GREAT BASIN RESOURCE WATCH

Working with Communities to Protect Their Land Air and Water

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Nevada Mining Oversight and Accountability Commission
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Informational Briefing on Hard Rock Mining Pit Lakes in Nevada
Background, Existing Legal Framework, and Policy Recommendations

BACKGROUND

What is a Pit Lake and how much water is involved?

It is often the case that a deposit of ore will lie at least in part below the natural level of the groundwater, the "water table." In such cases mining companies will pump a large volume of groundwater from the bottom of the mine pit and around the perimeter to artificially lower the water table in the area of the open pit, as shown schematically below, Figure 1. Seldom is there a requirement for the mine company to fill in the mine pit after all of the ore has been excavated, so at the end of mining the company will just stop pumping groundwater and a portion of the open pit will fill with water as the water table tries to restore itself, resulting in a pit lake.

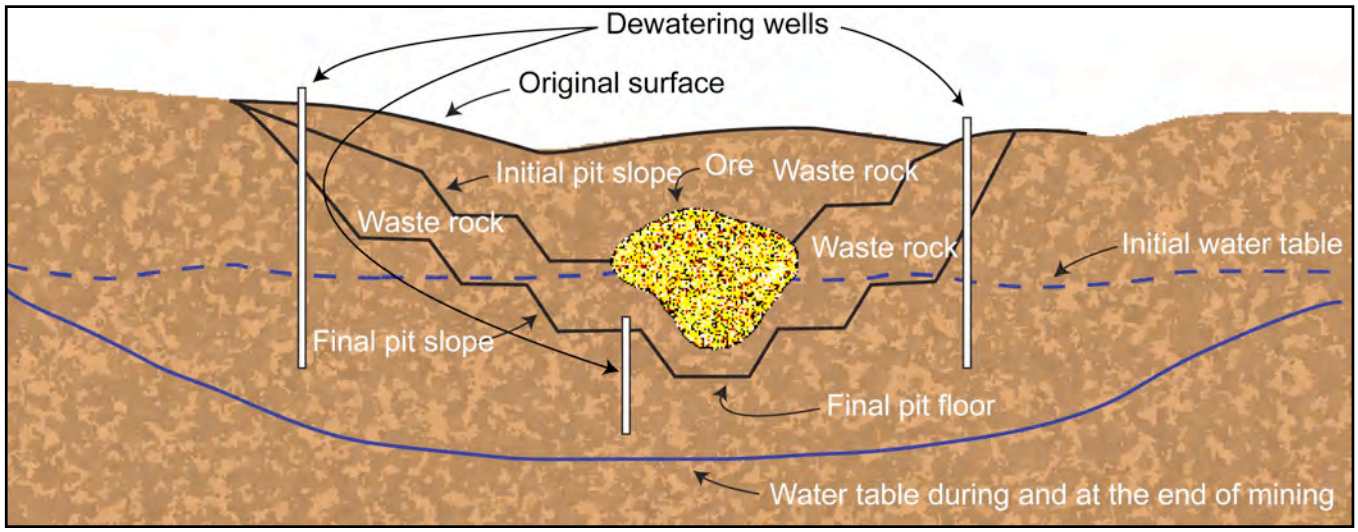


Figure 1. Simplified cross sectional view of a dewatering scheme when the ore body lies at least in part below the pre-mining groundwater level.

Pits lakes vary widely in size and water quality. Currently, the largest pit lake in Nevada is mostly likely the Anaconda Yerington Pit Lake with 40,000-45,000 AF[1] of water, and in general the size of these lakes vary from 100 acre-feet (AF) to about 540,000 AF (an acre-foot corresponds to 325,829 gallons).[2] Ultimately, in aggregate the amount of water destined for pit lakes in Nevada is staggering. The preponderance of pit lakes will be in the Humboldt River basin where these lakes are estimated to eventually hold approximately 1,052,000[3] acre-feet of water (more than the all existing reservoirs in Nevada, 600,000 AF, excluding Lake Mead)[1]. In addition to this volume held by the pit lakes another 9,700[2] acre-feet per year will be lost to evaporation in the Humboldt basin.

What is the quality of the water in pits?

The water quality can often be very poor, especially early in pit lake development. The Lone Tree mine, only a mile from the Humboldt River, ceased pumping groundwater (dewatering) in 2006, and the pit lake has been developing rapidly. Late in 2007 the lake acidity began to increase (pH dropping) to a point so severe that corrective action was required since it was a risk to wildlife.[i] Figure 2 shows the pit lake after only two and a half years of filling and early in the treatment operations. Currently, the acidity of the lake has been kept in check with continual additions of lime (~39,000 tons[4] as of the beginning of 2012), a commonly used acid neutralizing agent. It is unknown how long lime additions will be needed. Eventually, the Lone Tree pit lake will probably stabilize; however, the water is likely to be high in salts, which will effectively eliminate its use as drinking water, stock water or many additional municipal and industrial uses, nearly all of which were beneficial uses of the groundwater prior to its natural movement into the pit lake.



Figure 2. Lone Tree Pit lake taken April 2009 at the early stages of development with considerable acid formation. ***Photo: Travis Rummel, feltsoulmedia.com.***

Other pit lakes in Nevada also showed very poor water quality early on, and are now no longer acidic, but high in salts. The Sleeper pit lake is a good example, where significant treatments were done to this initially highly toxic and acidic pit lake. The Sleeper Pit lake (Humboldt County) is no longer acidic and does support aquatic life and could serve a recreational use. In many cases a pit lake may take 100 years or more to reach its near final level and water quality, so it is still not completely known what will be the long term water quality, although evaporation is likely to increase the concentration of the water soluble contaminants. There are some like the Berkeley Pit in Montana where the water quality has remained poor and is now a Superfund site. In Nevada the Yerington pit lake contains excessive selenium, which is a risk to birds. In general, for Nevada, treatment methods using mostly lime have been effective in arresting the acidity

[i] In 2008 Newmont Mining Corp received approval from NDEP to add ~1,900 tons of caustic soda (sodium hydroxide – lye). This is the amount needed to neutralize the acid in about 2 million average car batteries.

problems and thus reducing many of the metal contaminants such as manganese, chromium, lead, and mercury. In some cases, like the Yerington pit lake, other contaminants such as selenium, arsenic, and cadmium will continue to exist under less acidic and neutral conditions all within acceptable limits of pH.

Pit lakes become contaminated and acidic as a result of reactive minerals, typically sulfides, that are exposed to air and water as the pit fills, and the process is catalyzed by bacteria that are always present. There are a number of methods that attempt to predict water quality at mines and in pit lakes. These acid/base accounting methods and longer-term kinetic testing can give an indication, but seldom are they very predictive when the geochemistrty of the rock and ore is neither very reactive or unreactive. In a 2006 study of water quality predictions in mines of western U.S. it is stated, "Of the 25 case study mines, nine (36%) have developed acid drainage on site to date. Nearly all the mines (8 of 9) that developed acid drainage either underestimated or ignored the potential for acid drainage in their EISs."[5] Because of the complexity of wall rock and the lack of understanding of what reactions occur when groundwater is removed, it is practically impossible to account for all of the factors in calculating future water quality in pit lakes.

In general, however, the examples of the Sleeper pit lake and the Lone Tree pit lakes indicate that once the pumps are turned off, and the pit lakes form, treatment of the resulting acidic water can result in a pit lake with near neutral water quality, and toxic contaminants reduced. One example where this has not been the case, is the Ketchup Flat pit lake at the Paradise Peak mine (Nye County). Nine months after Meridian Mining Company sold this mine, it went bankrupt, and the resulting pit lake tended towards acidity (pH less than 5) and the pit walls began to collapse. This pit lake now poses not only a potential risk to wildlife, but also presents an attractive nuisance to persons who may want to hike down to the bottom, cross steep and unstable slopes to a contaminated water body. Because of the danger of the slopes, water quality samples have not been reported to the NDEP for over 10 years.

Pit lakes in Nevada are often local hydrologic sinks, in that water tends to flow into them and not out. It is the high evaporation rate that drives this one-way flow of water. One consequence of the high evaporation is that constituents in the groundwater will typically become more concentrated in the pit lake, so there is a tendency for the water pit lakes develop lower water quality than the groundwater. The one-way flow of water into the pit lake can prevent the groundwater from being degraded by poor water quality in a pit lake. There is a greater potential once the water level in the pit lake stabilizes for water to flow out of a pit lake and into groundwater, called a "flow-though" condition. Although expected to be unlikely a flow-through condition could degrade groundwater depending upon the water quality of the pit lake.

NEVADA REGULATIONS

There are no specific numerical water quality standards for the water in pit lakes. However, pit lake water falls within "Waters of the State," defined in the NRS as:

> **NRS 445A.415.** "Waters of the State" means all waters situated wholly or partly within or bordering upon this State, including but not limited to:
>
> 1. All streams, lakes, ponds, impounding reservoirs, marshes, water courses, waterways, wells, springs, irrigation systems and drainage systems; and
>
> 2. All bodies or accumulations of water, surface and underground, natural or artificial.
> (Added to NRS by 1973, 1709)—(Substituted in revision for NRS 445.191)

Waters of the State are protected and it is illegal, in general, to degrade these waters. Degradation is defined by:

NAC 445A.357. "Degrade" means to alter the physical or chemical properties of or to cause a change in the concentration of any substance in the waters of the State in violation of the standards established pursuant to NAC 445A.424.

Pit lakes only exist after mining is concluded, so there is no existing surface water during mining. The pit lake is a new surface water, which although Waters of the State, does not have a designated beneficial use for which specific numerical standards exist. Control of water quality in pit lakes is found in the Nevada Administrative Code:

NAC 445A.429 Procedures required to prevent release of contaminants; requirements concerning impoundments. (NRS 445A.425, 445A.465)

1. The holder of the permit must institute appropriate procedures to ensure that all mined areas do not release contaminants that have the potential to degrade the waters of the State.

2. Open pit mines must, to the extent practicable, be free-draining or left in a manner which minimizes the impoundment of surface drainage and the potential for contaminants to be transported and degrade the waters of the State.

3. Bodies of water which are a result of mine pits penetrating the water table must not create an impoundment which:

(a) Has the potential to degrade the groundwaters of the State; or

(b) Has the potential to affect adversely the health of human, terrestrial or avian life.

4. The holder of a permit may apply to the Commission to establish a beneficial use with a level of protection less than that required by paragraph (b) of subsection 3 for water impounded in a specific mine pit.

This regulation is essentially the "standard" used. Although not numerical it does qualify under NRS 445A.420 as a "descriptive" water quality standard, which states, *"Water quality standard" means the degree of pollution of water or the physical, chemical or biological condition of water, as expressed numerically or descriptively, used for controlling the quality of water in each segment of a stream and each other body of surface water in this State.* To date there has no "beneficial use" established for any hard rock pit lakes, although NDEP does have the authority to do so. Ultimately, the Bureau of Water Quality Planning would be responsible for designating a beneficial use and developing the appropriate administrative code including numerical standards.

Thus, action should be taken by NDEP if the pit lake is causing groundwater to become degraded, or if the water in the pit lake is of such poor quality that it "has potential to affect adversely the health of human, terrestrial or avian life." This was the case for the Sleeper pit lake and has been the case for the Lone Tree pit lake. Unlike a numerical standard, NAC 445A.429 allows for an ecological risk assessment (ERA) to determine compliance. ERA's hinge on a numerical modeling process that uses input data and calculates "hazard quotients" for wildlife. All of which is based on the known understanding and assumptions of how the ecosystem absorbs and transports contaminants and the sensitivity of wildlife to these contaminants. Thus, ERA assessments can vary considerably depending upon the input parameters, and conceptual basis of the calculations.

Nevada reclamation requirements also do not specify a post mining use for pit lakes. **NAC 519A.275** specifies requirements for productive postmining use of the land:

"1. A productive postmining use of the land required to be submitted with a plan for reclamation need not provide a use of the land and degree of productivity which is identical with the use of the land before the mining began or the use of the adjacent land or the degree of use.

2. Land which is returned to its pre-mining use or reclaimed after mining or exploration to a level of productivity which is generally consistent with the pre-mining level of productivity or the level of productivity of the surrounding land shall be deemed to be a productive postmining use."

In addition **NAC 519A.250** allows for an exception to reclaim open pits and rock faces:

"1. An operator may request in writing that the Division grant an exception to the requirements for reclamation for open pits and rock faces which may not be feasible to reclaim.

2. If the operator proves to the satisfaction of the Division that reclamation is not feasible, the Division shall exempt an open pit or rock face from the requirements for reclamation of NAC 519A.010 to 519A.415, inclusive.

3. The Division shall base its determination of the feasibility of reclaiming open pits and rock faces on the technological and economic practicability of achieving a safe and stable condition suitable for a productive postmining land use. The Division shall consider, without limitation, the:

(a) Topography of the site;
(b) Geology and stability of the site;
(c) Time required to complete reclamation;
(d) Consumption of resources required to complete reclamation;
(e) Potential adverse environmental impacts to the quality of the air and water associated with the activities for reclamation; and
(f) Future access to mineral resources.

4. Upon request by the applicant, the return of material to the open pit from which it was extracted shall be considered to be not feasible for the purposes of reclamation.

5. If an open pit or rock face is exempted from reclamation, public safety must be provided for by means other than reclamation, including, but not limited to, restrictions on access to the site or restrictions on the deed to the property."

In most cases in accordance with section 5 above reclamation of pit lakes involves some stabilization of pit walls and fencing off the pit lake to prevent human intrusion. NDEP does according to **NAC 519A.345b** have authority "if appropriate" to require certain reclamation as stipulated in subsection 9:

"9. Open pit mines by:
(a) Performing activities that will provide for public safety;
(b) Stabilizing pit walls or rock faces where required for public safety;
(c) Constructing and maintaining berms, fences or other means of restricting access;
(d) Creating a lake for recreational use, wildlife or other uses; and
(e) Revegetation.
(f) Reclamation of open pits or rock faces does not require backfilling although backfilling in whole or in part with waste rock from an adjacent mining operation may be encouraged if backfilling is feasible and does not create additional negative environmental impacts."

Thus, a use could be established for a pit lake, but just as with the water quality regulations it is not required by law and conditional within the discretion of the agency.

If the mine is on public (federal) land or both private and public land then it is the federal land management agency (often the Bureau of Land Management or Forest Service) that determines post-mining land use. The State of Nevada retains its authority through NDEP to designate beneficial use

of the water. In accordance **NAC 519A.150 and NAC 519A.155** the Nevada reclamation permit is incorporated into the Plan of Operations the mining company submits to the federal agency, and is reviewed to the same level of detail for public and private land. Generally, the federal agency holds the surety only for projects where the majority of the disturbance will be on public land; NDEP holds the bond for projects where the majority of the disturbance will be on private property. The federal agencies and NDEP work cooperatively through MOU's to ensure the reclamation of lands disturbed by mining and exploration.

REGULATIONS IN OTHER WESTERN STATES

The states surrounding Nevada have varying regulations regarding pit lakes. An article in Southwest Hydrology presented the following table in a 2002 issue:[6]

Pit Lakes State by State

	Number of existing pit lakes	Number of projected pit lakes	Pit Lake Water Quality Standards	Bond required
Arizona	21	2 to 5	Must meet aquifer water quality standards	Yes, in millions
California	5	0	No exact pit lake standards	Yes, but some were prematurely released
Montana	1	6	Must be suitable for drinking, culinary and food processing purposes, after conventional treatment	Presently state bonds expected cost for the next five-year period. Bonding methods to address long-term treatment issues are currently being developed
Nevada	20	20	Regulated on case-by-case, risk analysis basis	No
New Mexico	10	5	Must meet groundwater or surface water standards, depending on location	Yes, amounts vary
Utah	0	1	Lake water quality regulated according to type of environment its water supports	Yes
Wyoming	21	1	Must meet livestock, agriculture or domestic water quality standards, depending on location	Reclamation bonds posted with the Land Quality Division are reevaluated annually.

The data above are provided by state regulatory agencies and are estimates only.

Since the publication of this table, California now requires open pits to be backfilled, thus eliminating future pit lakes.

The state of Montana also appears to have updated its regulations since 2002, only applying a standard to a pit lake if it is deemed to be state water, and then the existing surface water standards apply, such as protection of aquatic life.[7] If the pit lake is terminal then it maybe determined as not state waters, but rather "water that is impounded for the purpose of treatment," but Montana would still try to maintain a waterfowl standard.

In general, regulations across the western U.S. seem not to have specific water quality standards for pit lakes or a uniform designated use. As in Nevada there is a tendency to handle pit lakes on a case-by-case basis. While, on the surface it may appear that a specific standard exists, but upon further investigation, as in Montana, exceptions are allowed.

GBRW POSITION - DISCUSSION AND POLICY RECOMMENDATIONS

Nevada will have more precious metals pit lakes than any other state in the union, and as discussed above will consume a considerable portion of Nevada's scarce water. The policy of the state of Nevada should be to preserve and protect our water supplies, as well as protect the general public from risks associated with pit lakes. Nevada code, NAC 445A.429, only defines a standard for pit lakes in terms of a "potential" to degrade groundwater or adversely affect human, terrestrial or avian wildlife. The term potential is too vague in our view. In the development of a mine project an assessment is made as to water quality of an anticipated pit lake, and often there is some probability of poor water quality, which could be in violation of NAC 445A.429. When is this probability so small that the potential to degrade groundwater or adversely affect human, terrestrial or avian wildlife does not exist? How is the state to enforce this statute?

Also significant is the risk to the general public. As noted above, the amount of water in pit lakes will exceed the total amount of water in all of the man-made reservoirs in Nevada. While the water in pit lakes

is generally going to be degraded, compared to the pre-mine groundwater, many of the pit lakes will be able to support fish and probably water contact recreation. If they do support fish, it is likely that someone, over the years, will stock the pit lakes with fish able to survive. If that happens, fisherman will want to get down to the pit lakes, and fences, particularly in the rural areas, are not likely to be sufficient to prevent the general public from getting to the pit lakes for recreational fishing. These lakes will thus provide an "attractive nuisance" and unless the pit lake walls are stabilized and a safe access is provided, they will become a dangerous attraction. Reclamation regulations require that the pit lakes are not a hazard to the public, but not a specific use. Since most of these pit lakes will exist for centuries and beyond, simple fences are not going to be much of a deterrent, and people will want access.

Many of these pit lakes can be turned into a recreational resource, but it will be expensive for resource agencies to make these lakes accessible and safe. A major policy decision for the state of Nevada is to determine how these pit lakes can be utilized in a productive manner, perhaps primarily for recreation, but at a minimum, for safe access. If nothing is done, the pit lakes will remain an attractive nuisance and become a liability for both the mining company, but also for the land management agencies. Arguments can be made that the entities that created the pit lakes have a responsibility to provide a productive post-mining use that minimizes the risk to the general public.

It is worth noting that the Sparks Marina, a very valuable recreational lake resource, is a pit lake, and developed following gravel removal for several decades. The major difference between this pit lake and precious metals pit lakes is that the Sparks Marina rock is well-washed and unreactive gravel, while pit lakes formed from gold and copper mines are generally much more reactive. However, the recreational potential of many of the gold mining pit lakes also exists.

GBRW understands that NDEP is developing an in-house contaminate profile for pit lakes. We see this as a step in the right direction and may help to clarify the application of NAC 445A.429. The mining companies will abide the law as best satisfies their bottom line, and while NDEP does have the authority to designate beneficial use of pit lakes in reclamation the law does not *require* it. It may seem reasonable to handle pit lakes on a case by case basis; however, it appears as though without a requirement for beneficial use the lakes sit fallow, dangerous, and our precious water is wasted.

CLOSING

Great Basin Resource Watch appreciates the action of the Commission to discuss and address concerns of pit lakes. We hope this brief has been useful in your understanding of pit lakes and the issues that surround them. If you have any further questions for us on this issue please contact us by phone or email provided below. We will be at the meeting on September 26, 2012 as well for questions and discussion.

We also like to express our appreciation for the cooperation of the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation for providing information regarding pit lakes, fielding questions that we have had about specific mine sites and regulations, and productive discussions.

Thank you for your time on this issue and your work on this Commission.

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[1] U. S. Environmental Protection Agency, "Description and History, Anaconda Mine Superfund Site, Region 9, http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/vwsoalphabetic/Anaconda+Mine?OpenDocument.
[2] Miller, G.C., "Precious metals pit lakes: controls on eventual water quality," Southwest Hydrology 1(3):16-17, 2002.
[3] Myers, T, "Hydrogeology of the Humboldt River Basin, Impacts of Open-Pit Mine Dewatering and Pit Lake, Formation (Preliminary Draft)," Prepared for Great Basin Resource Watch, Reno, NV, June 2010.
[4] NDEP, "Lone Tree Pit Lake Report 4th Quarter 2011, January 2012.
[5] Kuipers, J.R., Maest, A.S., MacHardy, K.A., and Lawson, G. 2006. Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements.
[6] Bolen, Alisen, "Regulating the Unknown, Pit Lake Policies State by State," Southwest Hydrology, September, October, 2002.
[7] Wayne Jepson, Montana Department of Water Protection, GBRW conversation August, 2012.