

# The Proposed Resolution Copper Mine and Arizona's Water Future

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Lake Mead on the Colorado River has dropped 130 feet in recent years and is currently at 37% capacity. In August of 2021, authorities declared a drought emergency which will cut Arizona's supply of Colorado River water by about one third, losing an amount of water that could serve nearly 1 million people.

## Executive Summary

The Resolution Copper mine would be the largest underground copper mine in the United States and consume vast amounts of groundwater, leaving less water for everyone else in Arizona during an unprecedented, climate change-fueled drought. The proposed mine would be located east of Phoenix in the Tonto National Forest, in an area known as Oak Flat. Final approval of the land transfer that would facilitate development of the mine is pending even as the drought is expected to worsen. The Colorado River is dwindling, and Lake Mead, which supplies Arizona with one-third of its water, has dropped to its lowest level since the reservoir was filled in the 1930s. Just this month, federal officials announced the first-ever official Colorado River water shortage, triggering cuts in water allocations for Arizona, Nevada, and Mexico, and pushing urban and rural water users to rely more on unsustainable groundwater pumping. Groundwater tables are dropping, aquifers are drying up, and the ground is buckling for lack of water.

Much has been written and many studies completed over the past 15 years as Rio Tinto and BHP's Resolution Copper has sought, despite federal land protections, to mine copper some 7,000 feet beneath Oak Flat. Yet there has not been a comprehensive analysis to verify how much water the Resolution Copper mine will use and the consequences of that use to the people and wildlands in the region. The Resolution Copper mine will place an enormous new water demand on an area of the southwest already experiencing severe water shortages.

Recognizing the need to aggressively manage the state's finite groundwater resources and to support a growing economy, the 1980 Arizona Groundwater Act created Active Management Areas (AMAs) to manage aquifers in areas,

including Phoenix, with heavy reliance on mined groundwater. Resolution Copper's own studies project that the mine's operations will lower the region's groundwater level by up to 1,000 feet over an area covering roughly 300 square miles.

This analysis examined new and existing data and found:

- Resolution Copper Mine would use at least 250 billion gallons of water over the life of the mine. Much of this water will be pumped from the East Salt River Valley which is part of the Phoenix AMA, about 15 miles west of the mine. If the water Resolution plans to use was stored in a tank the dimensions of a football field, such a tank would need to be 147 miles high to accommodate all the water.
- A goal of the Phoenix AMA is to achieve a long-term balance between the annual amount of groundwater withdrawn and the amount of groundwater recharged, thus avoiding depletion of the aquifer. This goal unquestionably will not be met if Resolution is allowed to pump billions of gallons from the aquifer for the next 50 years.
- Resolution Copper's groundwater use would make nearly 3,500 acres of the Superstition Vistas Planning Area unfit for development, costing Arizona's state Land Trust more than \$536.6 million.
- Resolution's mine could potentially use double to triple the amount of groundwater that it claims if the promised, but unproven water-saving measures are not realized.
- The U.S. Forest Service's environmental analysis failed to adequately account for Colorado River shortages and newly announced allocation cutbacks have been triggered under the Drought

Contingency Plan. It also failed to look at the project's impact on regional water resources when combined with these shortages.

- The mine's tailings would permanently threaten groundwater and surface water quality in the region, including the Gila River. In 2015, a similar but smaller dam at a BHP project in Brazil failed, causing catastrophic damage.

Mining has been banned in Oak Flat since 1955 because of special protections put in place by the federal government. To circumvent these protections, Congress inserted language into the 2015 National Defense Authorization Act requiring the U.S. Forest Service to give Oak Flat to Rio Tinto and BHP in a land swap. Congressional action is needed to stop this mine. A bill to repeal the land swap (*Save Oak Flat Act*, HR 1884, S. 915) is pending in the U.S. House and Senate.

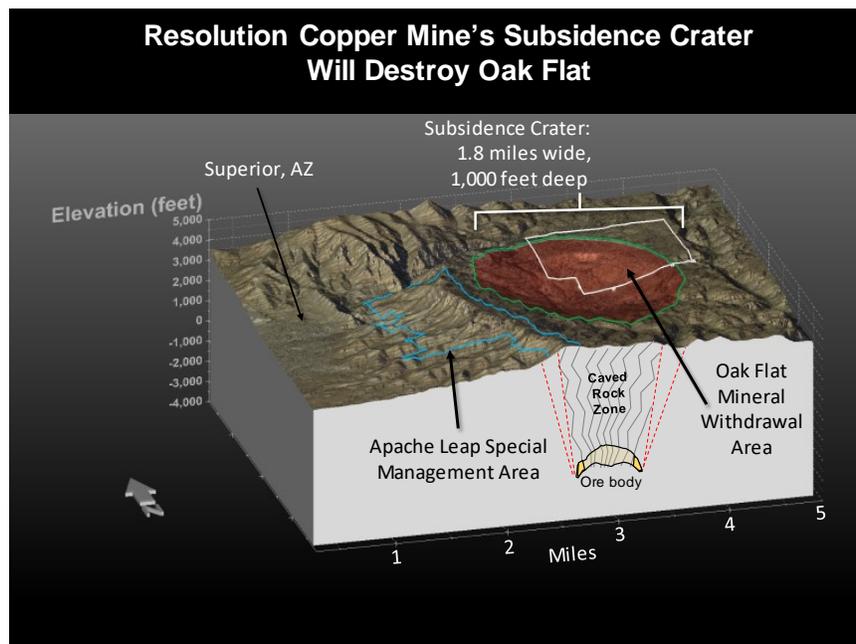
In addition to being protected against mining since 1955, Oak Flat is designated as a Traditional Cultural Property by the National Park Service and listed on the National Register of Historic Places. Oak Flat is also beloved by campers, climbers,

hikers, and birders and is a sacred place to the Apache people.

Resolution Copper plans to use block cave mining, which would create a nearly two-mile-wide, 1,000-foot-deep subsidence crater that would swallow Oak Flat. Nothing can stop the cratering process once it has begun. Reclamation or restoration of the subsidence crater will be impossible.

Over the last 150 years, mining has brought certain benefits to Arizona but it also has serious costs. The legacy of open pits, acid mine drainage, and huge tailings dumps are obvious to anyone who has spent time in Arizona's "Copper Triangle." However, the massive water requirements of modern mines is a hidden cost that has taken on greater urgency in the 20<sup>th</sup> year of drought conditions in the desert southwest.

Arizona faces an existential water crisis that threatens livelihoods and Arizona's prosperity. This analysis shows that developing another copper mine will come at the expense of drinking water for Arizona's cities, real estate development, farming, recreation, and other industries.



## I. Introduction: Is the Proposed Resolution Copper Mine good for Arizona?

Mining is an important part of Arizona's history. Even before Arizona was a state, mining was seen as a way to bring people and prosperity to the southwest. But mines use a lot of water and the southwest is facing a severe water shortage. In modern times, with less polluting industries on the rise and the scarcity of water as a limiting resource for economic development, we need to ask: Is the proposed Resolution Copper Mine good for Arizona?

If the Resolution Copper Mine is approved, it will commandeer a vast amount of the State's water, leaving less for everyone else. Should mining be getting *more* water while other water users are forced to cut back? This is a tough and urgent question that Arizonans must face in light of impending water shortages.

### *Background on the Resolution Copper Mine.*

Resolution Copper is a limited liability company owned by international mining giants, Rio Tinto and BHP. Located about 60 miles east of Phoenix near the Town of Superior (see Figure

1), the Resolution Copper Mine would be the largest underground copper mine in the United States.

This is a project that—on its own—could not meet the rather low bar required for mining on federal lands. Mining on federal lands is still largely guided by the General Mining Act of 1872. This nearly 150 year old law contains substantial incentives for private companies to mine on federal lands, including charging no royalties for extracting these public resources. Thus the foreign mining companies will pay nothing for the copper they plan to remove from National Forest Service land currently owned by the American people.

The mine site is in a portion of Tonto National Forest known as Oak Flat, a starkly beautiful natural area that is loved by Arizona campers, climbers, hikers and birders, and is a sacred place (known as Chi'chil Bildagotell) to the Apache people. Oak Flat is currently off-limits to mining due to special protections put in place

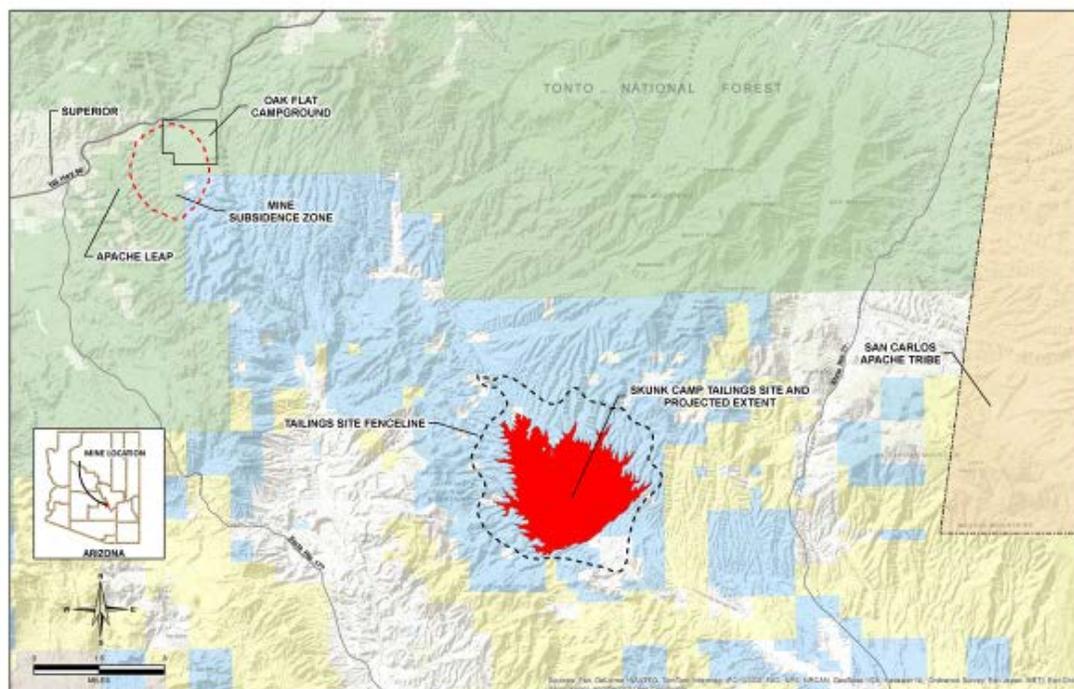


Figure 1. Location of Proposed Resolution Copper Mine and Tailings Storage Facility.

by the federal government in 1955.<sup>1</sup> Special legislative action was needed to undo these protections and make this project possible. That action came in 2015 in the form of language inserted at the last minute into the National Defense Authorization Act (NDAA), which requires the Forest Service to hand over Oak Flat to Rio Tinto and BHP in a land swap. The land swap provisions obviously had nothing to do with funding the military, but by inserting the language into a “must pass” bill, it quietly became law even though the land swap regularly had been rejected in normal Congressional proceedings.

In addition to being protected against mining since 1955, Oak Flat is also designated as a Traditional Cultural Property by the National Park Service and is listed on the National Register of Historic Places, but none of that matters if the land swap goes through.

Resolution chooses to employ block cave mining at Oak Flat because that's the cheapest way to mine the deep ore body. A consequence of this mining method is a 1.8-mile wide, 1,000 foot deep subsidence crater that will swallow Oak Flat.

## II. Water Use by Resolution Copper

Resolution projects that the mine will consume enough water to supply a city of roughly 140,000 people every year for 50 years. This is a vast new water demand for an area of the southwest that is already experiencing water shortages. Resolution's water use will probably be even higher than it is disclosing. The current estimate (accepted at face value by the Forest

Service) promises that this mine will use about 1/3 of the average water used (per ton of ore) by existing copper mines in the United States. This optimistic estimate is based on Resolution's assurances that it can implement significant and unproven water-saving procedures in its ore processing and tailings handling operation.

Even if one accepts Resolution's highly optimistic estimate for water usage, the mine will use about 775,000 acre-feet<sup>2</sup> of water—or about 250 billion gallons—over the life of the mine<sup>3</sup>, of which approximately 70% will be pumped from a large network of new extraction wells in the East Salt River Valley about 15 miles west of the mine, closer to Phoenix and its eastern suburbs. The amount of water Resolution Copper proposes to withdrawal from the Desert Wellfield represents nearly 7 percent of the total available groundwater in the East Salt River valley subbasin.<sup>4</sup>

It is hard to visualize the immensity of this amount of water. A football field covers about one acre, so if the water Resolution plans to use was stored in a tank the dimensions of a football field, such a tank would need to be 775,000 feet or 147 miles high to accommodate all the water.

Resolution's proposed Desert Wellfield is in the Phoenix Active Management Area (AMA). The state created AMAs under the landmark 1980 Groundwater Management Act to better manage aquifers in parts of Arizona that were experiencing depleted groundwater. However, Arizona water law grants exceptional leeway to mines, which are essentially unregulated water users. That means Resolution Copper could develop an unlimited number of wells and pump an unlimited amount of water from the East Salt

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<sup>1</sup> Public Land Order 1229 set aside Oak Flat and other Forest Service lands for use as campgrounds, recreation areas and for other public purposes.

<sup>2</sup> An acre-foot of water equals 325,850 gallons. It is the amount of water that would cover an acre of land to a depth of one foot. For comparison, an Olympic sized swimming pool holds about 2 acre-feet of water. As a rule of thumb, EPA estimates that a family of 4 uses about 1 acre-foot of water per year.

<sup>3</sup> Final Environmental Impact Statement (Final EIS), Appendix H, Table H-3. This is the volume of water estimated to be needed over the life of the mine for Tailings Storage Facility (TSF) Alternative 6, Skunk Camp, which is the Forest Service's preferred alternative.

<sup>4</sup> Final EIS, p. 418.

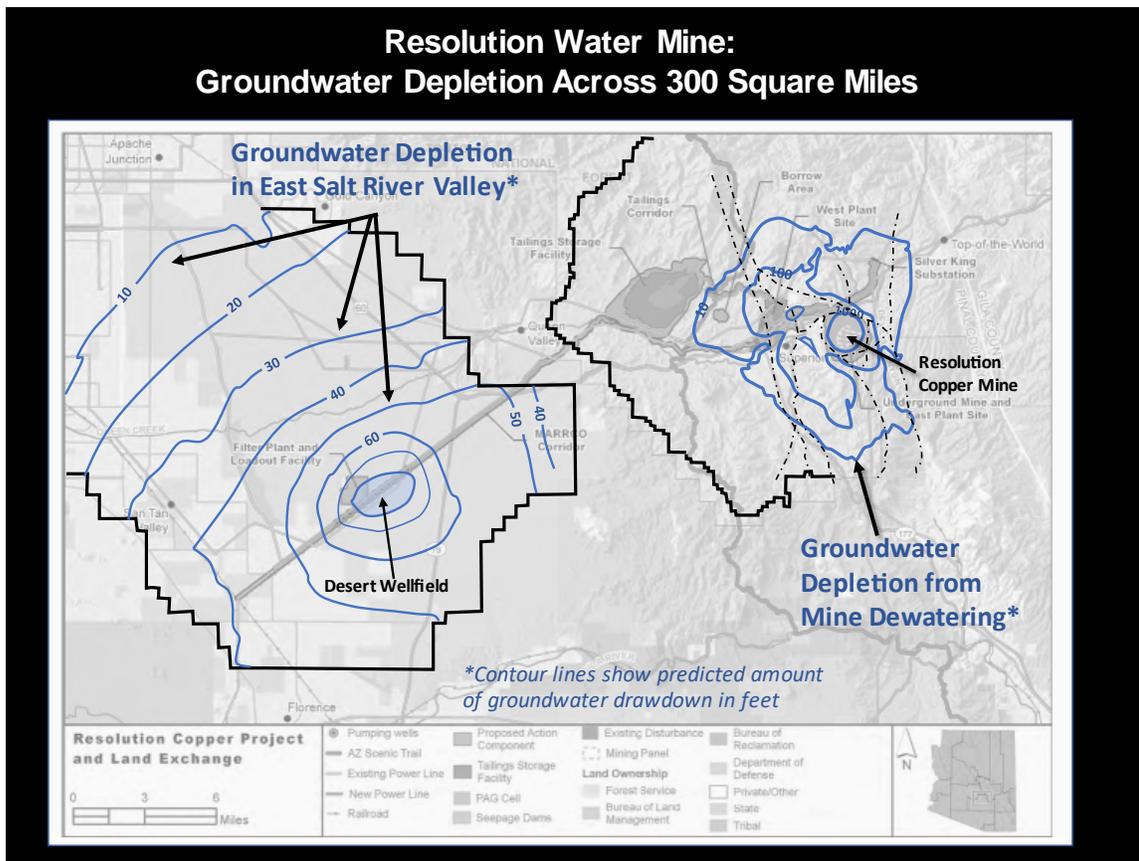


Figure 2. Map showing predicted groundwater drawdown from the Desert Well Field in the East Salt River Valley and from mine dewatering.

River Valley even as agricultural users and cities are forced to cut back. It doesn't matter that groundwater resources are already being depleted in the Phoenix AMA.

Computer modeling in the Tonto National Forest's Environmental Impact Statement (EIS) for the mining project acknowledges that cumulative effects of Resolution's pumping along with other known demands in the East Salt River Valley are likely to result in a drop in groundwater levels of approximately 450 feet in parts of the Phoenix AMA. The computer modeling did not include any of the water demands from future development in the 175,000 acre Superstition Vistas Planning Area,<sup>5</sup>

a sprawling exurban development expected to be home to more than 1 million people by 2060.<sup>6</sup>

Resolution's own assessment acknowledges that groundwater will be depleted by at least 10 feet (and in some places, more than 1,000 feet) over an area covering about 300 square miles. Such drawdown threatens to dry up existing wells and makes it more expensive for other users to pump groundwater. As shown on Figure 2, this is a consequence of dewatering at the mine site as well as pumping in the East Salt River Valley.

Resolution Copper's cumulative pumping total conflicts with the goal of the Phoenix Active Management Area to achieve "safe yield" in this groundwater basin by 2025. Safe yield

<sup>5</sup> The Superstition Vistas Planning Area consists of 275 square miles of undeveloped land east of Phoenix held in trust by the Arizona State Land Department. This land is managed for the benefit of the school children of Arizona. As noted on the State Land Department website, "State ownership of Superstition Vistas provides a unique opportunity to maximize the financial return to the education trust fund and allows for the development of a coherent vision for the area." If there is inadequate water to develop Superstition Vistas, Arizona's school children will lose the most, but the state as a whole is also a loser due to limits to growth of its economy.

<sup>6</sup> Superstition Vistas, Spring 2011, Final Report & Strategic Actions.

requires that the amount of groundwater pulled from aquifers must be balanced by the amount of water that is recharged, naturally or artificially, back into the AMA.

In its EIS, federal officials failed to take the “hard look” required under the National Environmental Policy Act to determine the environmental impact of the proposed mine’s cumulative water usage on the Phoenix AMA. Instead, the Forest Service wrote that the state would likely give Resolution Copper a groundwater withdrawal permit because there is no authority under state law to deny it.<sup>7</sup> The EIS failed to consider whether enough water will be available for other water users if the copper mine becomes operational.

The EIS says “Resolution Copper’s legally permitted use of water adheres to the norms and values placed on water by the State of Arizona.”<sup>8</sup> The Forest Service is oversimplifying this complex issue: it is not adhering to the values of the State of Arizona to greenlight a project that is guaranteed to deplete scarce groundwater resources in the East Salt River Valley.

In the 2019 draft EIS, the Forest Service acknowledged that “groundwater demand is substantial and growing” and “total demand on the groundwater resources in the East Salt River Valley is substantial and could be greater than the estimated amount of physically available groundwater”<sup>9</sup> These sober assessments do not appear in the final EIS.

Where will all this water go? Most of it will be used by Resolution to process the ore and transport its tailings. Most of the water will end up as part of the toxic soup in the tailings dump to be located in Dripping Springs

Wash (see Figure 1). There, what had been a resource (fresh groundwater available for Arizona’s cities and farms) will be transformed into a perpetual liability--contaminated water threatening, essentially forever, groundwater and surface water quality, including even the Gila River.

### III. Long-Term Consequences For Arizona’s Water Future

Recent reports and actions by local jurisdictions show that Arizona does not have enough water to accommodate the Resolution Copper mine.

In an October 2019 study of the Pinal AMA, Arizona Department of Water Resources (ADWR) identified a future unmet demand of 8.1 million acre-feet.<sup>10</sup> In a stark example of how scarce water supplies will affect growth and prosperity, these findings led the ADWR to stop

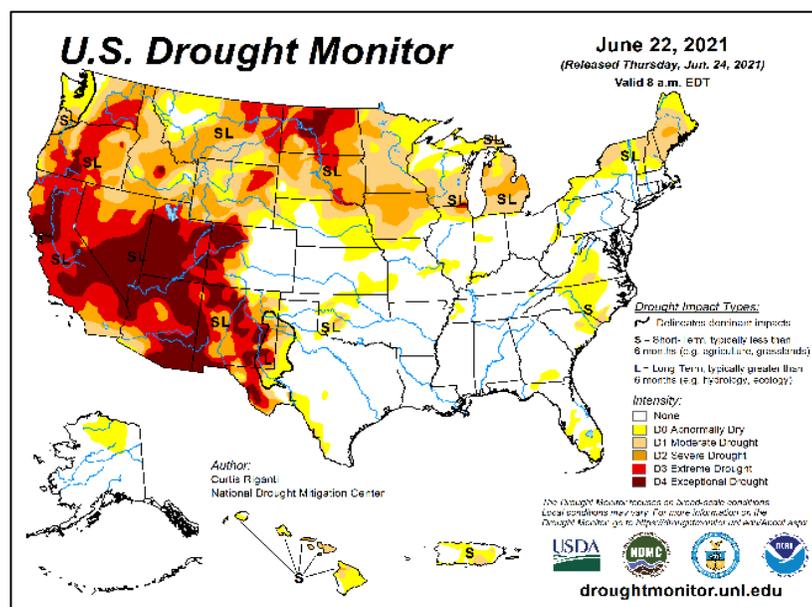


Figure 3. Current drought conditions are severe in Arizona and the entire lower Colorado River Basin.

<sup>7</sup> January 2021 EIS, p. 971.

<sup>8</sup> January 2021 EIS, pp. 813, 967, and Appendix R, R-285.

<sup>9</sup> Draft EIS, p. 342.

<sup>10</sup> Arizona Department of Water Resources, 2019 Pinal Model and 100-Year Assured Water Supply Projection Technical Memorandum.

approving applications for future subdivisions in Pinal County. Tens of thousands of people in Pinal County rely on groundwater for their water supply and already, private wells are drying up.<sup>11</sup> In its latest study, the ADWR predicted demand to exceed supply into the foreseeable future for this basin and also predicted irreversible loss of aquifer capacity due to overpumping.<sup>12</sup>

Arizona State University's Kyl Center for Water Policy recently warned that the state's groundwater is seriously overallocated, allowing for unsustainable pumping and failing to protect Arizona's water resources for future generations.<sup>13</sup> The May 2021 report, "The Myth of Safe Yield," said the problems are exacerbated by industrial users, like copper mines, that are not required to replenish the groundwater they use. Co-authored by one of the architects of the state's landmark 1980 groundwater act, the Kyl Center Report called for measures to curb the state's authority to issue new industrial groundwater use permits.

A newspaper report earlier this year aptly describes the situation: "Unlike wildfires or hurricanes, a diminishing water supply is a slow-moving, mostly invisible crisis.<sup>14</sup> Many outer suburbs of Phoenix rely almost exclusively on groundwater, making them extremely vulnerable to water shortages compared to other areas that may have more diversified supplies.

Colorado and other parts of the desert southwest remain in an almost perpetual drought (see Figure 3). The EIS on the Resolution Copper project failed to evaluate "reasonably foreseeable future" Colorado River shortages and cuts, as well as the events that have just been triggered for the first time under the Drought Contingency Plan<sup>15</sup> once the inevitable shortages occur. It also failed to look at the project's impact on regional water resources when combined with these shortages.

Scientists predict a permanent decline in water flows in the Colorado River, source of critical water supplies to Arizona via the Central Arizona Project (CAP). A 2017 Report to Congress noted that the Colorado River has experienced lower-than-normal flows for the past 16 years, with some of the lowest annual flows in 900 years. The Report to Congress also noted that "a transition to a more arid average climate in the American West" may already be under way. Likely consequences of climate change include higher temperatures in the West, higher evapotranspiration, reduced precipitation, and decreased spring runoff.<sup>16</sup> Researchers from the U.S. Geological Survey have determined that annual mean discharge from the Upper Colorado River Basin has been decreasing (and will

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<sup>11</sup> ABC15 News, Private Wells Running Dry in Pinal County, Oct. 24, 2019; <https://www.abc15.com/news/region-central-southern-az/private-wells-running-dry-in-pinal-county>.

<sup>12</sup> Arizona Department of Water Resources, 2010, Modeling Report #22, A Salt River Valley Groundwater Flow Model Application. 100-Year Predictive Scenarios Used for the Determination of Physical Availability in the Phoenix Active Management Area.

<sup>13</sup> Kyl Center for Water Policy, May 2021, The Myth of Safe-Yield: Pursuing the Goal of Safe-Yield Isn't Saving our Groundwater.

<sup>14</sup> High Country News, June 1, 2021, "Rapid growth in Arizona's suburbs bets against an uncertain water supply.

<sup>15</sup> The Lower Basin Drought Contingency Plan was finalized in 2019. The DCP consists of proactive water conservation actions to be taken by water users in Arizona, California, and Nevada, and by the US Bureau of Reclamation, which are designed to leave more water in Lake Mead during severe droughts to avoid loss of power generation potential and to prevent the lake from reaching critically low levels, (Source: US Bureau of Reclamation, March 2021, Colorado River Basin, SECURE Water Act Section 9503(c) Report to Congress.

<sup>16</sup> Congressional Research Office, November 9, 2017, Drought in the United States: Causes and Current Understanding, pp. 14-15.

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continue to decrease) at an alarming rate of 9.3% per degree Celsius of warming.<sup>17</sup>

Lake Mead, which supplies water to the Central Arizona Project (as well as other lower Colorado basin users) is at record low levels not observed since the construction of Hoover Dam in the 1930's (Figure 4).

Arizona receives about one third of its overall water needs from the Colorado River. Arizona has a junior water right for Colorado River supplies relative to California. The consequence of junior water rights is that shortages in the Colorado River basin from drought or climate change will disproportionately impact Arizona, and in particular its lower rights users, which include agricultural users and groundwater banking entities.

This year, Lake Mead's water level dipped below 1,075 feet (above mean sea level). This is important because according to the Drought Contingency Plan, when the Lake falls below

1,075 feet, Arizona's water deliveries from the Colorado River will be significantly curtailed, beginning with a reduction of over 500,000 acre-feet per year. Further cutbacks will occur at lower reservoir water levels. Just this month, the US Bureau of Reclamation invoked water rationing (for the first time ever) on the Lower Colorado River Basin. At first, the impacts from reduced water deliveries to Arizona from the Colorado River will mostly affect agricultural users, but this water scarcity will eventually hit urban areas as well, with water restrictions and higher prices virtually inevitable.

With CAP restrictions, farmers, cities and towns will need to pump even more groundwater to make up for the lost supply from the Colorado River. However, Arizonans already withdraw more groundwater from the major Arizona aquifers than nature can replenish. Thus Arizonans are in a situation where current users need to pump even more water from already depleted aquifers in order to survive, at the same

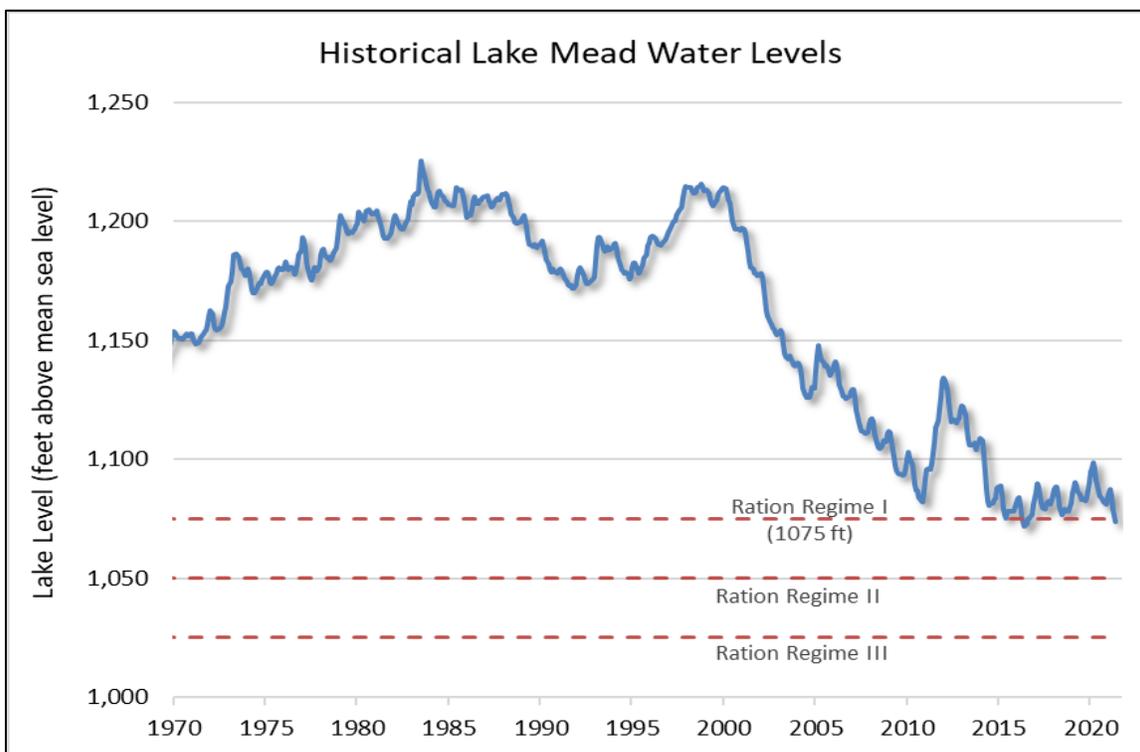


Figure 4. Water Levels in Lake Mead since 1970.

<sup>17</sup> Milly and Dunne, 2020, Colorado River flow dwindles as warming-driven loss of reflective snow energizes evaporation, Science, v. 367, pp. 1252-1255.

time Resolution Copper insists on pumping 250 billion gallons of water from the same aquifers.

The tough truth is that there is simply not enough water to go around in Arizona. In the Phoenix AMA, where Resolution will be pumping, there are many municipalities and commercial operations that also rely on groundwater, including Phoenix, Scottsdale, Tempe, Mesa, Gilbert, Chandler, Apache Junction and other towns.

### III. Opportunity Costs

Resolution says the mine will bring jobs and tax revenues to Arizona. This is true, although their numbers are exaggerated. As documented in this study, Resolution will also need lots of water to make good on these economic benefits. What neither Resolution Copper nor the Forest Service explain is that other uses of that same water would have even greater economic benefits than a mine and without the high environmental costs such as destruction of Oak Flat, annihilation of natural springs, acid mine drainage, 1.3 billion tons of toxic tailings burying 16,000 acres of land as a consequence of large scale mining.

What did the EIS say about opportunity costs? Nothing! According to the Forest Service, "Analysis of the economic value of the water used by Resolution Copper, the other beneficial uses to which water could be put, or extrapolation of economic harm to other entities due to Resolution Copper's legally permitted use of water, is outside the scope of analysis of this EIS."<sup>18</sup>

A study from Arizona State University found that the average economic benefit to Arizona from CAP water is \$40,000-\$50,000 per acre-foot of water.<sup>19</sup> At that rate, Resolution's use of about 15,000 acre feet of water each year

translates to a lost opportunity cost of more than \$600 million. This is the cost of not doing other things (such as growing crops, supplying water to new homes, or supporting non-polluting commerce) with the water that Resolution will use up. For comparison, the proposed mine is projected to generate between \$80 and \$120 million in state and local tax revenue each year. In exchange for \$600 million worth of water, Arizona citizens will get back \$80-\$120 million in taxes. This is not a good deal for Arizona.

Much has been made of the benefits to Superior, the town closest to the mine. The EIS determined that Superior will likely receive about \$400,000 per year in tax revenues from the mine project. This would surely be a welcome financial boost, but is hardly a life-altering amount of money for a town.

The demand for copper and copper prices go through boom and bust cycles. In addition, technology and automation reduce the labor requirements of modern mines, shrinking the workforce needed to mine a given amount of copper. This instability in the copper industry discourages investment in local economies and encourages potential residents (including copper miners, themselves) to live a considerable distance from the mine and ore processing facilities. As a result copper mining towns in Arizona and across the nation are rarely prosperous.<sup>20</sup>

The Arizona State Land Department has determined that Resolution's groundwater withdrawals in the East Salt River Valley would cause a loss development potential for 3,440 acres of State Trust land in the Superstition Vistas Planning Area, representing a "minimum potential loss to the Trust of at least

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<sup>18</sup> Final EIS, p. 813.

<sup>19</sup> Arizona State University, W.P. Carey School of Business, 2014, The Economic Impact of the Central Arizona Project to the State of Arizona, Authors: Tim James, Anthony Evans, Eva Madly.

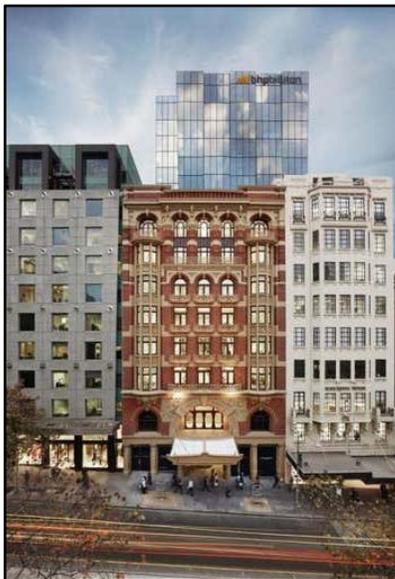
<sup>20</sup> Power Consulting, November 2019, Deficiencies in the Socioeconomic Section of the Resolution Copper Project and Land Exchange Draft Environmental Impact Statement.

\$536,640,000 in revenue.”<sup>21</sup> The reason for these profound losses is that other entities wishing to use groundwater in the Phoenix AMA must demonstrate a 100-year Assured Water Supply in order to secure project approval. Resolution Copper does not have to make this same showing. After Resolution takes all the groundwater it needs, there is less groundwater in storage for other potential users.

By green-lighting this mine, the people of Arizona are embarking on an uncontrolled experiment on social priorities pitting the state's agricultural, municipal, real estate and tribal interests against those of multinational mining companies and the mining companies are winning.



*Who benefits from modern mining? If there was ever any doubt, a quick comparison of downtown Superior to the gleaming headquarters buildings of BHP and Rio Tinto answers this question.*



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<sup>21</sup> Arizona State Land Department, November 7, 2019 Letter to Neil Bosworth, Tonto National Forest. (Reproduced on p. R-43 of FEIS).

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#### IV. Other Environmental and Cultural Consequences of Resolution Copper Mine

The EIS prepared by Tonto National Forest identified a number of profound environmental impacts from this project that cannot be mitigated. The scale of this project is hard to fathom and unfortunately the Forest Service fell short of its obligation under NEPA to take a hard look and ensure scientific integrity in its evaluation of these environmental impacts.

Because of how the copper will be mined, the Resolution Copper mine will have greater impacts on the environment than most U.S. copper mines. As shown on Figure 5, Resolution Copper's use of block cave mining will destroy a greater amount of Arizona landscape than typical mining operations, leaving a 1.8-mile wide, 1,000-foot deep subsidence crater that would destroy the Oak Flat area.

**Land Subsidence in East Salt River Valley Due to Groundwater Pumping.** A different kind of subsidence threatens the East Salt River Valley. Land subsidence due to groundwater pumping causes a permanent reduction in the storage capacity of an aquifer. The Forest Service initially claimed it was not possible to analyze how much land subsidence the project might cause, but eventually conducted such an analysis and found that "drawdowns associated with the Desert Wellfield likely would result in subsidence of roughly 24 to 52 inches."<sup>22</sup> This information was not disclosed in the Draft EIS and was not subject to public review and comment. This newly quantified environmental

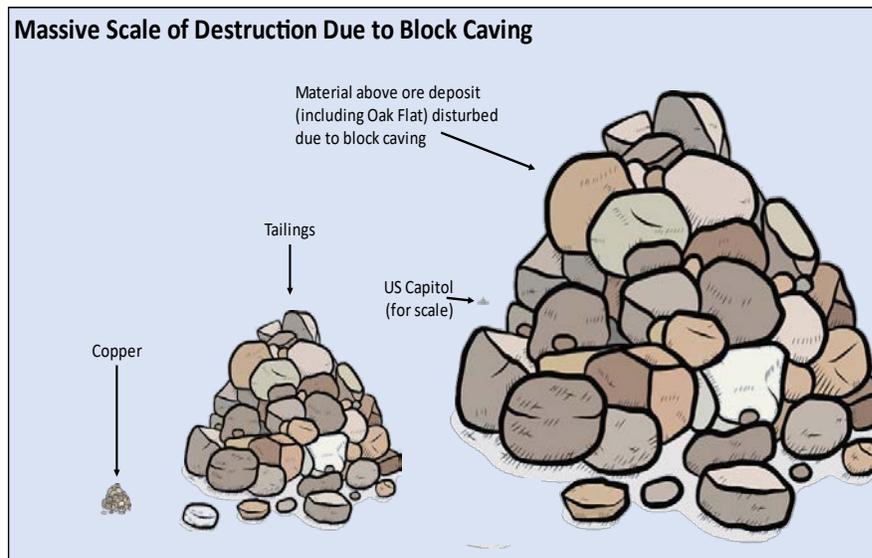


Figure 5. Relative volumes of copper, tailings and material above ore deposit that would be disturbed due to block caving at the Resolution Mine. US Capitol is shown for scale.

impact is important because even after the drawdown recovers from Resolution's pumping, that portion of the aquifer in the East Salt River Valley will never hold as much groundwater again, thus constituting an unmitigable impact. Or, as admitted by the Forest Service, "An important aspect of subsidence is that it is irreversible; once sediment layers collapse when dewatered, they remain collapsed even if water levels recover."<sup>23</sup>

Land subsidence from groundwater pumping harms public infrastructure such as roads, pipelines and utility lines, as well as harming homes and other structures.

**Loss of Sacred and Ecologically Important Springs.** The EIS acknowledges that "Sacred springs would be eradicated by subsidence or construction of the tailings storage facility, and affected by groundwater drawdown."<sup>24</sup> In the arid southwest, springs and perennial streams are extremely rare and constitute irreplaceable

<sup>22</sup> Final EIS, p. 412.

<sup>23</sup> Final EIS, p. 412, emphasis added.

<sup>24</sup> Final EIS, p. 856, emphasis added.

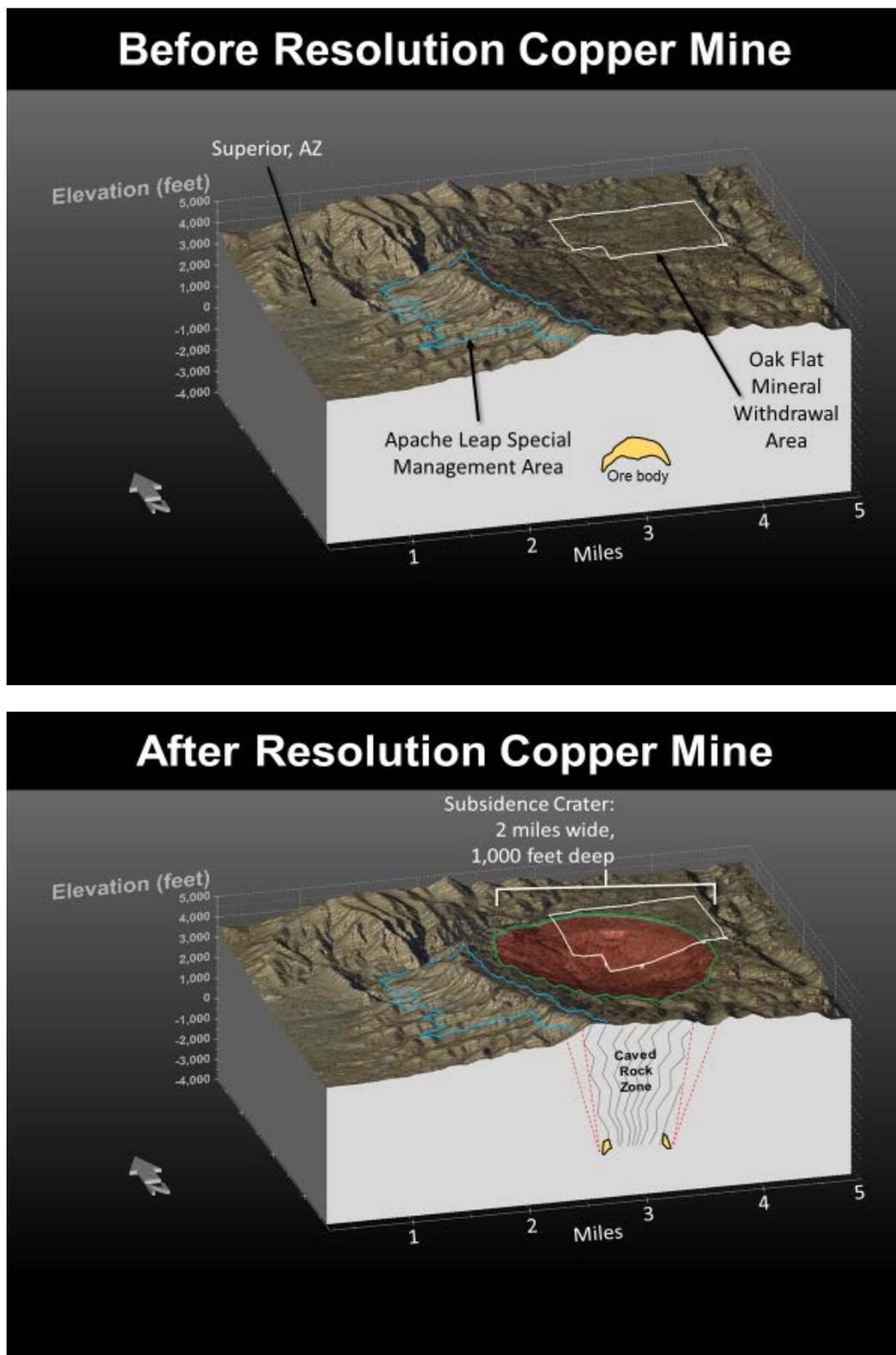


Figure 6. Depiction of Oak Flat and Apache Leap before and after block cave mining.

habitat. Because of impacts to springs, the proposed groundwater use by Resolution Copper Mine is contradictory to the Forest Service policy:

“Groundwater shall be managed for the long-term protection and enhancement of the Forest’s streams, springs and seeps, and associated riparian and aquatic ecosystems. Development and use of groundwater for consumptive purposes shall be permitted only if it can be demonstrated that such proposals will adequately protect Forest resources.”<sup>25</sup>

Tonto National Forest’s Draft Land Management Plan also requires that Forest activities must not negatively impact riparian

areas.<sup>26</sup> As stated in the FEIS, “The deep groundwater system is being and would continue to be actively dewatered, and once block caving begins the Apache Leap Tuff would begin to dewater as well.”<sup>27</sup>

The Apache Leap Tuff Aquifer is a critical source of water for springs and creeks, many of them sacred to Western Apaches. This permanent impact would not occur if alternative underground mining methods were employed, but the Forest Service did not conduct an analysis of alternative mining methods. Instead it accepted Resolution Copper’s assertion that any method other than block cave mining would be too expensive.



*Figure 7. Ga'an Canyon, near Oak Flat (also known as Devil's Canyon). This rare perennial desert stream and its ecosystem are threatened by the proposed Resolution Copper Mine.*

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<sup>25</sup> Martin and Loomis, Keeping Our Streams Flowing: Tonto National Forest Groundwater Policy, in: Furniss, Clifton and Ronnenberg, eds., 2007, Advancing the Fundamental Sciences: Proceedings of the Forest Service National Earth Science Conference, October 2004, PNW-GTR-689, USDA, Forest Service, Northwest Research Station.

<sup>26</sup> Tonto National Forest, 2019, Draft Land Management Plan, see Section on “Riparian Areas, Seeps, Springs, Wetland and Riparian Management Zones, pp. 110-113.

<sup>27</sup> Final EIS, p. 369.

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**Impacts from Block Cave Mining.** BHP and Rio Tinto will use block cave mining because it is the cheapest way to mine the deep Resolution ore body. Even Resolution Copper cannot stop the cratering process once it has begun. This is the very definition of an irreparable harm. Reclamation or restoration of the subsidence crater is simply impossible: just a sturdy fence and maybe some “no trespassing” signs. Once block cave mining commences, the subsidence crater becomes inevitable and unstoppable.

The EIS disclosed a number of profound impacts due to the collapse crater that cannot be mitigated, including impacts to scarce water resources. As noted by mining expert, Dr. David Chambers, if Resolution chose to use underground mining methods instead of block caving, Oak Flat could be preserved and many other environmental and social impacts would be reduced.<sup>28</sup> By failing to conduct an acceptable and competent evaluation of project alternatives that could avoid the impacts caused by the collapse zone, the Forest Service would allow Resolution's profitability to outweigh the project's extensive environmental, cultural and recreational costs.

**Dewatering of Groundwater Dependent Ecosystems.** The EIS concluded that the Resolution Copper Mine project will or is likely to deplete water supplies and harm or destroy the streams, springs, seeps and other water features in Oak Flat, Ga'an Canyon (see Figure 7), Mineral Creek and Queen Creek: “Dewatering or direct disturbance would impact between 18 and 20 groundwater dependent ecosystems (GDEs), mostly sacred springs. While mitigation would replace water, impacts would remain to the natural setting of these

places.”<sup>29</sup> The proposed mitigation for GDEs is inadequate.

Mitigation plans are outlined in a September 2020 report commissioned by Resolution Copper.<sup>30</sup> This report calls for replacing water flows in springs and creeks by pumping water from nearby wells (i.e., tapping groundwater from deeper in the aquifer), storing water in tanks and piping the water to the creek or stream or by constructing various water-collecting devices such as so-called “guzzlers,” surface water capture systems or even trucking water in from alternative sources. Replacing a natural system with a manufactured facsimile of the system is not the intention of mitigation under NEPA. Just as it would not be permissible to replace the real Half Dome with a plaster model of Half Dome, it is not permissible to replace lost GDEs with artificial copies of natural systems. It was not the intention of NEPA to replace nature with theme park-like imitations of nature.

The GDE monitoring plan to be implemented by Resolution Copper is also inadequate because its discussion of triggers (i.e., occurrences or observations that would trigger mitigation activities) is vague and incomplete. In Resolution's 2020 Mitigation Plan,<sup>31</sup> they devised (and the Forest Service has bought into) ways to avoid implementing mitigation measures for these fragile ecosystems by assessing whether its groundwater pumping has caused the damage. Resolution claims it will be able to differentiate the impacts from its dewatering from other variables such as “changes in weather and/or climate, impacts to the regional and/or local groundwater system from other human causes, landscape changes such as landslides and fires, natural succession

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<sup>28</sup> Chambers, October 18, 2019, Comments on the Resolution Copper Draft Environmental Impact Statement.

<sup>29</sup> FEIS p. 156.

<sup>30</sup> Montgomery & Associates, 2020, “Monitoring and Mitigation Plan for Groundwater Dependent Ecosystems and Water Wells.”

<sup>31</sup> Montgomery & Associates, 2020, “Monitoring and Mitigation Plan for Groundwater Dependent Ecosystems and Water Wells.”

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of the GDE into a new presentation such as an increase in phreatophytic plants coincident with a reduction in spring flow rates, or other reasons not included in this document.”

Other than noting that Resolution will employ “multiple lines of evidence” there is no quantitative or qualitative discussion of how Resolution will accomplish this difficult task. Considering that most of the GDEs covered by the monitoring plan have already been identified in the EIS as likely to be impacted by mine dewatering, Resolution’s methodology for identifying impacts to GDEs is unworkable and is inadequate under NEPA.

**Acid Rock Drainage.** As noted in the EIS, “The [copper ore] deposit is associated with hydrothermal alteration and includes a strong

pyrite “halo” in the upper areas of the deposit, containing up to 14 percent pyrite. This mineralization has ramifications for water quality, as sulfide-bearing minerals such as pyrite have the potential to interact with oxygen and cause water quality problems (acid rock drainage).”<sup>32</sup> Much of this pyrite halo will not be mined out; instead, it will become a permanent part of the collapse zone.

The EIS made the unsupported claim that the mineralized, fractured pyrite in the collapse zone will not be in contact with oxygen, thus it will not form acid rock drainage. This is a conclusion that defies common sense. As the collapse zone forms, the rock will be transformed into a giant rubble heap, increasing its hydraulic conductivity<sup>33</sup> many orders of magnitude and



*Figure 8. Aftermath of the Fundão tailings dam disaster in Brazil. This mine was a joint venture of BHP. As the dam broke, 45 million cubic meters of iron ore waste and mud covered the nearby town of Bento Rodrigues and beyond. 19 people were killed and at least 60. BHP has previously estimated that tailings would flow about 3.5 kilometers in the event of a potential dam break would flow about 3.5 kilometers. After this very real dam break, the tailings traveled over 600 km, eventually reaching the Atlantic Ocean, illustrating mining company’s history of downplaying risks from their tailings dumps.*

<sup>32</sup> Final EIS, p. 173.

<sup>33</sup> Hydraulic conductivity is a measure of how groundwater flows through an aquifer. This, in turn, affects the groundwater velocity through the aquifer. Solid rock has a very low hydraulic conductivity; sandstone has a higher hydraulic conductivity and very coarse grained sediments like gravels have even higher hydraulic conductivity.

draining it of groundwater. For the purposes of groundwater modeling, Resolution assumed that the hydraulic conductivity of rock in the cave zone would increase by as much as a factor of a million: “Maximum hydraulic conductivity values were altered by a multiplier of 1E+6 or to a hydraulic conductivity of 100 ft/day, whichever occurs first...The maximum hydraulic conductivity value of 100 ft/day was selected because it is much higher than the natural, un-altered bedrock, but higher values caused the model to become unstable”<sup>34</sup> This statement highlights another deficiency of the groundwater model: hydraulic conductivity of rock in the collapse zone was arbitrarily limited to 100 ft/day because the model would crash if higher, more realistic values were used.

Atmospheric air will easily penetrate the dewatered fracture zone, supplying oxygen into a subsurface environment that has been devoid of oxygen for thousands if not millions of years. The assumption that no oxygen will reach rocks in the collapse zone and thus no acid-generating reactions will occur is incorrect and understates the environmental risks from acid rock drainage within the mine and in ore stockpiles. This assumption is also inconsistent with Resolution's treatment of potentially acid generating (PAG) material in the tailings. In the tailings, Resolution acknowledges that PAG needs to be submerged under a layer of water to prevent contact with oxygen and minimize acid rock drainage. However, in the collapse pit, no such protection will exist, yet Resolution somehow concludes (and the Forest Service believed it) that acid rock drainage will not occur.

***Water Quality Impacts from the Tailings Storage Facility.*** The volume of toxic mine

tailings produced by Resolution Copper would fill Sun Devil Football Stadium to its brim, not once but nearly 1,800 times. This vast volume of waste material will permanently disturb 16,000 acres of land of which nearly 8,000 acres is Arizona State Land. Water quality impacts from the tailings is one of the most profound and concerning environmental issues for a mine of this size, yet there remains great uncertainty about the magnitude of water quality impacts from the tailings storage facility.

***Tailings Dam Risk of Failure.*** Tailings would be transported through about 20 miles of pipeline across sensitive habitat—including Ga'an Canyon—to the tailings dump in Dripping Springs Wash, a tributary of the Gila River. Over the life of the mine, the tailings dump would grow to cover 3,995 acres<sup>35</sup> of this watershed behind a three mile long, 500 foot high earthen dam—about as high as the Washington Monument—above the natural land surface.<sup>36</sup> Tailings dams are made from the tailings themselves and by one estimate, they fail at a rate 100 times higher than conventional dams.<sup>37</sup> A failure of the tailings dam would put downstream lives at risk and contaminate the Gila River.

In 2015 the Fundão tailings dam in Brazil failed, killing 19 people, contaminating hundreds of miles of the Doce River, and eventually spewing toxic waste into the Atlantic Ocean more than 400 miles downstream. That dam was much smaller than the proposed Resolution Copper dam — about 300 feet tall compared to the 500-foot dam planned by Resolution Copper. Resolution Copper's tailings facility will contain nearly 20 times greater volume than the Brazilian facility.

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<sup>34</sup> WSP, February 2019, Resolution Copper Groundwater Flow Report, pp. 37-38.

<sup>35</sup> The direct footprint of the TSF would be 3,995 acres however, according to the FEIS, a total of 8,647 acres would be off-limits to the public due to tailings operations.

<sup>36</sup> FEIS, p. ES-21.

<sup>37</sup> Cornwall, Warren, August 2020, Catastrophic failures raise alarm about dams containing muddy mine waste, *Science*, Vol. 369, Issue 6506, pp. 906-909.

***Impacts to Apache Leap Special Management Area.*** There is a high degree of uncertainty in Resolution's subsidence predictions, but the public has been assured that the subsidence crater will not extend to the crest of Apache Leap. True or not, it is certain that the subsidence zone will creep up the eastern slope of Apache Leap and profoundly degrade the quality of this theoretically protected place. In 75 years, if we could stand together on the crest of Apache Leap, instead of the world-class view across Oak Flat, we would see a massive pit of collapsed rock, just a couple hundred meters away, devoid of life & gradually filling with toxic mine water. Imagine standing on the stairs of the US Capitol and seeing nothing but a 1,000-foot deep rocky pit, swallowing not only the Smithsonian Museums and the Washington Monument, but extending all the way to the Lincoln Memorial. That's how immense this subsidence crater will be.

***Rush to Finalize the Environmental Impact Statement.*** The Final EIS was published on January 15, 2021, in the final days of the Trump administration. The federal government later withdrew it on a temporary basis on March 1, 2021, but will re-release it later this year, setting in motion the land swap that will ensure that the mine goes forward.

The Forest Service chose to focus the EIS on evaluating different locations for the waste tailings. Considering this focus, it was surprising that the Draft EIS was issued without a competent evaluation of the geotechnical suitability and water quality impacts of Skunk Camp, the preferred Tailings Storage Facility (TSF) site. To make up for these omissions, Resolution embarked on substantial field investigations and computer modeling efforts, generating a large body of new information after the Forest Service issued the DEIS. This new information consisted of at least a dozen new studies and reports totaling thousands of pages that are relevant to environmental concerns. In particular, there is substantial new groundwater modeling work to evaluate the cumulative impacts to groundwater resources in the East

Salt River Valley, site of the proposed Desert Wellfield where much of the water required by the mine would be pumped. Additionally, voluminous new studies of water quality impacts from the Skunk Camp TSF and a brand new assessment of possible surface water discharges from the mine operations under Resolution's AZDEPES permit have been prepared. All of this information was developed after publication of the DEIS, was not subject to public review or comment, and was not adequately analyzed by Tonto National Forest to determine whether this new information could impact the preferred alternatives or mitigation measures set forth by Tonto National Forest in its FEIS.

## Policy Recommendations

The proposed Resolution Copper mining project will have permanent consequences for Arizona's groundwater resources and the Phoenix AMA. By pumping billions of gallons of groundwater from the East Salt River Valley, this project would make Arizona's goal for stewardship of its scarce groundwater resources unreachable. Ongoing drought conditions and newly announced severe reductions in deliveries of Colorado River water to Arizona mean Resolution Copper's proposed groundwater pumping will exacerbate water shortages among the millions of current and future users of this groundwater basin.

In addition, the local hydrology surrounding the mine will be permanently degraded. The Apache Leap Tuff Aquifer will be destroyed by the mine's subsidence crater, forever altering the area's water resources, and eradicating regional springs, many of which are sacred to Arizona tribes. To better secure Arizona's water future, here are some recommended actions:

- The US Department of Agriculture's future EIS for this project needs a more complete analysis of the alternatives to be performed. Copper and mining is necessary, but we do not need to

green-light every mining project if the cultural and environmental costs are too high, as they are for this project.

- New projects with large water demands need to be scrutinized in a new light, considering the newly announced reductions in Arizona's allotment of water from the Colorado River. Congress should pass the Save Oak Flat Act (HR 1884, S. 915) to put a pause on the Resolution Copper Mine. This would allow Arizonans time to consider the wisdom of allowing a large new water use now that we know the state is facing a time of severely reduced water supply.
- Water use by mines should be addressed in the same manner as other large users so State planners can better respond to this era of scarce water resources and protect the vitality of Arizona's economy. The Arizona State Legislature can take a big step in this direction by revoking mining industry exemptions from groundwater management laws in light of the severe drought.

### About the Author

Dr. Wells has been a practicing environmental geologist for nearly 30 years. He is a Registered Geologist and earned a Bachelor's Degree from Dartmouth College and Masters' and PhD degrees from the University of Washington in Seattle, all in Geological Sciences. For the last seven years, he has advised the San Carlos Apache Tribe on environmental and water resource matters related to the proposed Resolution Copper Mine, as well as other matters. Dr. Wells has twice testified at Congressional Hearings in Washington, DC on environmental impacts of the Resolution Copper Mine.

At the invitation of the US Forest Service, Dr. Wells served on the Groundwater Modeling Workgroup which advised Tonto National Forest on its preparation of the Draft Environmental Impact Statement (DEIS), using complex groundwater modeling methods to predict water and ecosystem impacts from the proposed mine. The working group consisted of Forest Service and Resolution Copper personnel, as well as professionals from agencies such as US Environmental Protection Agency, US Geological Survey, Arizona Game and Fish, and Arizona Department of Environmental Quality. Also, at the invitation of Tonto National Forest, Dr. Wells was also a member of the Resolution Copper Mine Water Resources Working Group which advised the Forest Service on its efforts to respond to public comments on the DEIS.