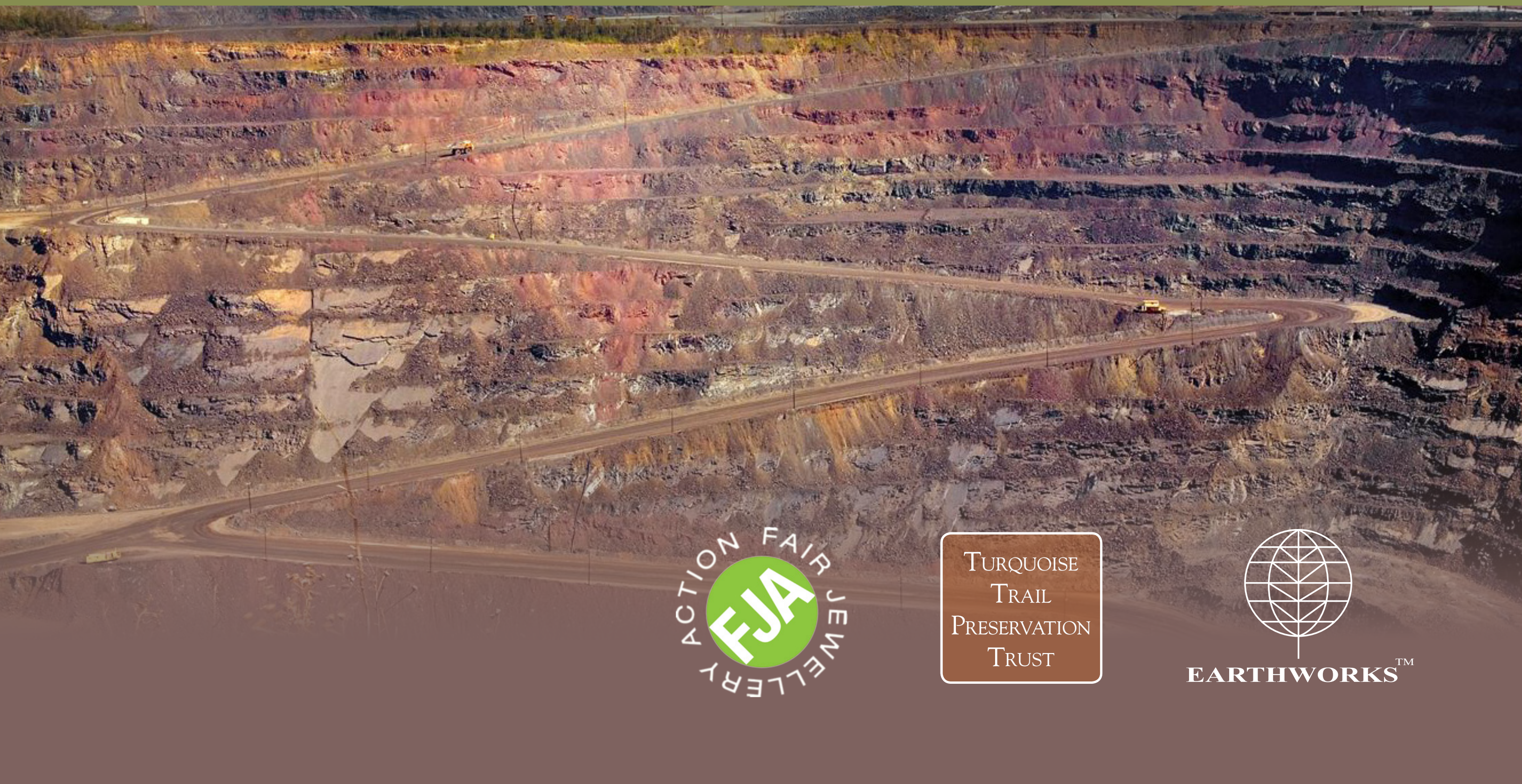
Public Risk, Private Reward

An analysis of the Ortiz Gold Mine proposal



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Public Risk, Private Reward

AN ANALYSIS OF THE ORTIZ GOLD MINE PROPOSAL

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Executive Summary

The Ortiz gold mine, proposed by Santa Fe Gold approximately 25 miles south of Santa Fe, New Mexico, for a nine year operational life, epitomizes the public risk, private reward nature of modern large scale mining.

Based on the best available information compiled by Santa Fe Gold and previous studies, and by comparing the proposal to a similar deposit mined five miles away, *Public Risk, Private Reward: An analysis of the Ortiz Gold Mine proposal* reveals that:

The mine would be extremely wasteful:

- Because the Ortiz deposit contains low grade ore, roughly 169 metric tons of mine waste would be generated per ounce of gold.
- The mine may consume as much electricity as over 5,000 households.
- The mine could consume over 3 million gallons of diesel fuel per year, which would release more than 604 million pounds of greenhouse gases over the life of the mine.

The Ortiz mine would consume large amounts of scarce groundwater:

- Santa Fe Gold predicts the mine would consume water equivalent to the use of 4,600 New Mexicans.
- However, compared to a similar proposal, Santa Fe's water consumption prediction is optimistic. Ortiz potentially will consume the water equivalent of more than 7,800 New Mexicans.
- The mine pit may form a toxic lake after closure, putting at risk groundwater and causing perpetual evaporative water loss.

The mine, and its wastes, could leach acidic water and heavy metals in perpetuity

- A similar, nearby mine is dealing with acid mine drainage problems, and will continue to do for the foreseeable future.
- The Ortiz Mine ore contains some of the same acid generating minerals as its aforementioned neighbor, the Cunningham Hill Mine.
- New Mexico state law prohibits mines that would require perpetual care, yet Santa Fe Gold has not yet performed formal acid drainage prediction modeling to ensure that it can be legally permitted.

Santa Fe Gold is on very shaky financial ground, to the point where it is very reasonable to question its ability to operate responsibly:

- The company has never turned a profit
- The company cannot afford to buy insurance to cover its liability for environmental hazards caused by mining
- Should unforeseen problems arise, such as water contamination, the company may not be able to afford proper remediation or ongoing maintenance liabilities.

Santa Fe Gold declares to stakeholders that a healthy environment is more important than the economic benefits of their mine[1] **"…the company believes the area's unspoiled air, clean water, and natural beauty are more valuable than any mineral wealth." If their statement is true, experience and analysis demonstrate that Santa Fe Gold should decide not to build the Ortiz Mine at all.**

Introduction

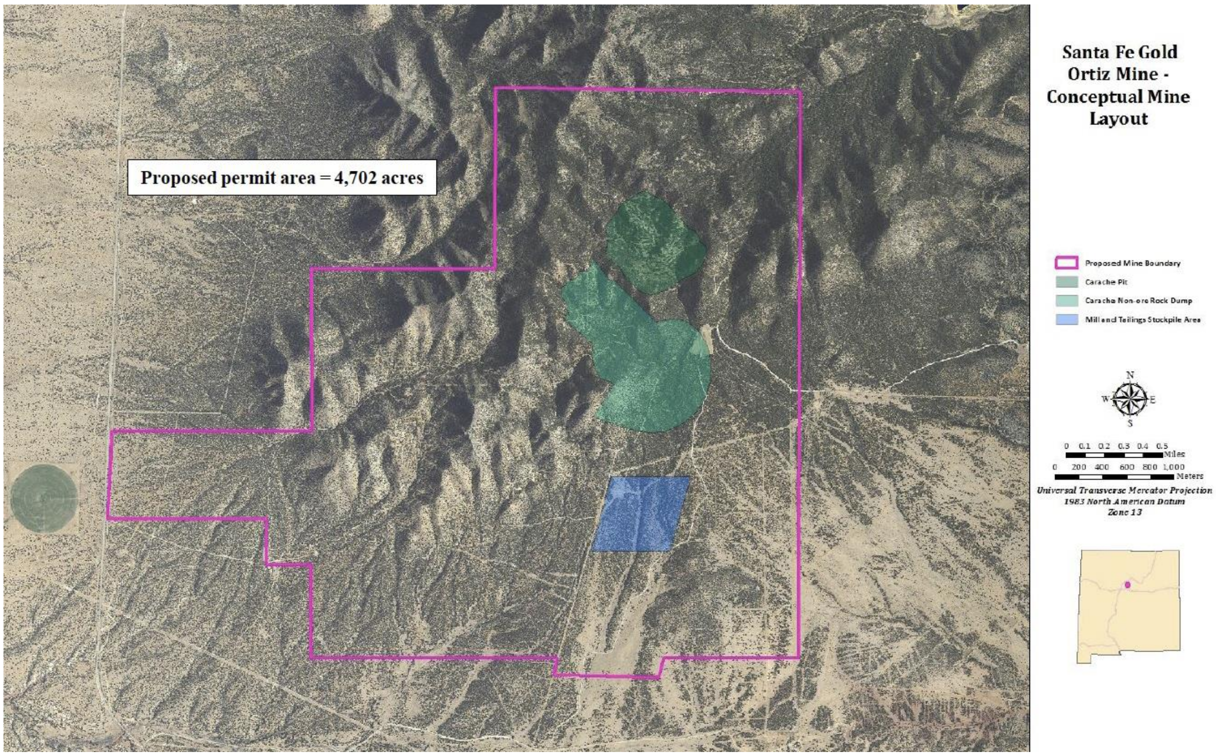
This report aims to offer a summary of potential environmental liabilities at the proposed open pit Ortiz Mine, south of Madrid, New Mexico. The report covers reasonably foreseeable life of mine issues as well as potential legacy issues that often plague similar mines. While this report cannot possibly be truly comprehensive until further studies become available as part of the mine permitting process, it can generally characterize environmental threats based on previous geochemical and hydrogeological studies referenced in the Sampling and Analysis Plan and other studies conducted during previous exploration efforts in the area. It also provides case studies of mines that have experienced problems that may also arise at Ortiz.

The report is intended for stakeholders already familiar with the region and the Ortiz Mine Grant area. Therefore, extensive background on land status, climate, and a history of mine activities on the Grant will not be provided. Much of that information is available within the Sampling and Analysis Plan (SAP) provided to the New Mexico Mining and Minerals Division in July, 2013 and found here[2]. At the time of this writing, the project proponent, Santa Fe Gold, has not yet released a plan of operations for the mine. This document will need significant updating if or when that permitting benchmark is reached.

It is important to understand that although the SAP planning area covers two main deposits from which baseline data will be gathered; the Carache Canyon Deposit and the Lukas Canyon Deposit, Santa Fe Gold's emphasis at this time is Carache Canyon, and is therefore the basis of this report. The SAP states (p. 9) that "The current plan proposes to develop the Carache deposit as a conventional open pit mine" and makes no similar statements about Lukas. Although a Preliminary Economic Assessment (PEA) may be released to the public soon that includes financial scenarios for mining both deposits simultaneously and sequentially (with Carache first), as well as only mining Carache, it is too early to tell what the preference will be in a final Plan of Operations. When publicly available, the PEA may help shed some light on what path forward the company may take, though at the time of this writing, Santa Fe Gold has refused to release the PEA despite several attempts to obtain it (most mining companies release PEA's to the public immediately after completion). Additions to this report will be essential if development of Lukas seems likely, or if resources become available to study that deposit in as much detail as Carache.

The Sierrita Mine in Green Valley, Arizona, a large mine with a long history of adverse groundwater impacts.
See page 18 of Earthworks' U.S. Copper Porphyry Mines report.[38]

Overview of the Ortiz Mine's Proposed Open Pit at Carache Canyon



The Carache Canyon proposed mine is a medium sized gold ore body. In the map above, the boundary indicates the SAP permit area (4,702 acres), with the pit, waste rock dump, and tailings impoundment marked from north to south, respectively. According to the SAP, the pit has the following characteristics.

- Minimum pit depth (south side): 600 feet
- Maximum pit depth (north side): 1060 feet
- Mine life of 9 years, or 18 if Lukas is mined after Carache
- Daily mill throughput of 4,500 tons per day, or 1.5 million tons per year
- Total material moved from pit over life of mine: 125 million tons
- Stripping ratio (ratio of waste rock to milled ore): 8.5 to 1
- Proposed pit will not be backfilled
- Waste rock will be placed into an adjacent canyon for permanent disposal
- Milled tailings will be dewatered and “dry stacked” for permanent disposal
- Total measured and indicated gold resource: 594,950 ounces
- Average measured and indicated grade: 1.57 grams per tonne of ore (the metric tonne, or 2,240 pounds, is often used in foreign publications and to express grade)

Location of the proposed mine, looking north. Photo by Orlando Diaz

PIT CHARACTERISTICS, GRADE AND THROUGHPUT

The Carache Pit has a high stripping ratio. This means that 8.5 units of waste rock will need to be removed to mine each unit of millable ore. The average grade in both the "measured" and "indicated" categories is 1.57 grams of gold per tonne of gold-bearing ore. However, when including the waste rock, 9.5 tonnes of rock will need to be removed from the pit to produce 1.57 grams of gold, producing a "gold to total rock removed ratio" of 0.16 grams per tonne, or roughly 0.006 ounces per ton. To compare Carache's grades with high-grade, mostly underground, mines around the world, click here[3].

9.5 tonnes of rock will need to be removed from the pit to produce 1.57 grams of gold.

According to this analysis[4] from Gold Investing News, Carache's grade falls at the lower end of the spectrum for current-era open pit gold mines, which varies from 1 to 4 grams per tonne. The high stripping ratio in addition to this low grade suggests that the Carache deposit may have challenging economics and a relatively high cost of production per unit of produced gold as compared to other mines. Future analysis of the PEA and/or the JORC resource estimate (the Australian system for estimate certification for publicly traded companies) will help shed light on the economics of the mine.

A 2012 filing with the US Securities and Exchange Commission[5] contains many statements from Santa Fe Gold regarding future profitability and feasibility. These include:

- "Since our inception in 1991, we have not been profitable. As of June 30, 2012, our total accumulated deficit was approximately $64.0 million. We may suffer significant additional losses in the future and may never be profitable."
- "We ceased mining operations at our Black Canyon mica property in 2002 after unsuccessful attempts to begin profitable operations."
- "We may be at risk of losing title to our Ortiz gold property lease if we fail to perform our obligations. Under the terms of our lease with Ortiz Mines, Inc., we are required to meet certain obligations... Among other requirements, we must begin mineral production by February 2015…"

- "We may not be able to obtain an adequate supply of water to complete desired development and mining of our Summit silver-gold property or of our Ortiz gold property"
- "Our ongoing operations, including past mining activities, are subject to environmental risks that could expose us to significant liability and delay, suspension or termination of our operations. Environmental hazards may exist on…the Ortiz gold property"
- "We have not purchased insurance for environmental risks including potential liability for pollution or other hazards as a result of the disposal of waste products occurring from exploration and production, as it is not generally available at a reasonable price."

Regarding throughput, Carache's mill throughput, or the amount of ore being milled to produce gold, is projected at 4,500 tonnes per day. By comparison, Santa Fe Gold's Lordsburg Mill in 2010 was projected[6] to produce 400 tonnes per day. Mega-mines worldwide have mill throughputs in excess of 100,000 tons per day and pits as deep as 3,000 feet. By Santa Fe Gold's standards, the Ortiz project is large, but in the mining space would generally not be considered a "mega-mine".

Below: a 1,200 foot deep pit (source[7]), comparable in depth to Carache's north side.

1,200 foot deep pit, comparable in depth to the proposed Carache pit's north side.
Photo by savethewildup.org

Acid Drainage, metals leaching and groundwater contamination

Acid mine drainage and metals leaching could permanently contaminate groundwater. This sample, heavy in iron and other metals, is highly acidic and was collected from a small Arizona mine.

Acid Mine Drainage and Metals Leaching, or AMD & ML (but usually referred to as simply AMD), is perhaps the most significant environmental problem facing hardrock mining operations. AMD is triggered by the oxidation of sulfide minerals when recently unearthed rock is exposed to air and water. This exposure causes sulfuric acid to leach from waste rock, tailings, pit walls and other areas where the surface is disturbed, exposing the sulfide minerals. The result is increased acidity in surface and groundwater, which then leaches metals from surrounding rock and further contaminates waters. Common heavy metals leached from AMD can include iron, arsenic, copper, cadmium, lead, mercury, nickel, cobalt, chromium and manganese, among others. This poses surface and groundwater contamination problems, but in the case of the Ortiz Mine, if it becomes a problem, would generally be a groundwater issue as perennial streams do not exist in the area.

Acid drainage is usually a self-perpetuating source of contamination that requires ongoing treatment before discharging to surface or groundwater. This treatment may be necessary for hundreds, or even thousands of years. Indeed, small mines built during the Roman Empire are still leaching acid and heavy meals today. Through lime treatment, AMD can be neutralized and a large percentage of the metals can be precipitated out, although sulfate concentrations and other contaminants may still remain. Even though the water quality will be improved, it is an ongoing expense that in many cases is absorbed by governments, municipalities, and even citizen groups after a mining company goes bankrupt and does not have a sufficient fund or bond in place to cover costs over the long term. This can, and has, happened despite financial "assurances" put up by mining companies. Click here[8] for an informative but brief page about AMD, and click here[9] for Earthworks' detailed report about perpetual water treatment.

Fortunately, the New Mexico Mining Act[10] of 1993 has a clause (p. 18) that prohibits new mines that will require "perpetual care", making it one of the strongest pieces of legislation in the country (only one other state has such a law) to effectively prohibit mines that will require water treatment in perpetuity. The Act states that a new mining permit can only be issued if:

> *"the mining operation is designed to meet without perpetual care all applicable environmental regulations imposed by the New Mexico Mining Act and regulations adopted pursuant to that act and other laws following closure."*

Accurately predicting acid drainage at future mines is difficult and expensive and may not always be truly conclusive. Indeed, in this report[11], case studies are provided in Canada showing that even after AMD prediction efforts, mines still had unexpected AMD problems. The Ortiz SAP lays out (beginning on p. 45) how AMD prediction will be done as part of the permitting process. It involves the analysis of previous drill cores (assays) and water samples from those holes for geochemical and hydrogeological data specific to AMD. Where this may be insufficient, new holes and new groundwater sampling will be completed for further analysis.

In addition, kinetic testing will be completed. This is a laboratory and field-based method of AMD analysis that attempts to simulate in small scale, over real time, the reaction of ores, waste rock, and other potentially acid-generating mine components. However, before kinetic testing can occur, a detailed Plan of Operations must be available, as it will determine the criteria and conditions for kinetic testing. For the Carache pit, the closest thing to formal AMD prediction that can be achieved now is by comparing the proposed mine to that of its acid-generating neighbor, the Cunningham Hill Mine, and by inventorying sulfide minerals present at Carache.

According to a 2010 water discharge permit renewal[12] for the now-closed Cunningham Hill Mine (operated 1979-1986) roughly three miles away from Carache, "ground water monitoring, site maintenance, and water treatment are ongoing activities at the mine site." It states (pp. 1-2):

> *"The regulated discharge includes leachate from the Residue Pile and Waste Rock Pile, the Acid Rock Drainage (ARD) Interceptor Wall and treatment facility, collection ponds, land application areas, and impacted storm water. Discharges of leachate directly or indirectly into ground water have occurred from the Residue Pile and the Waste Rock Pile. The Waste Rock Pile produces ARD discharge in exceedance of health-based water quality standards (§20.6.2.3103.A NMAC) for cadmium and domestic water supply standards (§20.6.2.3103.B NMAC) for sulfate, pH, iron, manganese, and TDS.*
>
> *Leachate from the Residue Pile exceeds health-based water quality standards (§20.6.2.3103.A NMAC) for nitrate and cyanide; domestic water supply standards (§20.6.2.3103.B NMAC) for iron, manganese, sulfate, and TDS; and irrigation standards (§20.6.2.3103.C NMAC) for cobalt. Discharge from the Residue Pile consists of a cyanide-nitrate rich leachate that has discharged to ground water in the Cunningham Gulch area. The cyanide-nitrate ground water plume is currently being remediated by pumping a series of Recovery Wells located in the drainage northeast of the Residue Pile. Impacted ground water is pumped into a synthetically lined treatment pond and treated using passive evaporation and selective land application to specified areas on the mine property to allow for rapid evaporation."*

Clearly, the Cunningham Mine is battling AMD now, and will for the foreseeable future. It also has other groundwater contamination issues that may take generations to be fully remediated. Some of the problems are likely due to the mine's cyanide gold heap leach operation (the cyanide-nitrate ground water plume) – a component that will not be a part of the Ortiz Mine – but it also displays the classic AMD & ML issues caused by the presence of sulfide minerals.

The Cunningham Mine, like Carache, is a breccia pipe within sedimentary rocks. Like Carache, it contains sulfide minerals known to generate acid. Below is a comparison of gold bearing mineralization at both mine sites, according to this study[13] (more here[14] and in the SAP).

Known acid generating sulfide minerals present at Cunningham Hill Mine and Carache Canyon, with similarities highlighted.

Cunningham	Carache
pyrite (iron sulfide)	pyrite (iron suldife)
chalcopyrite (iron, copper sulfide)	chalcopyrite (iron, copper sulfide)
	pyrrhotite (iron sulfide)
	sphalerite (zinc sulfide)
	arsenopyrite (iron arsenic sulfide; listed in the SAP)

In addition to both deposits containing pyrite and chalcopyrite – known acid generators – both also have similar porphyry structures (disseminated mineralization); latite-andesite porphyry sills at Carache, and latite porphyry dikes at Cunningham. Although some mineralogical differences may exist between the two deposits, they contain very similar geological structures and many of the same minerals (in additional to sulfide minerals). However, this doesn't necessarily imply that Carache will be an acid-generator. It's possible that sufficient neutralizing capacity will exist if the quantities of alkalic or calc-alkalic rocks counter the acid-generating tendencies of sulfide minerals, but based on Cunningham – the nearest open pit mine to Carache which has very similar geology – stakeholders should be aware that acid generation and groundwater impacts are very real possibilities.

Arsenic contamination, which can occur separately from acid drainage but is also exacerbated by it (arsenic can be released in neutral and elevated pH drainage environments), can be a major and very long lasting problem at mines with arsenopyrite, such as Carache. Arsenopyrite can produce acid and leach arsenic – a poisonous metalloid – into groundwater. According to this study[15], "When humans are implicated in causing or exacerbating arsenic pollution, the cause can almost always be traced to mining or mining-related activities." Though arsenic is naturally present in some groundwater, the mobilization of it into the environment is usually mining-related.

"When humans are implicated in causing or exacerbating arsenic pollution, the cause can almost always be traced to mining or mining-related activities."

In addition to AMD, groundwater can be contaminated in other ways as well. Nitrate groundwater plumes have degraded waters at several mines (click here[16] for a case study specific to nitrate pollution at open pit mines), including the Cunningham Hill Mine which has a nitrate-cyanide groundwater contamination plume beneath it. As a result, a series of recovery wells have been drilled to remove the contaminated water (see footnote 11, p. 2). Nitrate contamination is usually caused by explosives or by oxidation of cyanide complexes following leaching in mills or heap leach piles (the latter being the case at Cunningham Hill). This issue is often not generally considered in Environmental Impact Statements. Ammonia contamination can also be associated with blasting agents. According to the Idaho Department of Environmental Quality, infants, the elderly, and sick people should not drink[17] water higher than 10 milligrams per liter nitrate (some consider this the maximum contaminant level for all humans), and livestock should avoid water higher than 100 milligrams per liter. Finally, fuel and chemical spills on roadways and within the mill can also contribute to groundwater degradation, as can some forms of dust suppression agents (click here[18] for more on dust suppression.)

DRY STACKING AND WATER CONSUMPTION

Santa Fe Gold proposes to use a "dry stack" method of tailings disposal rather than conventional, aqueous tailings disposal. In hard rock mines such as Ortiz, ore is pulverized into a fine powder before reporting to mill circuits. The leftover powdered waste material is called tailings and has virtually the same mass as what originally entered the mill. In conventional mines, this powdered waste material is mixed with water to form a slurry, which is then piped to a lined, dam-like facility called a tailings impoundment. In the impoundment, the silty material sinks to the bottom and a cover of water remains on top, but the water is often toxic, and because of evaporation there is substantial water loss. Eventually, during mine reclamation, aqueous tailings are dewatered and capped with a topsoil cover with hopes of having acid-neutral runoff drainage and the reestablishment of native vegetation, though it doesn't always result in such.

Though more expensive during the life of the mine because tailings must be trucked or transported by conveyor belt and dumped rather than simply piped, and because tailings filtration and dewatering is more costly, dry stacking provides water savings to an operation. Dry stacking also avoids other direct groundwater contamination problems that originate from leaking tailings pond liners or impoundment dam failures.

However, long term management issues still exist. According to this article[19], dry stacking leaves tailings more susceptible to the oxidation of sulfide minerals, as there is no water cover to slow the oxidizing process as there is with conventional tailings storage during the life of the mine. It states that dry stacking "may not be practical for some ore types…detailed geochemical testing is required."

However, no detailed geochemical testing with regard to the feasibility of dry stacking has been done for the Ortiz mine. Oxidation of sulfide minerals within the dry stack facility could produce significant acid drainage from rainwater percolating into the tailings, which could require the perpetual treatment of water collected from the liner underneath. While certainly less water intensive, dry stacking doesn't necessarily eliminate the need for perpetual care of the tailings facility. Finally, dust problems are generally present at dry stack facilities in arid climates, requiring ongoing abatement, without which fugitive dust could become a major problem.

According to the SAP, Santa Fe Gold projects to consume 215 acre-feet of water per year for the entire operation (because clarifying information is not available, this report assumes 215 acre feet to represent net water loss at Ortiz; see note in next chapter regarding net water loss). According to the United States Geological Survey (USGS)[20], the average New Mexican in 2005 withdrew 107 gallons domestically per day, or 0.12 acre feet per year. Therefore, the Ortiz Mine would consume as much water as is withdrawn by 1,791 New Mexicans.

However, most water used within households is recycled at treatment plants or percolated into groundwater through septic systems. For example, within the city of Santa Fe, 61% of all water pumped to customers is returned through sewer systems (return flow), treated, and recycled[21]. If we apply this return flow rate to the state per capita use average, and consider that, at best, only 39% of domestic water use may actually represent net loss, per capita use drops to .047 acre feet per year. Therefore, Ortiz may consume as much water as nearly 4,600 New Mexicans, though this is a conservative estimate because it fails to take into account that most unreturned residential water is used for landscaping — a significant portion of which serves to recharge local aquifers and is not lost.

There is also reason to question Santa Fe Gold's estimate. Below is a comparison to the proposed Rosemont Mine in Arizona. Further research of existing mines in similar climates currently using dry stacking will increase the statistical accuracy of average water consumption data and therefore offer a more reliable comparison to Santa Fe's estimate.

Mine	Mill Throughput	Daily Water Use	Water Use per 1000 Tonnes Ore
Ortiz Mine, NM	4,500 tonnes/day	0.58 acre feet	.13 acre feet
Rosemont Mine, AZ	75,000 tonnes/day	16.43 acre feet	.22 acre feet

It is unclear how Santa Fe Gold has projected annual use at 215 acre feet per year considering that no plan of operations has been written yet. This is likely a rough estimate that warrants further investigation. The Rosemont Mine, however, states the following[22]:

> *Rosemont Copper will employ water conservation and recycling techniques never before implemented at an Arizona copper mining facility. These techniques, including the use of dry-stack tailings and state-of-the-art processing technologies, will result in Rosemont using 50% less water than traditional mining practices.*

Therefore, according to Santa Fe Gold, the mine would use roughly half as much water per unit of milled material than that of a highly efficient, "state of the art" proposed mine. However, if it cannot achieve its stated water savings, and instead requires similar per-ton water use as Rosemont, the per capita net water loss comparison would increase to roughly 7,800 New Mexicans – about 11% of the population of Santa Fe.

Though Earthworks does not support the Rosemont Mine, it does propose to achieve significant water savings as compared to its conventional counterparts. This begs the question of whether or not Ortiz is considering all forms of water use in their estimate, such as dust abatement, camp and buildings, mine construction, reclamation, as well as what milling techniques the company proposes to employ to achieve such seemingly efficient water use. And as we will see in the following chapters, evaporative loss from a potential pit lake and water consumption associated with electrical generation required by the mine are additional factors not considered herein that will only serve to increase the projected water demand.

HYDROGEOLOGY AND GROUNDWATER

Mine dewatering is a major issue at many mines, both underground and open pit. Dewatering is required when a mine intercepts groundwater, requiring continual pumping to remove water to make mining possible. In an open pit mine, water removed from the bottom of a pit is often contaminated with heavy metals and high acidity levels, requiring treatment before discharging back into groundwater. It can also create a "cone of depression" – an area surrounding the pit in which regional groundwater levels drop. Another major problem comes after mine closure; as the pit is no longer dewatered, it will eventually fill back up with water until it reaches equilibrium. This causes perpetual evaporative water loss, and if the water is contaminated, it could impair groundwater below the pit unless the water is continually treated.

According to the SAP, "Mine dewatering will not be required because the proposed mine pit is above the measured regional groundwater level elevations" (p.65). This deserves further scrutiny. Former exploration in 1989 likely assumed that groundwater would not be present, and miners began to dig a decline adit (downward sloping tunnel) into the mountain at the site of the currently proposed Carache pit in order to conduct bulk ore sampling. The adit then filled with water and the project was abandoned. The SAP states that a "temporary water inflow coupled with regulatory issues" led to the abandonment of the adit, although it is possible that a "temporary" inflow could be a permanent condition, as groundwater flooding resulting in the abandonment of a 1,719 foot tunnel deep within a mountain generally does not indicate a temporary condition. Further research regarding the elevation of the inflow in relation to the bottom of the proposed pit and an explanation of the "temporary" nature of the problem will help to better predict whether the water may infiltrate the Ortiz pit.

A cursory review has shown that the bottom of the pit is extremely close to static groundwater levels in the region – levels physically recorded from previous exploration wells and outlined in the SAP. While the SAP states that dewatering will not be needed, the decline adit indicates that unknown water sources (likely unrelated to static groundwater levels) may result in unexpected water infiltration. The same problem could exist within a future pit.

The geologic structure of the deposit contains numerous faults that conduct rainwater downwards in so-called "perched aquifers". It is possible that the decline adit was infiltrated by water migrating downwards from one of these perched aquifers. If the Carache pit intersects one or several of these, the result could be the need for dewatering to allow mining and ultimately prevent the formation of a pit lake. As noted above, pit lakes often contain acidic, heavy metal-laden waters that can then infiltrate groundwater, resulting in contamination plumes like that at Cunningham Hill and posing serious threats to down gradient water wells – in this case agricultural wells at the Lone Mountain Ranch, Rancho de Chavez, and possibly others.

Stakeholders should be aware of the history of flooding at the decline adit, the contamination posed by pit lakes, and the potential impacts to those dependent on water wells. They should also be aware that if Santa Fe

Gold drills local wells for its water supply, there is a strong possibility that this use will lower the water table substantially and render obsolete existing wells in the area.

Click here[23] for more information on the hydrogeology of the Ortiz Mountains.

NOTE ON DISCHARGE PERMITS AND NET WATER LOSS: The Ortiz Mine will require water to be imported to the mine site – either from local wells or from distant sources brought in by pipeline – and therefore be a net water consumer of an estimated 215 acre feet per year. However, there may also be discharges into groundwater, including storm water, potential water removed from the pit, and possibly treated water from various mine facilities that will recharge groundwater and likely require permits.

Stakeholders should realize that any discharge to groundwater originating from existing aquifers or storm water would occur in the absence of a mine and therefore cannot be subtracted from total water demand numbers. Water demand should be defined as water that will be permanently removed from the hydrologic system, and include water lost to evaporation from cooling infrastructure and power generation, dust suppression, landscaping near outbuildings, steam vented from a number of industrial processes, and more. Third party analysis of water consumption numbers with this is mind could be useful in the future. Finally, should a pit lake be predicted to form, long term evaporative loss calculations should be made with regard to the lake, as this represents perpetual water consumption that would not occur in the absence of an open pit mine and would instead recharge local aquifers.

Energy Consumption

Hardrock mines use incredible amounts of energy and are major contributors to climate change. Though an exact calculation for Ortiz is not possible until a Plan of Operations is completed, we can compare Ortiz to other proposed and operating open pit mines. The vast majority of electricity in open pit mines is used in the mill, although in terms of total energy used, as much, if not more, is used in haul trucks – the largest of which can consume up to 65 gallons of diesel fuel per hour.

It is also important to understand that dry stack mines, although generally more water efficient, also consume more energy per unit of milled material. As noted above, tailings must be filtered and dewatered, transported using expensive and energy intensive methods, deposited strategically, compacted, and treated for dust control. Increases in electricity usage can also increase water demand at power plants, whether on site or not, due to evaporative losses in the water cooling processes at many power plants.

ELECTRICITY

MINE	Electricity Consumption	Mill Throughput	Megawatts per Tonne
Donlin Gold[24]	153 Megawatts	59,000 tonnes/day	.0026
Fort Knox[25]	35 Megawatts	40,000 tonnes/day	.0009
Livengood[26]	75 Megawatts	100,000 tonnes/day	.0007
Pebble[27]	378 Megawatts	200,000 tonnes/day	.0019
(all data is approximate, examples are from Alaska as data was most accessible)			

Although mines clearly vary in electricity use based on factors such as stripping ratios, ore grades, transmission distances, rock hardness, equipment utilizing electricity rather than diesel (such as electric shovels), and type of milling circuits employed, averaging the above mines together creates a use of 0.0016025 Megawatts per ton of daily throughput which can serve as a general baseline for open pit mines. However, it is important to realize that mines employing heap leach piles use substantially less energy than those that do not, and two of the above mines use or plan to use heap leach (Fort Knox does, and Livengood plans to). This is evident in the numbers above. Therefore, the Ortiz Mine will likely use more electricity than stated below.

Applied to Ortiz, the above would amount to 7.2 Megawatts. Adding more mines to this sampling – particularly from non-heap leach conventional open pit gold mines in similar climates – will yield a more accurate baseline number. According[28] to the US Energy Information, the average US household consumed 940 kilowatt hours per month, which equals an average current of 1.3 kilowatts. Therefore, the Ortiz Mine may be consuming as much electricity as over 5,500 single family homes, much of which is likely derived from coal, which creates substantial greenhouse gas emissions.

DIESEL FUEL

Although pit mines require increasing amounts of diesel fuel per unit of excavated material as the mine grows deeper, we can generally estimate diesel fuel needs based on comparisons to proposed and operating mines elsewhere. Some mines derive all or a portion of needed electricity from diesel fuel generation, but because the Ortiz Mine is likely to tie into a regional power grid, it would probably use diesel primarily for haul trucks, loaders, bulldozers, drill rigs, support vehicles, and other miscellaneous uses.

The proposed mine may burn more than three million gallons of diesel fuel per year.

Mine-specific diesel consumption data is difficult to obtain, but according to the Donlin Gold Plan of Operations[29], the open pit mine – which, like Ortiz, would not use diesel fuel for electric generation – would use 40 million gallons of diesel per year to sustain a 59,000 tonne daily throughput, or 21.53 million tons per year. This equals 1.86 gallons of fuel per ton of ore milled. Applied to Ortiz, this would result in annual diesel fuel consumption of roughly 3 million gallons per year. However, because the stripping ratio at Ortiz is higher (8.5 versus about 5.5), diesel consumption will likely be higher per unit of milled ore than Donlin, as more rock must come out of the pit in order to mill the same amount of ore.

Below are some sector-wide mining industry studies which calculate total energy and diesel fuel use:

- Estimates of Electricity Requirements for the Recovery of Mineral Commodities with examples applied to Sub-Saharan Africa[30]
- Mining Industry Energy Bandwidth Study, US Department of Energy[31]
- Benchmarking the energy consumption of Canadian Open Pit Mines, Natural Resources Canada[32]
- Analysis of diesel use for mine haul and transportation operations, Australian Government[33]

Air Emissions

Hard rock mines create hazardous air emissions of all types. The most notable is carbon dioxide from electricity generation and diesel fuel; the latter releases about 22.38 pounds of carbon dioxide pollution per gallon when burned[34]. In the case of Ortiz using 3 million gallons of diesel per year, this amounts to about 67 million pounds of the greenhouse gas per year, and based on a 9 year mine life at Carache, 604 million pounds over the life of the mine. Mining Lukas Canyon would potentially double the air emissions.

Diesel exhaust also emits nitrogen oxides and sulfur dioxide – compounds known to cause acid rain – though in lesser quantities than previous years based on ultra-low sulfur diesel standards and cleaner burning engines.

Mercury air emissions have been very problematic at many hard rock gold mines throughout the world and the US, particularly at mines that utilize roasters and autoclaves, as well as cyanidization, in the gold recovery process. Santa Fe Gold plans to separate gold using only water and gravity, however, gold smelting will be performed on site to produce semi-pure gold dore bars from the separated material. Gold smelting can be the source of hazardous emissions as well, but because gold is in such low quantities after gravity separation, this is not likely to be a significant source of contamination.

FUGITIVE DUST

Fugitive dust (fugitive means not from point sources) is a common problem at most mine sites and can be harmful to health and air quality. Fugitive dust can contain particulate matter with particle size diameters from under 2.5 microns to over 10 microns, with the former being more hazardous to respiratory health. Although some mines have fugitive dust control and suppression programs that greatly reduce dust on roadways and in other high use areas, many mines still emit plumes of dust that can be visible from many miles away, making it a regional air quality and visibility issue. Blasting, pit walls, and the dumping of waste rock are all sources of dust for which control and suppression measures are not usually employed.

Santa Fe Gold's Proposed Gravity Separation

In its promotional brochure distributed to New Mexicans in mid 2013 (foot note at summary), Santa Fe Gold notes that "modern practices eliminate the need for chemical leaching," and that "relatively coarse gold can be recovered through a gravity processing method." However, non-chemical gravity gold separation processes are the oldest form of gold recovery and date back hundreds of years in the form of placer mining that includes riverbed panning, sluicing, and dredging, as well as hard rock mining. Through gravity, smaller gold particles fall out to the bottom and are recovered non-chemically. Although Santa Fe will aide this process using centrifugal force (spinning the ore), the principle is the same as mines of hundreds of years ago.

The SAP states (p. 10):

> *Cyanide and other forms of chemical leaching are not proposed as part of the milling and concentrating process…A conventional crushing circuit will be employed that consist of a series of crushers in combination with a screening unit to reduce ore to 1/2 inch minus material. The crushed ore will be fed into a ball mill for further grinding. Material discharged from the ball mill will undergo gravity concentration in centrifugal concentrators. Concentrates from the centrifuges will report to hoppers and will be smelted daily for production of doré metal. Slag generated in the gold smelter will be crushed and returned to the ball mill for reprocessing.*

There are very few – if any – hard rock gold mines in the United States that use only gravity separation today, though higher grade mines in other countries still employ this technique. Most hard rock mines using "modern practices" – especially low grade porphyry mines like Ortiz – use chemical leaching (either within a mill or an outdoor heap leach) because the recovery rates are higher, and that is important when mining low grade deposits. Santa Fe's stated milling process would be an exception to the general rule of low grade porphyry gold mines using chemical leaching.

More research is needed to identify porphyry gold mines throughout the world that use gravity as the sole separation method; comparisons of grade and ore type will possibly lend some credibility to Santa Fe's proposed milling method. At this point, however, we believe many more questions should be raised regarding the validity of this milling plan. While Santa Fe may employ gravity separation as a primary circuit, the same ore may then report to cyanide vat leaching circuits and thermal processing for further separation. In the event of Santa Fe later changing their plan to include chemical and/or thermal processing, the transportation of hazardous chemicals, energy use, and air emissions should be reevaluated.

Finally, Santa Fe is basing[35] their proposed milling technique on "historical metallurgical work indicating that gravity recovery is highly effective for the mineralization style." Although Santa Fe claims to use "modern practices" in their milling operation, they are in fact using outdated metallurgical studies that may not have been intended to determine the viability of gravity milling. Updated metallurgical testing should be completed specifically to gauge the feasibility of gravity-only separation using the equipment Santa Fe intends to use in the mill.

Photo by Orlando Diaz

Light and Noise Pollution

Virtually all industrial hard rock mines today operate around the clock, as shutting down operations on a daily basis is not feasible. Lighting is installed on roadways, around buildings, and elsewhere and can be seen from many miles away. Some mines are proposing to use specialized LED lighting systems that avoid some of the reflection into the sky, though if the ground is lit, it will be visible elsewhere. Light pollution would be especially noticeable along the Turquoise Trail[36], a National Scenic Byway. Noise pollution will also be a noticeable impact. Blasting, trucking and milling are especially noticeable during times of still winds, when sound can travel miles.

Cumulative Impacts

Cumulative impacts should be considered as well. These include additional vehicle miles traveled by mine employees to get to and from work, which increases carbon emissions and light and noise pollution. Less regionally, construction of a mine increases global demand for commodities such as steel, aluminum, and copper, thereby adding to the global energy and water requirements of industrial activity, and also increasing the worldwide pollution tally. In addition, commodities sourced from other, less regulated nations through the supply chain – though this can be difficult to track – may have substantially higher environmental impacts elsewhere. In comprehensive environmental impact analyses of mines, the cumulative – often global – impacts should be considered, not simply impacts of the mine in question.

Santa Fe Gold has declared to stakeholders "the company believes the area's unspoiled air, clean water, and natural beauty are more valuable than any mineral wealth."[37]

Photo by Orlando Diaz

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