's new Mining Act application and must be modified for the following reasons:

- The approved Air Quality Permit #0365-M3 assumed 25,000 tons per day would be processed through the SAG plant to create the slurry for pipeline conveyance to the wet tailings facility. NMCC's revised proposal is for 30,000 tons per day production with transport of the filtered tailings by truck to the filtered tailings storage facility. The permit must be modified to account for both the increased production rate and the potential to emit for fugitive dust from the new filtered tailings materials handling and storage process.

- Fugitive dust emissions were only estimated for unpaved access roads in Air Quality Permit #0365-M3 and therefore don't account for the large potential to emit for particulate emissions from the filtered tailings storage facility.

- Revised air quality modeling must be conducted to determine the effectiveness of proposed dust control measures at mitigating the increased fugitive dust emissions from the filtered tailings operation, since they are dependent upon equipment selection and use of water vs. dust suppressants.

We are very concerned that the Air Quality Bureau did not provide any comments back to MMD on the revised MORP. The memo dated June 17, 2026 from NMED to MMD states that the "Air Quality Bureau did not provide any comments." Did the Air Quality Bureau review the revised MORP? Does this mean that the Air Quality Bureau feels that Air Quality Permit #0365-M3 is adequate? Was the Air Quality Bureau aware of the significant changes in the revised MORP that would impact air emissions?

We believe that NMED's Air Quality Bureau can't provide its determination that the revised MORP meets applicable air quality requirements until it requires a NSR permit modification. Therefore, MMD can't approve the Copper Flat permit application.

<u>NMCC has not provided sufficient evidence that the Copper Flat Mine will not need perpetual care.</u>

One of the major changes to the Copper Flat MORP is rapid fill of the open pit over 2.5 years rather than 6 months as was originally proposed. The reclamation method theoretically will prevent acid rock drainage from pit walls and prevent formation of an acidic pit lake in year 2.5 after closure.

We are very concerned about this strategy over the long-term and the potential for pit lake water quality to deteriorate requiring long-term and potentially perpetual care to mitigate. Moreover, the Post-Mining Land Use is wildlife habitat, livestock grazing and recreation. An acidic pit lake that does not meet water quality standards will present a harm to wildlife and therefore could not serve as wildlife habitat.

As the NM Department of Wildlife points out in its March 16, 2026 comments:

> "Long-term post-mining pit lake water quality continues to be a concern for wildlife. NMCC proposes that "The first 2.6 years of the 100-year phase has rapid fill of the pit lake to prevent oxidation of sulfates below the pit lake water line, thus optimizing pit lake water quality". While this strategy may be effective in the short-term, the Department still has concerns about pit lake water quality in the long term. Since the open pit is a hydraulic sink and groundwater recharge from local precipitation to the crystalline bedrock is limited because of its low hydraulic conductivity, any metal leaching that occurs from the surrounding high walls and mining area into the pit lake could concentrate over time if the evaporation rate exceeds the recharge rate from local precipitation. This condition will be exacerbated if local climate conditions become hotter and drier in the future. NMCC should have a long-term mitigation plan in place to protect migratory birds and local wildlife if the water quality in the pit lake becomes toxic over time. This could include a combination of exclusionary fencing and bird balls."

MMD and NMED have first-hand experience with trying to manage poor post-closure pit lake water quality at the Cunningham Hill Mine in Santa Fe County that shut down nearly 40 years ago. Severe acid rock drainage from pit walls contributed to poor pit lake water quality that exceeded standards, prompting a citizen's suit under the Clean Water Act that ultimately resulted in a settlement agreement in 1996 and then an NMED abatement plan (AP-27) in 2002. The abatement plan called for diverting stormwater runoff into the pit to "drown" the acid-generating minerals in the pit walls with water, thus slowing down acid formation. This is a similar reclamation measure to the "rapid fill" approach contemplated for the Copper Flat Mine.

For a variety of reasons, the "drowning strategy" in the abatement plan did not work. Chemical treatments, such as hydrated lime, provided some short-term buffering capacity. Later long-term buffering capacity was achieved by pumping high alkalinity water into the pit. However, high sulfate levels required the addition of barium chloride di-hydrate to bind to sulfate to form the heavy, insoluble barium sulfate. Other treatments have been carried out by LAC Minerals/ Homestake over the years, but the company said that it will likely need to be at the site in perpetuity. MMD approved a pit waiver for the open pit in Permit Revision 20-1 in 2024.

As the state considers the probability of success with rapid fill of the Copper Flat Mine open pit to prevent acid rock drainage, we believe Cunningham Hill represents a cautionary tale of attempts to manage pit lake water quality over several decades that has now become utterly intractable as demonstrated by the pit waiver approval.

The Mining Act prohibits permitting of a new mine that will require perpetual treatment:

> "The operation will be designed to meet without perpetual care all applicable environmental requirements of the Act, 19.10 NMAC and other laws following closure." (19.10.6.603H NMAC)

We believe that NMCC has not sufficiently demonstrated that the Copper Flat Mine open pit will not need perpetual care and therefore MMD should not approve this permit. Contingencies for future water quality management need to be outlined in the reclamation plan and included in the reclamation cost estimate and financial assurance.

Reclamation Cost Estimate and Financial Assurance Considerations

Finally, MMD must require adequate financial assurance to protect the state, taxpayers and local communities from future liability at the Copper Flat Mine. **We request to be involved in review of the reclamation cost estimate once it is publicly available.**

Sufficient financial assurance should be provided to cover reclamation, including long-term water quality monitoring and any long-term maintenance costs that might be required, such as application of lime should the pit lake become acidic. We remain concerned about having sufficient financial assurance in place should the pit become a flow-through system rather than evaporative sink, therefore requiring perpetual treatment such as pumping and treating contaminated groundwater and pit water.

Since this is the first new mine considered for permitting under the Mining Act, what are the financial assurance contingency measures that will be put in place to cover long-term maintenance costs if needed? We strongly urge MMD to require additional financial assurance to cover future costs should they materialize. The risk to taxpayers and the public for future environmental liabilities at Copper Flat is significant.

Because BLM will jointly hold the financial assurance with MMD, we expect that no parent company guarantees will be allowed since they are prohibited under federal law. The previous Copper Flat Mine owner went bankrupt and left an unreclaimed site for nearly four decades. MMD has a responsibility to ensure that this marginal mining operation doesn't become an even bigger environmental liability in the future. We therefore urge MMD to accept cash trust, surety bonds or letters of credit as financial assurance for the full cost of reclamation of the Copper Flat Mine.

We thank you for consideration of our input. Please contact Allyson Siwik of Gila Resources Information Project with any follow-up questions or concerns at 575.590.7619 or grip@gilaresources.info

Sincerely,

Allyson Siwik, Executive Director
Gila Resources Information Project

Rachel Conn, Executive Director
Amigos Bravos

Max Yeh, President of the Board
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