Study of Mineral Production with Reference to the Rosemont Copper Project

by Dr. Madan M. Singh

Arizona Department of Mines & Mineral Resources
Special Report 24
July 2009

State of Arizona
Jan Brewer, Governor
Phoenix, Arizona

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Cover: Drill core from Rosemont copper deposit

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Including:

An Assessment of the Economic Impacts of the Rosemont Copper Project

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STUDY OF MINERAL PRODUCTION WITH REFERENCE TO THE ROSEMONT COPPER PROJECT

EXECUTIVE SUMMARY

Mining entails the extraction of valuable minerals and geologic materials from the earth for the benefit of mankind. As homo sapiens have evolved, they have depended on two basic industries: mining and agriculture. These industries supply the essentials for our civilization – food, fiber and fuel, which comprise the basis for feeding, housing, and clothing humans. Improvements in the standard of living have ensued from innovating, manufacturing and developing goods and infrastructure primarily from mined materials.

The importance of minerals in our society cannot be overemphasized. Minerals are evident in every facet of our everyday living. Uses include fertilizing, harvesting, preparing and preserving our food; pumping, piping and plumbing the clean water we rely on; providing the bases for our clothing, homes, and buildings; power generation; transportation; healthcare; communication; lighting; national defense and space exploration.

One of the metals used in the applications listed above is copper. This is critical to our society and is the main subject of discussion of this report. Copper has been used by humans for more than 10,000 years. For example, there are 440 lbs of copper in an average American home. It is a major component of the electric power sector.

Just as DNA is the building blocks of life, minerals are the building blocks of our way of life – our civilization!

With increased emphasis on green technologies the amount of copper used will increase markedly. A conventional 800-megawatt (Mw) generation station uses 100 tons of copper. An equivalent wind farm would require 106 7.5-Mw turbines, which would need 1,200 tons of copper, a ratio of 12:1. A conventional car has between 15 and 75 lbs of copper, but a hybrid electric may have 70 to 75 lbs more. Standard office buildings have about 0.55 lbs of copper/ sq ft; green buildings use 0.72 to 1.23 lbs/sq ft.

Balance of Payments

The United States consumed 2,090,000 metric tons (mt) of copper in 2008, of which 690,000 mt was imported. The average copper price during the year was $3.24/lb. Therefore, the amount paid for imported copper was $4.92 billion. If all the copper had been mined in the U.S., it would have reduced the balance of payments by this amount. The total payment deficit for the country was $6.73 trillion.

Copper mined in the U.S. in 2008 was 1,310,000 metric tons. This implies a value of $9.34 billion. Arizona's mine production was 830,000 metric tons valued at $5.93 billion. This is 63.3% of the copper mined in the country.

The Gross Domestic Product for Arizona for 2007 was $247 billion; the contribution of mining (including oil and gas) and its supporting industries was 4.5 billion, i.e. 1.8%. This compares with $2.3 billion for agriculture (including fishing and hunting) i.e. 0.9%, and $8.3 billion for accommodations and food services, i.e. 3.3%. The Department of Tourism claims that $19.3 billion was spent for tourism in Arizona in FY 2008, i.e. July 2007 through June 2008. The total tourism expenditures in Pima County are given as $2.2 billion.

Copper Demand and Supply

The world demand for copper is around 15 million tons annually. This is expected to increase by about 575,000 tons a year, and may be higher in future years. It is predicted that the demand will outstrip supply in the next couple of decades.

There have been 56 copper discoveries made in the last three decades; the rate of discoveries peaked in 1996. Of the 28 largest mines, 21 are not capable of expansion; many of these will be exhausted between 2010 and 2015.

The consumption rate of copper is equivalent to depletion of 3 mines being depleted each year. It has been estimated that copper may run out in 25 years, assuming a growth rate in usage of 2% per year.

Regional Benefits

Regional benefits of the Rosemont Project are discussed in greater detail in the Economic Impacts Report prepared by the Seidman Institute of the Arizona State University that is part of this document. It covers Pima and Santa Cruz Counties; the major benefits accruing to Pima County. Briefly, the pre-production phase of the contract will generate an annual $82 million of activity, and support 640 construction and type employment this 4-year period. Average annual wages and salaries for non-labor personnel will be $29.5 million. Local governments will receive $3.6 million in annual revenues during this phase. Total impacts over the preproduction phase will be $328 million in additional goods and services, $191 million in the gross regional product (GRP), $118 million in personal income, and $14.6 million in local government revenues.

During the production phase there will be an average annual $726 million in economic activity over the 21-year period. Employment in the mine, processing, and support areas such as maintenance and administration will average 425 personnel. It will also support another 1,570 jobs, giving a total of 1,995. Wages, salaries and non-labor income will be $118 million per year and contribution to local governments will be an additional $14 million annually. Over the life of the project the region will gain $15.7 billion in output, $9.6 billion in GRP, $2.6 billion in personal income, and $306 million in local government revenues.

Technological Improvements

Better technology helps to keep mines more competitive with operations that are not as progressive. This is especially pertinent in the global minerals market, where some countries do not enforce strict environmental rules and where labor is cheaper.

Although the mining process seems simple in concept, modern mining is quite sophisticated. Improvements in mining techniques, processing, and equipment are being made continually.

Water Conservation

Water is a scarce resource in all desert locations, and Arizona is not any different. A detailed study of methods of conserving water is beyond the scope of this study. However, a few areas where water usage may be reduced are included, such as recirculation of waters from tailing dams and dumps, filtering of tailings, and use of drainage pipes.

The Rosemont Copper Project is planning to have dry tailings, use drip emitters, and is already recharging water from the Central Arizona Project into the Tucson Active Management Area where it has permits to withdraw water. Rosemont plans to employ the best available technology and have a state-of-the-art facility.

Cultural Resources

Southern Arizona has a rich tradition and culture of mining. The early Spanish explorers came to the region not for the love of adventure but because the mineral laws at the time permitted them to keep some of the gains of their efforts. Several expeditions were conducted looking for Cibola, the legendary seven cities of gold. These were fabled to be in what is currently Arizona. The mineral deposits of Ajo were said to have been discovered in 1750 by prospectors from the missions. Similarly mining was conducted at Quijotoa and Aribac (Arivaca) in the 1770s and perhaps considerably later. There is evidence that 20 mines in Arivaca were transferred to Americans in 1856.

Pima County contains parts of the Tohono O'odham Nation, as well as all of the San Xavier Indian Reservation, Organ Pipe Cactus National Monument, Ironwood Forest National Park and Saguaro National Park.

The Rosemont deposit and the area surrounding it is not pristine property. There has been mining in the vicinity for over a century.

Sustainability

Sustainability may be defined as satisfying the requirements of the present without compromising the ability of future generations to fulfill their wants. The core principle of sustainable development is to enhance human welfare, and to preserve these improvements over time. This implies assessing materials while being responsive to environmental concerns, societal desires, and economic viability. Rosemont Copper Mining Company plans to meet these criteria during its operations.

Since use of materials and resources determines that the needs of tomorrow are not jeopardized, this is of importance to the copper industry. Future demand for copper will continue to be met with the discovery and mining of new deposits, technological enhancements in the extraction of the metal, and efficient design and manufacture of products made from it. The rehabilitated employment of copper by reuse and recycling is critical in this regard.

National Security

Copper is a very valuable commodity in the economies of both developing and advanced nations. The extraction, processing, manufacture of goods from, and recycling of, the metal creates employment opportunities and wealth for the country. Its use in the building of infrastructure, especially the power sector, is critical to the living standard of all countries.

The metal is directly required in many defense industries, ranging from ordnance, to ships, to airplanes. A Triton-class submarine requires 100 tons of copper, a space shuttle uses 5 tons, and an airplane may have 4.5 tons. The need for electronics for the sophisticated weapons being used today is crucial. Disruptions to foreign supplies can occur because of a number of reasons. Geopolitical situations can change dramatically in short order. Relying on foreign sources is not good policy.

Rosemont Copper will be an asset to the community and the nation. It is manifest that production of copper will fulfill the need for the metal, which will become more difficult and expensive to get. The needs of developing countries will be immense. Copper is a strategic material necessary for our standard of living and for defense purposes. Working towards becoming self-reliant is a goal that we must strive for; Rosemont helps to achieve that target.

STUDY OF MINERAL PRODUCTION WITH REFERENCE TO THE ROSEMONT COPPER PROJECT

1.0 IMPORTANCE OF MINING

Mineral production, and more specifically mining, entails the extraction of valuable minerals and geologic materials from the earth for the benefit of mankind. The term "earth" as used here includes the atmosphere, earth's surface, lithosphere (formations underlying the earth's surface), and hydrosphere (oceans). The minerals mined may be solid (e.g. ore, aggregate, coal), liquid (e.g. petroleum, mineral-bearing brines), or gaseous (e.g. helium, natural gas).

As homo sapiens have evolved through the Stone Age, Bronze Age, Iron Age, Industrial Age, Technology Age, and currently the Information Age, they have depended on two basic industries: mining and agriculture (including forests and aquiculture). At present even agriculture is reliant on mining – for fertilizers, machinery, and nurturing forests. These two industries supply the essentials for our civilization – food, fiber and fuel, which comprise the basis for feeding, housing, and clothing humans. Improvements in the standard of living have ensued from innovating, manufacturing and developing goods and infrastructure primarily from mined materials.

The importance of minerals in our society cannot be overemphasized. Minerals are evident in every facet of our everyday living. Uses include:

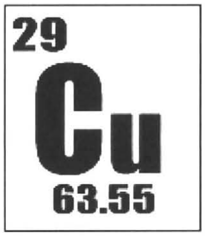
- Potash, phosphate, sulfur, and nitrates for fertilizers.
- Kitchen utensils, refrigerators, ovens, and cutlery for the foods we eat.
- Harvesters of the crops to fruit pickers and refrigerated vehicles for moving meat and produce from the farm to the grocery stores.
- Cans and bottles for packaging and the equipment required to perform these tasks.
- Clean water for drinking, washing, and household uses and the associated pumps, plumbing and piping needed to convey the water from reservoirs to the plants to the to the point of use.
- Clothing from natural fibers such as cotton and wool require fertilizers and feed; synthetic textiles are made from coal, petroleum, salt, and other mined substances.
- Homes, office buildings, entertainment centers, and factories are made of gypsum board, concrete, brick, glass, metals, and the paints used; piped fluids to these structures are all mineral-based.
- Power generation from oil, gas, coal or nuclear fuel, and the associated machinery and distribution equipment.
- Transportation by automobile, truck, trailer, rail, ship, or plane requires roads, airports, docks, rail-tracks – all from metals and other minerals.
- Specialty alloys and sophisticated equipment are seen in doctors' offices, clinics, and hospitals to provide for our health and safety.
- Telephones, telegraphs, televisions, cell phones, and radios are critical to communications, and composed of numerous materials from the earth.

Just as DNA is the building blocks of life, minerals are the building blocks of our way of life – our civilization!

One of the metals used in many of the applications listed above is copper. This is critical to our society and is the main subject of discussion of this report.

2.0 SOCIETAL BENEFITS AND COSTS

2.1 Uses of Copper



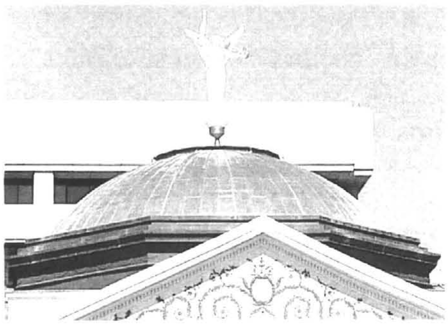
Copper has been used by humans for more than 10,000 years. A pendant made of the metal was discovered recently in northern Iraq dating back to 8,700 BC.

Today electrical uses are the most common. Since copper is the best non-precious metal conductor of electricity and heat it is commonly used in electrical goods and heat-conducting articles. It is also malleable and ductile and readily made into various shapes and drawn into thin wires. Copper is necessary to the production of wire, power cables, electromagnetic motors, generators, transformers and other electrical machinery, relays, busbars, switches, electromagnets, printed circuit boards, lead-free solder when alloyed with tin, magnetrons for microwave ovens, vacuum tubes and cathode ray tubes, integrated circuits, and wave guides for microwave radiation. Oxygen-free copper and oxygen-free high thermal conductivity copper are used in plasma deposition processes such as in the manufacture of semiconductors and superconductor components, and in high vacuum devices for particle accelerators. Some audio equipment use oxygen-free copper since it possibly improves low-frequency signal transmission.

Use of copper in electronic and communications is significant. DSL (Digital Subscriber Line) technology permits high-speed data transmission. Existing telephone lines can be used for internet service. Wide and local area networks (WANs and LANs), mobile phones, and personal computers use the metal or its alloys. Now "copper chips" in microprocessor and silicon chip circuits permit better energy efficiency and higher speeds. It is used in heat sinks for computers and transistors.

Copper is used for water pipes in buildings and in refrigeration and air-conditioning units because of its ease of soldering and manufacture. In plumbing pipes and fixtures, copper pipes prevent the spread of bacteria and do not emit toxic fumes in the case of fire in buildings. Use of copper in sprinkler systems makes them safer.

Transportation depends on copper in many forms. It is used in automobiles for motors, wiring, connectors, radiators, brakes, and bearings. Use of copper-nickel alloys in ship hulls decreases biofouling (inhibiting the growth of barnacles and mussels) and reduces drag resulting in enhanced fuel efficiency. Copper is used in vessels, tanks, propellers, pipes exposed to sea water, oil platforms, and power stations located on the coasts. The metal is also used in the manufacture of trains, airplanes, and space ships.



The use of copper in architecture and construction is familiar. In Arizona, the copper dome on the Capitol Building in Phoenix is recognized for the State's predominance in producing the metal. However, copper roofing of buildings is fairly common. The green-colored patina (copper carbonate) or verdigris is seen throughout the world. It is used in making statuary; the Statue of Liberty is doubtless the most famous, probably made of copper from a French-owned mine in Norway.

In Europe copper has been used for building since the Middle Ages; probably the oldest copper roof is on the cathedral in Hildesheim, Germany, built in the thirteenth century. Present European practice involves installing copper roofs as seamed-cladding, shingle-cladding, slots-in panels, and cassettes. The selection depends on the aesthetics and geometry. Copper cladding is durable, lightweight, and 100% recyclable at the end of building life.

Copper wires are sometimes used over non-conductive roofs to prevent growth of moss. It is used in electroplating as a base for other metals such as nickel. As a powder it is a Class D Fire Extinguisher to put out lithium fires by covering the metal and acting as a heat sink.

The biostatic properties of copper make it advantageous for use in hospitals and on ships it provides a similar service by inhibiting the growth of barnacles and mussels. In textile fabrics it serves as an antimicrobial protective.

2.2 Copper Alloys

There are over 400 alloys of copper that are in use at present. Brass, an alloy of copper and zinc, is commonly used in decorative articles because it is corrosion resistant, harder, stronger, and has a bright gold color. Door knobs, plumbing fixtures, hand rails, and items used by the public are often made of brass because of its anti-bacterial properties. Bronze consists of copper, tin, aluminum, silicon and beryllium.

Monel is a registered alloy of copper and nickel with some iron and other trace elements. Because of its corrosion resistant properties it is widely used in marine applications, such as piping systems, pump shafts, trolling wire and trainer baskets. A few of these alloys are non-magnetic, so they are used for anchor cable on minesweepers, and for housings for magnetic-field measuring instruments, and in the oil industry, especially for directional drilling collars. In recreational boats Monel is used for fuel and water tanks, propeller shafts, keel bolts, other underwater applications, and to seize shackles for anchor rodes. Superior tubas, French-horn rotors, and trumpets use Monel for valve pistons. There are a number of miscellaneous uses. Copper is used in weaponry of various types. Some uses in ordnance are listed in Appendix A.

2.3 Copper Compounds

Copper is commonly used in compounds, some of which have been referred to above. Copper sulfate is used as a fungicide to control algae in lakes and ponds and as an agricultural poison. It is used in water purification and in compounds for sugar detection. Copper compounds are used as a preservative for wood.

In chemistry it is employed as Fehling's solution among numerous other compounds. It is found in ceramic glazes and colored glasses.

A complex containing radioactive copper-62, copper-62-PTSM, is used as a positron emission tomography radiotracer for heart blood flow measurements. Copper-64 can also be used in a similar manner for medical imaging; when complexed with a chelate it can be used to treat cancer through radiation therapy.

2.4 Specific Examples of Copper Usage

Some statistics about copper usage are presented here.

There are 440 lbs of copper in an average American home, which are distributed as follows:

Building wire	195 lbs
Plumbing tube, fittings and valves	151 lbs
Plumbers' brass goods	24 lbs
Built-in appliances	48 lbs
Builders' hardware	12 lbs
Other wire and tubing	10 lbs

If the home is of multi-family construction it has approximately 280 lbs of copper.

Home buyers today expect the homes to be equipped for multiple phone lines, internet service, video distribution, other entertainment services, data and security services, facsimile (fax) machines, and several other accessories. Category 5 (Ethernet) cables are now standard and consist of 4 pairs of 24-gauge wire twisted together and can accommodate 100 megahertz (MHz) bandwidth. Category 6 cables carry data streams of 250 MHz at the rate of 1 gigabyte/second (that is the equivalent of 50,000 pages of text per second). Category 6a is Augmented Category 6 and can be used for 500-MHz data.

Common household appliances contain the following amounts of copper:

Unitary air conditioner	52 lbs
Unitary heat pump	48 lbs
Dishwasher	5.0 lbs
Refrigerator /freezer	4.8 lbs
Clothes washer	4.4 lbs
Dehumidifier	2.7 lbs
Disposer	2.3 lbs
Clothes dryer	2.0 lbs
Range	1.3 lbs

Other commonly identified items use copper, such as

Motorized farm vehicle	63 lbs
Construction vehicle	66 lbs
Diesel-electric railroad locomotive	12,000 lbs (6 tons)
Boeing 747-200	9,000 lbs (includes 632,000 ft of wire)
Triton-class submarine	200,000 lbs (100 tons), primarily in electric generation and storage
Space shuttle	10,000 lbs (5 tons)

2.5 Future Use – Helping Us Live "Green" and Other Benefits

With the increased emphasis on green technologies the amount of copper used will increase markedly. A conventional 800-megawatt (Mw) generation station, including distribution, uses 100 tons of copper. An equivalent wind farm would use 106 turbines, 7.5-Mw each, but require 1,200 tons of copper; a ratio of 12:1.

A conventional car has between 15 and 75 lbs of copper. The hybrid electric may have 70 to 75 lbs more, including: HV wiring 15 lbs, Lithium ion battery 15 lbs, converter/rectifier 5 lbs, electric motor 27 lbs, and electric converter 7 lbs.

Standard office buildings have 0.55 lbs of copper/ sq ft; green buildings use 0.72 to 1.23 lbs/sq ft of area. This may entail such technologies as grey water recycling, heat recovery, thermal solar, individual room climate and light control, and such amenities.

A single Vesta V90 wind turbine that generates 3 Mw of power requires 9,400 lbs of copper.

Copper also provides key health benefits, including the nervous, cardiovascular and skeletal systems. Some of these are mentioned in Appendix B.

2.6 Balance of Payments

The United States consumed 2,090,000 metric tons (mt) of copper in 2008, of which 690,000 mt was imported. The average price of copper during the year was $3.24/lb. Therefore the amount paid for the imported copper was $4.92 billion. If more copper had been mined in the U.S., this would have reduced the balance of payments by this amount. The total payment deficit for the country was $6.73 trillion.

Copper mined in the U.S. in 2008 was 1,310,000 metric tons. This implies a value of $9.34 billion. Arizona's mine production was 830,000 metric tons valued at $5.93 billion. This is 63.3% of the copper mined in the country.

The Gross Domestic Product for Arizona for 2007 was $247 billion; the contribution of mining (including oil and gas) and its supporting industries was 4.5 billion, i.e. 1.8%. This compares with $2.3 billion for agriculture (including fishing and hunting) i.e. 0.9%, and $8.3 billion for accommodations and food services, i.e. 3.3%. It should be borne in mind that this includes all food and accommodations, including those for gem and mineral shows, people visiting for business purposes and meetings, local inhabitants going out for weekend dinners or Sunday brunches, office workers getting lunch, and fast-food franchise sales. The Department of Tourism claims that $19.3 billion was spent in Arizona in FY 2008, i.e. July 2007 through June 2008. The total tourism expenditures in Pima County are given as $2.2 billion.

2.7 Copper Demand and Supply

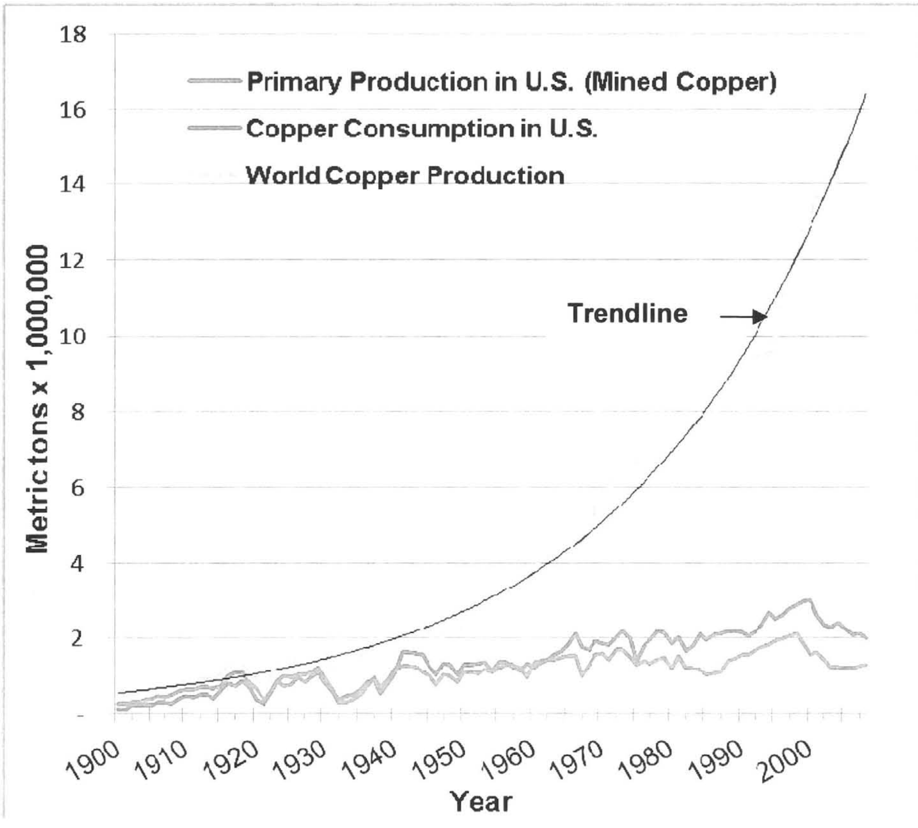
The world demand for copper is around 15 million tons annually. This is expected to increase by about 575,000 tons a year, and may be higher in future years. It is predicted that the demand will outstrip supply in the next couple of decades.

China's imports in 2008 were 4.9 million mt; in 2009 these are expected to be 5.2 million mt and in 2010 around 5.8 million mt. About 40% to 50% of the copper used in China is for the power sector. In 2008 China required 2.2 million mt of copper in 2008, and it is projected that this will increase to 2.35 million mt in 2009 and to 2.6 million mt in 2010. China accounts for over 22% of the world demand for the metal.

In India the use of copper is expected to increase at a rate of 10% compared to the world average of 4.56%. This is primarily due the increased electrification of the country, although the number of automobiles and other motorized vehicles is also escalating. The per capita consumption of copper in India is 0.4 kg compared with 2.6 kg for China and 15 kg for the western countries. As other developing countries build new infrastructure and power generation facilities, the amount of copper that will be required will increase dramatically.

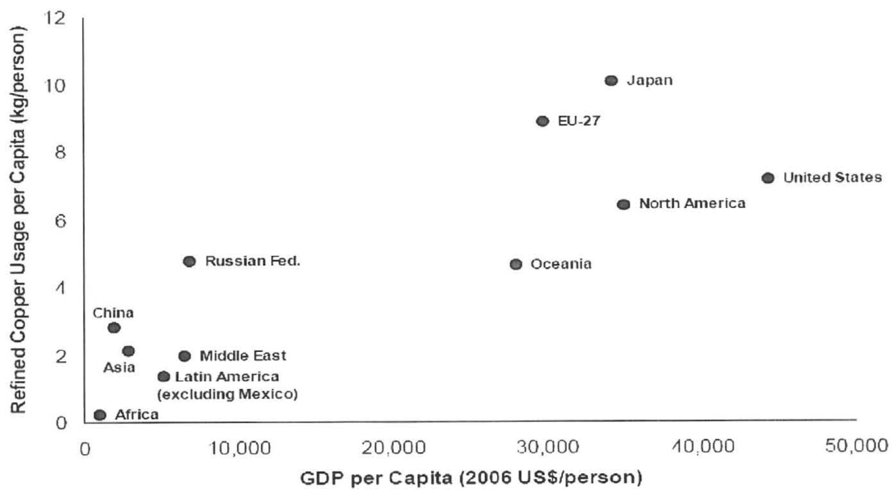
There have been 56 copper discoveries made in the last three decades; the rate of discoveries peaked in 1996. Of the 28 largest mines, 21 are not capable of expansion; many of these will be exhausted between 2010 and 2015. The consumption rate of copper is equivalent to the depletion of 3 mines being depleted every year. It has been estimated that copper may run out in 25 years, assuming a growth rate in usage of 2% per year.

Although copper has been used for 10,000 years over 95% of it has been mined since 1900. The growth has been exponential.



Primary Production and Consumption of Copper in the United States Compared to World Production
(Data Source: U.S. Geological Survey)

Economic and societal factors affect the production of copper. When the demand decreases because of a global slump or other reasons, mining of the metal is scaled back, and some mines close. Any planned expansions are delayed or cancelled. Mines that are low-cost producers can remain in operation. When the requirements for the product rise, the mines start up again or increase production.



Intensity of Refined Copper Use for 2006 (Courtesy of the International Copper Study Group)

The intensity of use relates the consumption of copper to the economic activity, that is, the Gross Domestic Product (GDP). It is evident that as the GDP of the developing countries increases, the demand for infrastructure will increase and larger quantities of copper will be required.

2.8 Regional Benefits

Pima and Santa Cruz Counties have a rich tradition of mining. The early Spanish explorers came to the region not for the love of adventure, but because the mineral laws at the time permitted them to keep some of the gains of their efforts. Several expeditions were conducted looking for Cibola, the legendary seven cities of gold. These were fabled to be in what is currently Arizona.

The mineral deposits of Ajo were discovered in 1750 by prospectors from the missions. Similarly mining was conducted at Quijotoa and Aribac (Arivaca) in the 1770s and perhaps considerably later. There is evidence that 20 mines in Arivaca were transferred to Americans in 1856. Peter R. Brady formed the Arizona Mining and Trading Company in 1854 to mine at Ajo; this was probably the first American mining company in Arizona. Charles D. Poston found silver in the Santa Rita and Cerro Colorado Mountains. He, along with some associates, located claims for the Salero, Heintzelman and Arenia mines in February 1857. Records show eight other claims from the time of the Gadsden Purchase up to 1862.

Currently there are four major copper mining operations in Pima County, although one is inactive. For 2008 these are, with their production figures:

Mission	153.0 million lbs
Sierrita	188.0 million lbs
Silver Bell	47.5 million lbs
Ajo	(inactive)

These produced 388.5 million lbs of copper in 2008, which is valued at $1.26 billion. In addition Rosemont has spent $20.4 million in the region conducting exploration and feasibility studies in that year. Rosemont Copper plans to produce 250 million lbs of copper per year, which would be worth

$810 million, if valued at the same price as above. In addition Rosemont will produce 8 million lbs of molybdenum and 3 million ounces of silver.

The mining activity in the area and the tradition of mining is responsible for several mining companies being headquartered in the Tucson area even though many of these do not have mining operations in southern Arizona. These include ASARCO, LLC, IMDEX, Inc., Liberty Star, lixusgold.com., Loren International, LLC, North Star International, Oracle Ridge Mine, Rosemont Copper Mining Company, VANE Ltd. This is not intended to be a complete listing.

There are nearly 20 mining consulting companies located in the region. Much of the work they perform is not necessarily for mines in Pima or Santa Cruz Counties, but all over the world. However, their personnel are located here and so the taxes are paid to the local governments.

Several mine contractors and suppliers are also located in the area. These also contribute to the local tax base.

In addition to the copper mines there are a number of aggregate and sand-and-gravel companies located in the area. A significant operation is the Arizona Portland Cement Plant in Rillito, AZ. A few major cement and concrete distributors are sited here.

A number of mineral specimen dealers are found in Tucson. The history of mining has helped locate the Tucson Gem and Mineral Show in the city. This event creates an economic activity of about $80 million within a three-week period.

All of the activities above employ personnel, creating jobs for the community. The personal income in Pima County for 2006 for mining was $134.6 million. The average annual wages in the mining industry in 2007 was $55,600 compared to $38,200 for all workers in the Tucson Metropolitan Statistical Area. In Pima County the per capita income in 2007 was $31,755.

2.8.1 Regional Benefits due to the Rosemont Project

The regional benefits are discussed in greater detail in the Economic Impacts Report prepared by the Seidman Research Institute of the Arizona State University that is part of this document. This covers Pima and Santa Cruz Counties; the major benefits accruing to Pima County. Briefly, the construction phase of the contract will generate $82 million of activity, and provide 2,570 person-years of employment during this period. Wages and salaries for non-labor personnel will be $29.5 million per annum. Local governments will receive $3.6 million per year during this phase. The impacts will be $328 million in additional goods and services, $191 million in the gross regional product (GRP), $118 million in personal income, and $14.6 million in local government revenues.

During the production and post-production phases there will be $745 million in economic activity over the 20-year production period. The employment in the mine and mill will average 406 workers with a peak of 444. It will also support an average of about 1,600 jobs, giving a total of 2,000. Wages, salaries and non-labor income will average $119 million per annum and contribution to local governments will be an additional $14 million annually. Over the life of the production and post-production phases the region will gain $15.7 billion in output, $9.6 billion in GRP, $2.6 billion in personal income, and $306 million in local government revenues. The total revenues for government will be higher since just the severance tax alone will exceed $100 million. There will be an increase in the economic activity of the area even after production at the mine has ceased. Even after five years in this post-production period the activity in the area will be greater by $75 million and residents' income will higher by $37 million than if the Rosemont Mine is not allowed to operate.

The need for copper is enormous and since the United States is an importer of the metal, the contribution that Rosemont Copper Mine may make in the future should be valuable, both to the State and the region.

3.0 TECHNOLOGICAL IMPROVEMENTS

Better technology helps to keep mines more competitive with operations that are not as progressive. This is especially pertinent in the global minerals market, where some countries do not enforce strict environmental rules and where labor is cheaper.

The basic method of mining copper is presented in Appendix C.

Although the mining process seems simple in concept, modern mining is quite sophisticated. It is beyond the scope of this document to discuss all new technologies that have been forwarded in recent years. Innovations and improvements in mining may be divided into various activities, and a few examples are presented in the Appendix D.

3.1 Water Conservation

Water is a scarce resource in all desert locations, and Arizona is not any different. A detailed study of methods of conserving water is beyond the scope of this study. However, a few areas where water usage may be reduced are listed below:

- Automatic control of the thickening system
- Permanent supervision of consumption
- Recirculation of waters from tailing dams and dumps
- Bioremediation treatment of contaminated effluents
- Leaching system drainage control
- Drip application systems for leach solutions
- Filtering of tailings
- Optimization of mine consumables
- Extreme thickening
- Dry grinding and pneumatic centrifuge
- Extraction of the remaining water in the tailing dam
- Use of drainage pipes
- Surface reservoirs for floods
- Underground reservoirs for flooding
- Transregional aqueduct
- Exploration of water resources

The Rosemont Copper Project is planning to have dry tailings, use drip emitters, and is already recharging water from the Central Arizona Project into the Tucson Active Management Area where it has permits to withdraw water.

Rosemont plans to employ the best available technology and have a state-of-the-art facility.

4.0 CULTURAL RESOURCES

The cultural history of southern Arizona and Pima County extends back nearly 12,000 years. The life of the hunter-gatherers and early agriculture in the region extended for about 10,200 years. The first Spanish explorers (Fray Marcos de Niza) passed through in the region now constituting Pima County in 1539. In 1820 the European population of Pima County was only 395. Now the total population has grown to over one million.

Pima County contains parts of the Tohono O'odham Nation, as well as all of the San Xavier Indian Reservation, Organ Pipe Cactus National Monument, Ironwood Forest National Monument and Saguaro National Park.

Mining has been an integral part of Arizona's history and culture. The Rosemont deposit and the area surrounding it is not pristine property. In the 1870s a large amount of timber was obtained from the Santa Rita Mountains. There has been mining in the vicinity for over a century, as is evident from the number of small holes in the mountainside and the slag pile that is very visible.

A full description of cultural resources is in Appendix E.

5.0 SUSTAINABILITY

Sustainability may be defined as satisfying the requirements of the present without compromising the ability of future generations to fulfill their wants. In other words, the core principle of sustainable development is to enhance human welfare, and to preserve these improvements over time. This implies assessing materials while being responsive to environmental concerns, societal desires, and economic viability.

Copper meets these criteria in the following manner:

- Copper is 100% recyclable and does not change in any of its properties in the process. The metal has been recycled for 10,000 years.
- Tubing manufacturers use 50% recycled copper and 42% of all the copper used in Europe is from recycled material.
- Recycling uses 15% of the energy that is required for primary production of the metal. This means that less energy is being used; conserving fuels and emitting less carbon into the atmosphere.
- The use of copper in electric motors and other equipment reduces the amount of heat loss and makes them more efficient in operation. This insinuates that less greenhouse gases are produced.
- Copper is the preferred material in the generation of renewable energy.

Since the manner of use of materials and resources determines that the needs of tomorrow are not jeopardized, this is of importance to the copper industry. Future demand for copper will continue to be met with the discovery and mining of new deposits, technological enhancements in the extraction of the metal, and efficient design and manufacture of products made from it. The rehabilitated employment of copper by reuse and recycling is helpful in this regard.

As is evident from the discussion above, copper is a very valuable commodity in the economies of both developing and advanced nations. The extraction, processing, manufacture of goods from, and recycling of, the metal creates employment opportunities and wealth for the country. Its use in the building of infrastructure, especially the power sector, is critical to the living standard of all countries.

A schematic in the Appendix F illustrates the flow for recycling.

6.0 CLOSURE

Rosemont Copper will be an asset to the community and the nation. It is manifest that production of copper will fulfill the need for the metal, which will become more difficult and expensive to get. The needs of China and the developing countries will be immense. Copper is a strategic material that is necessary for our standard of living and for defense purposes. National and homeland security details are in Appendix G and information about the U.S. National Defense Stockpile is in Appendix H.

Working towards becoming self-reliant is a goal that we must strive for; Rosemont helps to achieve that target.

APPENDIX A

USE OF COPPER ALLOYS IN MILITARY USES (ORDNANCE)

Use	Alloy	Properties for Selection
Small Arm Ammunition: Primer Caps, Bullet Jackets	C21000	Corrosion Resistance, Formability, Moderate Strength, Stress Corrosion, Cracking Resistance
Ammunition	C26000	Formability
Gun Sights	C38500	Corrosion Resistance, Durability, Architecture, Wear Resistance
Missile Components	C46400	Corrosion Resistance, Strength
Artillery Projectile Rotating Bands, Welded	C18900	Corrosion Resistance, Galling Resistance, High Strength, Weldability
Fuse Caps	C21000	Corrosion Resistance, Formability, Moderate Strength, Plateable
Ammunition Cartridge Cases	C26000	Corrosion Resistance, Deep Drawing Capability, Moderate Strength
Drawn Shells	C34000	Corrosion Resistance, Ductility, Machinability, Moderate Strength
Blending Chambers	C60800	Corrosion Resistance, Moderate Strength, Non-Sparking
	C61300	Formability, High Strength, Non-Sparking
	C61400	Corrosion Resistance, High Strength,Non-Sparking
Primers	C21000	Corrosion Resistance, Formability, Moderate Strength
	C33000	Corrosion Resistance, Ductility, Formability, Machinability, Moderate Strength
	C33100	Corrosion Resistance, Ductility, Formability, Machinability, Moderate Strength
	C33200	Corrosion Resistance, Ductility, Formability, Machinability, Moderate Strength
Firing Pins	C17200	Corrosion Resistance, Very High Strength
	C17300	Corrosion Resistance, Very High Strength
Rotating Bands	C22000	Corrosion Resistance, Formability, Moderate Strength
Mixing Troughs	C60800	Corrosion Resistance, Corrosion Resistance to Numerous Environments, Corrosion Resistance to Non-Oxidizing Acids, Moderate Strength, Non-Sparking
	C61300	Corrosion Resistance, Formability, High Strength, Non-Sparking, Weldability
	C61400	Corrosion Resistance, High Strength, Non-Sparking
Bullet Jackets	C21000	Corrosion Resistance, Formability, Moderate Strength
Mechanical Housings for Lighters	C26000	Corrosion Resistance, Drawability, Low Tool and Maintenance Costs, Moderate Strength, Plateable
Government Fittings	C95400	Corrosion Resistance (Excellent), Excellent Machinability, High Strength, Wear Resistance
	C95500	Corrosion Resistance (Excellent), High Strength, Toughness
Ordnance Parts	C82500	Corrosion Resistance, Ductility, Very High Strength
Shells, High Strength	C69000	Corrosion Resistance, Ductility, Formability, High Strength
Primer Caps	C22000	Corrosion Resistance, Formability, Moderate Strength
Shells – Mechanical Housings for Ammunition	C26000	Corrosion Resistance, Drawability, Low Tool and Maintenance Costs, Moderate Strength, Plateable
Ammunition Components	C26100	Corrosion Resistance, Formability, High Modulus of Elasticity, Moderate Strength
	C26130	Corrosion Resistance, Formability, Moderate Strength
	C26200	High Modulus of Elasticity, Moderate Strength
Small Arms Cartridges	C22000	Corrosion Resistance, Formability, Moderate Strength
Firing Pin Support Shells	C21000	Corrosion Resistance, Formability, Moderate Strength
Artillery Projectile Rotating Band, Press Fit	C22000	Corrosion Resistance, Galling Resistance
Gun Mounts,	C86200	Appearance, Corrosion Resistance, Moderate Strength, Wear Resistance
Gun Mountings	C95200	Corrosion Resistance (Excellent), High Strength, Wear Resistance
Gun Slides	C95200	Corrosion Resistance (Excellent), High Strength, Wear Resistance

APPENDIX B
HEALTH BENEFITS

Brazil nuts	2.3
Almonds	1.4
Hazelnuts	1.3
Walnuts	1.3
Pecans	1.3
Split peas, dry	1.2
Buckwheat	0.8
Peanuts	0.8
Sunflower oil	0.5
Butter	0.4
Rye grain	0.4
Barley	0.4
Olive oil	0.3
Carrot	0.3
Coconut	0.3
Garlic	0.3
Millet	0.2
Whole wheat	0.2
Corn oil	0.2
Ginger root	0.2
Molasses	0.2
Turnips	0.2
Green peas	0.1
Papaya	0.1
Apple	0.1

The activity of some human enzymes is improved by trace amounts of copper. It is beneficial to the nervous system (including the brain), the cardiovascular system (heart, arteries, and blood vessels) and the skeletal system. The highest concentrations are found in the brain and liver. Approximately half the copper occurs in the muscles and bones of the human body.

Anemia is often treated with copper because along with iron it develops the hemoglobin in the red blood cells. It may be a preventative for cancer. Some people believe in wearing copper bracelets since it has an anti-inflammatory effect on arthritis, by absorption through the skin.

Deficiency of copper manifests itself as general weakness, skin sores, elevated LDL and reduced HDL cholesterol, decreased immune function, and poor respiration. The cardiovascular system is affected because the heart and arteries are damaged, resulting in high blood pressure and abnormal cardiograms.

Copper (in milligrams) contained in a 100-gram (3.5-oz) serving of specific foods – nuts, grains, vegetables, fruits, etc.

APPENDIX C
COPPER MINING METHODS

General Mining Practice

Modern mining of most metals, including copper, involves prospecting for the ore body, performing an analysis as whether the mine would be profitable, obtaining the requisite permits from the appropriate government agencies, extracting the ore and processing it, and finally reclaiming the disturbed land. Since the nature of mining causes some environmental impact, both during the mining operations and perhaps after closure, regulations have been promulgated to moderate any negative effects. Particular attention is paid to safety; modern practices have markedly improved safety in mines. Current mining procedures make mining both safe and profitable, with modest negative impact to the environment.

Copper may be mined from underground mines or by open pit, depending on a number of factors. In Arizona all copper mining at the present time is by open pit. The last underground mine, San Manuel, was closed in 1996. In the future, Resolution Copper Mining Company is planning an underground operation at a depth of 7,000 feet.

Surface mining entails stripping the surface of vegetation and topsoil, which is generally stored for later use in reclamation. The ore is then excavated by drilling and blasting. This ore is crushed and ground, as required. Since the copper content in Arizona ores is generally less than 1% and sulfide in nature, it is then slurried with water. Chemical reagents, called frothing agents, are added and air blown through the system. This causes the copper particles to attach to the air bubbles and float to the surface. These are then skimmed off and the tailings sent to ponds. The water is recovered and recycled.

Sulfide minerals are generally then treated with pyrometallurgy in a process called smelting. The copper concentrates are dried and fed into a furnace. The sulfides are partially oxidized and melt. The lower layer, called matte, contains the copper and any iron in the concentrates. The impurities float to the top layer and are discarded as slag. The sulfur dioxide is collected and converted into sulfuric acid. The slag may be used as ballast or for sand-blasting grit. The matte is put into a converter, a vessel in which air, lime and silica are added. Sometimes scrap copper may be another ingredient. More sulfur dioxide may be collected here for making sulfuric acid. "Blister copper" is produced at this stage, which is then "fire refined." In this stage air and natural gas are blown through the copper to remove any residual sulfur and the oxygen. Anodes are made from the copper and placed in an electrolytic cell for further refining. This results in copper that is over 99% pure. Anode slime sinks to the cell bottom and is removed.

Oxide ore or oxidized copper wastes are subjected to hydrometallurgical processing. This entails placing the ore on heaps on specially lined areas and sprinkled with sulfuric acid to form a copper sulfate solution, termed "solvent extraction" (SX). The copper is leached out and the "pregnant" solution is collected and introduced into electrolytic cells along sometimes with an organic solution to aid the process. This "electrowinning" (EW) results in the copper being deposited on cathodes, again 99+% pure. The copper sheets are stripped off the cathode plates.

The copper from both these above processes are either sold as such or made into rods at the site. Any remaining organics are recycled. All sulfuric fumes or gases are fixed to meet the Clean Air Act of 1970 (as amended) standards. If the sulfur gases are over 4% these are made into sulfuric acid or sulfur compounds for use in agriculture. Slurries with lower sulfur and containing contaminants such as cadmium, lead, arsenic, and other metals are disposed as hazardous wastes under the regulations of the Resource Conservation and Recovery Act (RCRA) of 1976 as amended.

All pollutants from the mining and processing of copper are dealt with appropriately to meet or exceed all applicable environmental requirements. Particulate emissions are either allayed with the use of water, with or without surfactants depending on conditions. In processing these are captured using baghouses or other means. Sulfur dioxide is generally removed with electrostatic precipitators. Most of the water is reused with some refinement, if necessary. Liquid waste is treated to meet federal and state laws before being discharged.

Prior to closure, all mines reclaim the land that has been used, restoring it to its original condition or better. Many mines now perform concurrent reclamation to expose as little mined land as possible; this also helps to reduce the amount of bond being held by the government agencies involved.

Leaching

Leaching is the process by which ore is usually crushed, and often agglomerated, and stacked on a leach pad (which is a prepared containment system). This is leached with a solvent to extract as much of the metal as possible. The ore is placed in lifts (layers), generally less than 10 m thick. Copper ores are leached with sulfuric acid, although lixiviants such as ammonia have been experimented with. Copper oxides dissolve readily. Secondary sulfide ores (formed after supergene enrichment) sometimes require bioleaching and dissolution – the bioleaching makes the copper available to acid leaching. The bacteria occur naturally and spread quickly. To start a new bioleach, just transfer some ore from the old pad to the new. Chalcocite is more readily leached than chalcopyrite, the latter requires a more complex bioleach. The project is more successful if base-metal sulfide is not highly refractory.

There are over 200 leach projects since the 1970s; so the technology is well established. The size of the heap has increased from average of 10,000 m^2 with lined area of 3 million m^2 to heaps of 4 million m^2 with lined areas of 60 million m^2. Stacker-reclaimers have improved, as has understanding of geotechnical, hydrological, & metallurgical aspects of ore behavior. The sizes are increasing in both height and area. Heights are reaching 200 m – depending on topography and ore type. The weight of large heaps is a factor as regards pressure on the base. Heap leaches can be designed for high altitudes and cold weather conditions.

Copper leaches need sulfuric acid of the necessary strength; sometimes ferric iron is added to assist the leaching process. The pregnant solution flows to a pond by gravity and then is pumped to the SX/EW facility. Typically ore is crushed in two or three stages. Then, if required, it may be agglomerated (i.e. mixed in a drum with an acid and other material). Agglomeration adds cost, but improves initial recovery, percolation, and geotechnical performance. The agglomerates "cure" for a few days before being stacked. Heap leach may be used as stand alone or with other treatment circuits. Some projects may have both "heap" and "dump" leach circuits; the dump leach preconditions the liquor before used in the heap.

There are a number of developments in the heap leach process. The On-Off Pads or Dynamic Heaps refers to a design where a single lift (usually 7 m for copper) is stacked on a pad and leached to optimum recovery of metal. The leached ore is then rinsed or neutralized and removed for disposal in a dump. This material may then be re-leached for secondary recovery; generally for sulfide ores. The on-off pad is then loaded with another charge and the cycle repeated. Another development is that some on-off operations may be designed as a "racetrack."

Other improvements have been with geomembranes [where now low-density polyethylene (LLDPE) has replaced PVC (polyvinyl chloride) and HDPE (high density polyethylene)], and in stacker-reclaimer systems. There are a number of design factors that are considered during the design of the geomembrane liners and the stackers.

APPENDIX D
EXPLORATION AND TECHNOLOGY

Exploration

Exploration methods are continually being improved, but drilling finally confirms any geophysical methods used.

VTEM (Versatile Time-domain Electro-Magnetic) survey system has been used successfully on a number of projects. The method provides deep penetration, high spatial resolution, good resistivity discrimination, and detects weak anomalies. The system is provided by Geotech Ltd.

Deep Earth Imaging is designed to meet the various requirements of the mining industry. It measures resistivity (DC), chargeability (IP), and magnetotelluric resistivity (MT). The Titan 24 Distributed Acquisition System by Quantec Geoscience measures depths up to 750 meters with IP and 1.5 kilometer with MT. This, along with the accompanying digital signal processing system, provides good subsurface information about the geologic structure and the mineral deposits present.

A large number of geological systems are available and are continually being improved. Drillhole-data can be analyzed and the mining method and sequence determined.

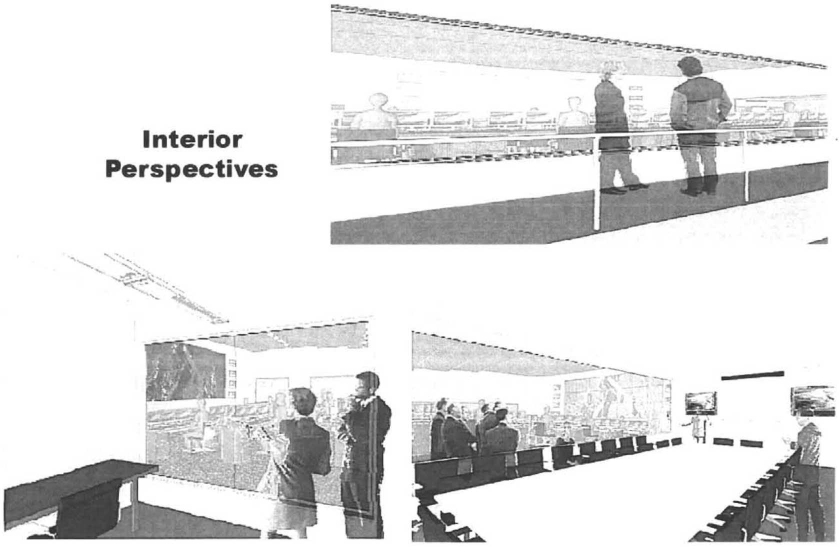
The NITON XRF Analyzer can provide a direct analysis of the core without sample preparation.

Personnel Training

Several simulators are now on the market to train equipment operators, without having to allocate expensive equipment, e.g. Similog has off-highway truck simulators for truck operators.

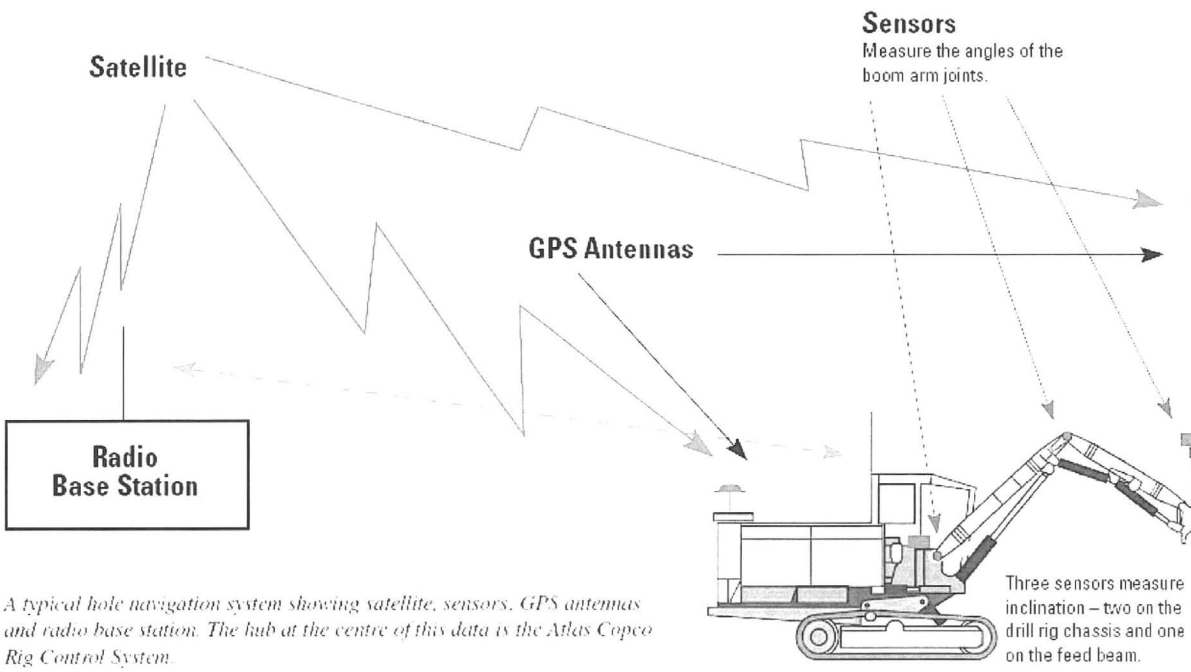
Management of Equipment and Operations

This encompasses the remote monitoring and control of trucks and load-haul-dump machines, such as in the Sandvik AutoMine to the control of the entire fleet, with theft deterrent, maintenance reports, and other features, as in the Caterpillar system, to the control over the entire operation as in the control rooms used in Morenci and Safford. Central controls are also used in most processing operations.



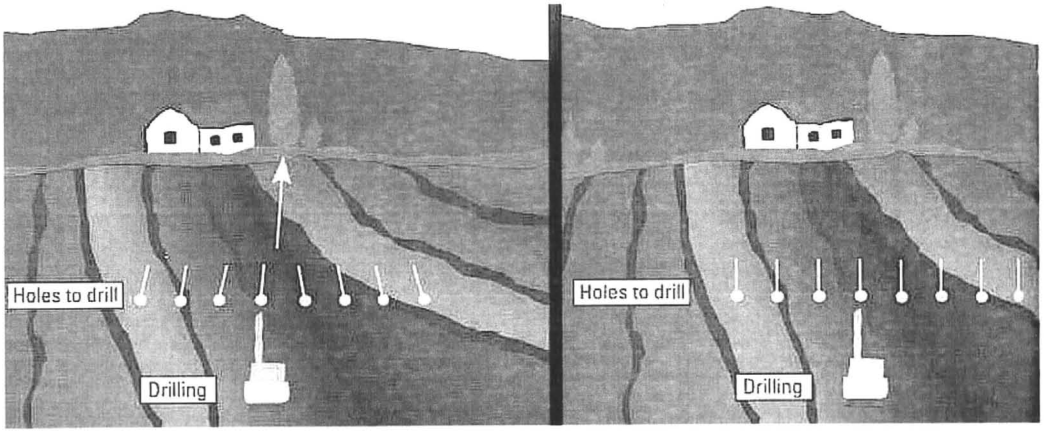
Morenci Operations Coordination Center (courtesy Freeport-McMoRan Copper & Gold, Inc.)

Drill positioning for blast holes is controlled by satellite. This ensures the exact location of the drill holes and also its verticality.



Drill Location with Global Position System (GPS) (courtesy of Mining and Construction)

This technology is also used for other mine equipment, such as shovels, scrapers, and trucks.



Note that the holes are not parallel when aligned up with a landmark, such as a tree.
Using GPS the holes are parallel; this improves blasting.
Use of Hole Navigation System (courtesy of Mining and Construction)

Mining Equipment and Accessories

Improvements in mining equipment are being made continuously. This implies metallurgical and design enhancements in crushers and grinders. With some equipment, such as in the Aubema Sizer, the reduction and classification can be performed in one operation. Drill bits and bearings for machines are being made better. The Nanosteel Company and Castolin Eutectic have collaborated to coat the teeth of shovels so that the ultra-refined crystalline structure provides wear resistance which is five (5) times better than chrome carbide or other complex carbide materials; the hardness is around 69 Rc. Liebherr is now selling 400-ton trucks; they have designed their trucks so the weight is distributed over the axles. The Ray Mine has such trucks, as shown below.

Leaching and Processing

There are a number of specialized leaching procedures developed for special conditions. Most of these are proprietary. Some (this is not all-inclusive) are listed below:

- Cuprochlor Heap Leaching
- Intec Deposition NaBr (sodium bromide)
- Outokumpu Hydrocopper
- CESL (Cominco Engineering Services, Ltd., a subsidiary of Teck Cominco Metals, Ltd.)
- Activox
- Phelps Dodge Pressure Leaching (now Freeport-McMoRan)
- Anglo American Corp/University of British Columbia (AAC/UBC) Process
- MIM(Metals Injection Molding Holdings)/Highlands Albion (Nenatech) Process
- Dynatec Process
- NSC (Nitrogen Species Catalyzed) Process

Biomining

Biomining is the processing of metal-containing ores and concentrates using (micro-) biological technology. All these processes are proprietary and have been primarily used in the extraction of gold, cobalt, and a few other metals. GEOCOAT has been used for copper and GEOLEACH may be applicable for sulfide ores.

Automation

Considerable effort is being devoted to automating equipment in mining, especially under special conditions. For example, Resolution Copper Mining Company hopes to use automated equipment underground because of the hot conditions that will be encountered at the 7,000-foot depth at which they will be operating. The equipment for this does not exist, so Rio Tinto has committed $18.3 million to the University of Sydney in Australia for research in this field. The firm expects to use the results for other ore bodies that it may develop throughout the world.

The 3D-R1 Robot has been developed by 3D Laser Mapping in Britain for surveying in dangerous environments encountered, primarily underground.

Direct reading x-ray mineral analysis instruments by several manufacturers are available for analysis of run of mine ores. These are being commonly used by non-metal mines. The advantage is that the mix can be changed if necessary without delay.

Automation helps meeting foreign competition in price because of high labor costs in the United States.

APPENDIX E
CULTURAL RESOURCES

The cultural history of southern Arizona and Pima County extends back nearly 12,000 years. The life of the hunter-gatherers and early agriculture in the region extended for about 10,200 years. This period may be divided into the Paleoindian (10,000 B.C to 8,000 B.C.), and the Archaic (8,000 B.C. to 200 A.D.) Periods. The Pre-Classic or Ceramic Period (200 A.D. to 1150 A.D.) essentially was dominated by Sonoran Desert farmers. The Hohokam lived during this period and the next. The Platform Mound Communities spanned about 3 centuries (1150 A.D. to 1450 A.D.) termed the Classic Period. During this time the Hohokam started living in village-like structures. Then the Spanish Conquistadors arrived and fashioned the life of the local inhabitants during what may be called the Spanish Arrival Period (1450 A.D. to 1700 A.D.).

The first Spanish explorers (Fray Marcos de Niza) passed through in the region now constituting Pima County in 1539. It should be remembered that the explorers were looking for Cibola or the "cities of gold." Father Eusebio Kino and Captain Juan Mateo Manje went through the area in 1631. The Spanish Colonial and Mexican Period (1700 A.D. to 1856), that followed, involved building missions, presidios, and rancherias. Initially Father Kino and the Jesuits established self-sufficient missions near the native settlements and converted the locals to Christianity. Later relations between the Indians and Europeans deteriorated culminating in the Piman Revolt in 1751. This led to the construction of defensive garrisons or "presidios." The first of these presidios was built in the area now called Tubac in 1752. This was later moved to Tucson in 1775. The interval leading to Statehood (1856 A.D. to 1912 A.D.) may be referred to as the American Territorial Period. Arizona became a state in 1912 and the era since then is the Statehood Period.

In 1820 the European population of Pima County was only 395. By 1870 this grew to 5,716; by 1900 it was 14,689; by 1950 the total population, including all races, was 141,216; in 2000 it had grown to 843,746; and now it is well over one million.

In 1864 the first Territorial Legislature created four counties in Arizona; Pima was one of them. At that time it covered all the land south of the Gila River and east of Yuma. Gradually Maricopa, Pinal, Cochise, Santa Cruz and Graham counties were carved out of it. Tucson was always the capital of Pima County.

Pima County contains parts of the Tohono O'odham Nation, as well as all of the San Xavier Indian Reservation, Organ Pipe Cactus National Monument, Ironwood Forest National Monument and Saguaro National Park.

Mining has been an integral part of Arizona's history and culture. Over 29,670 square miles of land was purchased from Mexico in 1853 for $10 million – the Gadsden Purchase. Obviously Mexico was not aware of the mineral wealth that existed in the land at the time. Most of this acquired land lies in Arizona and mining has contributed heavily to the development of the region. T. A Rickards stated that "civilization follows the flag, but the flag follows the pick." The Arizona Mining and Trading Company was established in 1854 to mine the ores at Ajo. The Sonora Exploring and Mining Company was organized in 1856 with its headquarters in Tubac. The same year the Castle Dome mine near Ft. Yuma was discovered. The San Xavier Silver Mining Company was founded in 1857. Although there may have been some gold found in the Red Hills in 1857 and later in Burro Creek, the discovery in 1858 along a two-mile stretch of the Gila River caused a stampede. In 1858 a group of soldiers stationed at Ft. Buchanan purchased the Corral Viego mine from a Mexican prospector and named it the Patagonia (later to be called the Mowry mine). The Collins silver mine was developed in the late 1850s. The Pauline Weaver prospecting party found gold on the western slope of the Dome Rock Mountains, which led to the settlement of La Paz. In 1863 the Peeples expedition found rich placers near the Antelope and Weaver Creeks, around Rich Hill. Henry Wickenberg discovered the lode deposit of the Vulture mine the same year. Meanwhile the Walker party discovered gold in Lynch Creek. The Tombstone silver mines were started by the prospecting efforts of Ed Schieffelin in 1877. The first claims in the Bisbee area were also located that year.

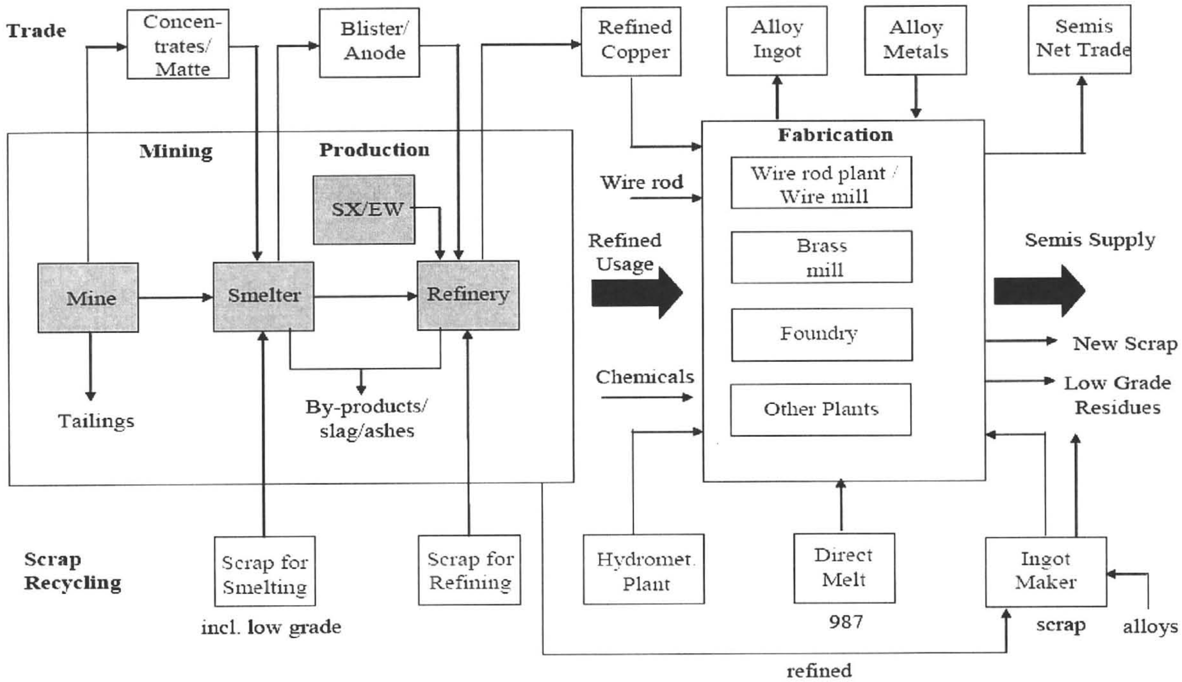
Charles Debrille Poston, known as the "father" of Arizona, was a founder of the Sonora Exploring and Mining Company and came to Arizona with the objective of forming a mining company. Herman Christian Ehrenberg was an associate and an employee of the Sonora Company. In 1856 he helped draft a petition to Congress requesting that Arizona become a separate territory (it was part of the New Mexico territory since its purchase from Mexico under the Treaty of Guadalupe-Hidalgo in 1848). After considerable effort, on December 29, 1863 Governor John N. Goodwin proclaimed the Territory of Arizona at Navajo Springs, in what is now Apache County. A census in 1864 found that there were 4,573 persons in the state, excluding Indians. Tucson had a population of 1,568. Nearly a quarter of the people at the time gave their occupation as prospector or miner. This emphasizes the role of mining in the formation of Arizona, especially the southern region.

The Rosemont deposit and the area surrounding it is not pristine property. In the 1870s a large amount of timber was obtained from the Santa Rita Mountains. There has been mining in the vicinity for over a century, as is evident from the number of small holes in the mountainside and the slag pile that is very visible. There has been prospecting there since the middle of the 19th century. The Helvetia and the Rosemont Mining Districts were established in 1880. There were two small smelters, the Columbia on the west side of the Santa Rita Mountains and the Rosemont on the east side. There was manifestly sufficient mining to support both these smelters. By the time copper production ceased in 1951, 227,300 tons of ore had been mined yielding nearly 17.3 million pounds of copper, about 1.1 million pounds of zinc, and approximately 18,000 ounces of silver. Since that time several exploration campaigns have been conducted between the Peach-Eglin and the Rosemont deposits. Lewisohn Copper Company drilled the Peach-Eglin deposit in 1955 and 1956, American Exploration Company drilled the Broadtop Butte area, and Banner Mining Company drilled the discovery hole in the Rosemont deposit in the late 1950s. In 1963 Anaconda purchased the property and performed enough drilling to categorize the Rosemont deposit as being significant. The Peach-Eglin and Broadtop Butte deposits were also expanded. In 1973 Anaconda joint ventured with Amax to form Anamax, and continued exploration drilling until 1986. By the end over 90,600 meters (297,300 feet) had been drilled by Anamax, of which 59,500 meters (195,000 feet) defined the Rosemont deposit. ASARCO acquired the property in 1988 and continued drilling the Peach-Eglin and Rosemont deposits. Engineering studies were started on Rosemont, but then the property was sold to a real estate company in 2004. This was before the acquisition of ASARCO by Grupo Mexico. Augusta Resource Corporation purchased the property in 2005, and has continued its exploration and feasibility for mining. Now it is in the process of obtaining the necessary permits for mining.

The Rosemont Copper Project team is very cognizant of the culture and other community requirements and is planning to meet or exceed them as much as possible.

APPENDIX F
COPPER RECYCLING

The following schematic produced by the International Copper Study Group (ICSG) depicts the flow for recycling of copper.



The success of recycling depends on the efficiency of scrap collection at the end of the useful life of the product. Technology, economy, societal values, government rules, and design of products control the efficiency of recycling. There are close to 150 national and international laws, regulations, directives, and guidelines that apply to the end-of-life management of copper products (such as appliances, electronic equipment, batteries, motorized vehicles, telephones, computers, and the like) which affect both producers and consumers. The following chart resulted from a study conducted by the ICSG in 2004:

Flow/Stock	European Union	Japan	United States
Copper stock in car in use	~3.0 million mt	~0.8 million mt	~3.0 million mt
Copper available for recycling in one year	250,000 mt	75,000 mt	200,000 mt
Copper collected for domestic recovery	150,000 mt	65,000 mt	190,000 mt
Copper export in used end-of-life cars	50,000 mt	10,000 mt	N/A

Rosemont Copper intends to develop a mine that fulfills sustainability criteria; it will set an example to be respected.

APPENDIX G
NATIONAL AND HOMELAND SECURITY

As is apparent from the brief history of mineral stockpiles for national security presented in Appendix H, there is considerable difficulty in managing such stocks. There are conflicts as to whether the President or Congress controls them, and bureaucratic delays in implementing the withdrawal even when permission is granted. With the rapid rate of progress in technology and its adoption by defense equipment manufacturers, it is complicated to ascertain what materials should be stored and in what quantities.

Relying on foreign imports is also involved. Geopolitical situations change abruptly. Suddenly, sources of materials may no longer be reliable. Even small terrorist groups can cause major disruptions.

The need for copper in China is immense, because of the copper required for its power sector; the figures for imports were given in the Demand and Supply section of this report. China plans to complete its ultra-high voltage network in 2015, so the need is evident. In addition, China's automobile industry is expanding and will consume larger quantities of the metal. Cathode production in the country was 3,499 kt and 3,778 kt in 2007 and 2008 respectively and expected to be 3,854 kt in 2009. Its cathode consumption for the corresponding periods is 4,547, 4,818, and 5,134 kt. The requirements for increased amounts of copper are apparent.

Recently China's State Reserves Bureau (SRB) has been buying copper and other industrial metals on a scale that appears to far exceed the usual rebuilding of stocks for commercial reasons. A part of the reason for this may be that the price of the metals is low, so it is appropriate to purchase them now. Another reason may well be that China expects the value of the dollar to drop in the future caused by the deficits being accumulated by the United States. China has 40% of the debt incurred by the U.S., so it has large reserves of dollars that it would like to invest soon. China is also amassing other metals such as aluminum, zinc, nickel, titanium, indium, rhodium, and praseodymium.

China is also buying properties with copper and other minerals in various countries around the world. The failed attempt by Chinalco (China Aluminum Company) to secure more control over Rio Tinto has received considerable attention, although China may challenge the Rio Tinto –BHP Billiton Joint Venture on antitrust grounds. OZ Minerals has had to remove its copper mine from sale to China Minmetals because of security reasons. However, Chinalco has purchased the Toromocho Project in Peru with the ability to produce 210 kt of concentrates per year, and Minmetals has bought the Galeno Copper-Molybdenum Project, also in Peru, expecting to produce 144 kt per year of concentrates. The China Non-Ferrous Metal Mining (Group) Co., Ltd. (CNMC) has the Chambishi Copper Mine in Zambia, and is establishing the China Investment Zone around the mine. It is also involved with the Oyu Tolgoi Copper-Gold Project in Mongolia. It has built the Hatongabade Copper Smelting Plant in Iran, and a copper plant in Vietnam. In Zambia, CNMC is investing $400 million in the Luanshya Copper Mine (LCM) and also developing the Mulyashi Project, which is predicted to produce 60,000 tons of copper by 2010. CNMC may also invest another $400 million in the Baluba copper mine. These mines are also cobalt producers. CNMC has operations or licenses to mine in Myanmar (Burma), Mongolia, Thailand, Laos, Cambodia, Philippines, and North Korea, in addition to Zambia. Not all these are for copper, however. China Metallurgical Group is developing the Aynak copper deposit in Afghanistan. The U.S. Geological Survey estimates that there are 60 million mt of copper in Afghanistan. With the Democratic Republic of Congo, China has a $9-billion infrastructure-for-minerals deal in which China is building desperately-needed roads, railways and hospitals in exchange for concessions for copper and cobalt mining in the cash-strapped country. More information could be provided, but it is evident that China is trying to capture much of the known copper throughout the planet.

India's requirements for copper will also be large because of the power distribution networks that will be erected. Sterlite Industries, an Indian company, is trying to buy ASARCO. Currently India is a net exporter of copper but this will change in the next few years.

Chile is the world's largest copper producer, and Codelco is the largest copper company. Codelco is state owned. It should be borne in mind that in the 1950s the three major copper mines in Chile were Chuquicamata and El Salvador owned by the Anaconda Copper Company and El Teniente, which belonged to Kennecott Copper Corporation. In 1955 President del Campo created the Copper Office to deal with these large mines. In 1966 President Montalva changed that Office to the Copper Corporation of Chile (Codelco). In 1967 the government invested in La Exotica (so Anaconda owned 75% and the Government of Chile, 25%). The same year the government took 51% of El Teniente. In 1971 President Allende expropriated the remaining part of the mines with little compensation. It should be remembered that even after Pinochet's coup d'état in 1973 the state retained control over the nationalized mines. Currently the Mining Code states "The State has absolute, exclusive, inalienable and imprescriptible ownership of all mines," although anyone can explore and obtain concessions for mining. Foreign companies need to follow certain rules and can get certain tax exemptions for a period of time. According to the U.S. Geological Survey (USGS) Chile has the largest reserves of copper, 160 million mt, and a reserve base of 360 million mt.

Peru mined 1.2 million mt of copper in 2008 and has the second largest reserves, 60 million mt. The reserve base, according to the USGS, is 120 million mt. Southern Copper Corporation is the largest producer of copper in Peru and is based in Phoenix. However, it is largely owned by Grupo Mexico. Antamina is the second largest miner. Freeport McMoRan operates the Cerro Verde mine. A number of other large projects are being investigated. It has already been mentioned that China has acquired the Toromocho and Galeno deposits. There is considerable uncertainty about growth in the country; recently the Peruvian Congress overturned two of President Garcia's decrees amid protests by indigenous groups.

To date Bolivia is not a large producer of copper, but President Morales has decreed that South Korea could start developing the Corocoro deposit, with a 10 million mt of reserves. They expect to invest $210 million in developing the mine. The potential for copper mining in Bolivia is large, and the country would like to become the third largest producer of the metal. President Morales has a socialistic policy and has nationalized the oil industry and wants to redistribute the wealth, so the future remains indeterminate.

The major mines in Argentina are Aqua Rica, El Pachon, and San Jorge. The Bajo de la Alumbrera copper-gold mine in north-west Argentina is operated by Minera Alumbrera Limited (MAA). However, the country is not a large producer at this time.

Venezuela is gradually nationalizing its major industries. Since 2006 the cement, steel, electricity, telecom, and four major oil producers have been taken over by the government. It is not a large producer of copper, so that industry will not be affected much, but take over by the state may be expected.

Freeport-McMoRan Copper and Gold, Inc. is mining copper from its Ertsberg and Grasberg deposits in Irian Jaya in Indonesia. There are also some other smaller mines. In 2008 the total copper production was 6.5 million mt. The reserves are estimated at 36 million mt. However, there are problems with labor and NGOs (Non-Governmental Organizations).

Mongolia has been negotiating with Ivanhoe Mines regarding the taking of 34% of the Oyu Tolgoi gold-copper mine. President Elbegdorj, who has just been sworn in, however, does not want to take an equity position in the company; he wants to take 50% of the profit. If all of Mongolia's copper deposits are developed it would become one of the 10 largest producers. It has not renewed Centerra Gold's license.

Mongolia, Guinea, the Democratic Republic of Congo, and some other countries have attempted to renegotiate their contracts with the mining companies operating there.

According to the Fraser Institute the exploration industry is reluctant to hazard investing in projects where the policy structure is unclear, unstable, and unpredictable. Nations that do not respect negotiated contracts, property rights, or the rule of law will not interest mining investment. Some of the countries that are low on their list for attracting mineral exploration include Bolivia, Democratic Republic of the Congo, Ecuador, Guatemala, Honduras, Indonesia, Kyrgyzstan, Venezuela, and Zimbabwe, although not in that order.

It is evident from the above discussion that the most reliable source of copper is that which is produced within the boundaries of the United States. This is especially true since there are still significant ore deposits that exist here. Disruption from other countries is possible and could occur without any prior warning.

Production of copper from the Rosemont Mine will help towards making the United States more self-sufficient in the metal.

APPENDIX H
UNITED STATES NATIONAL DEFENSE STOCKPILE

(summarized from National Academies (2008), Materials for a Twenty-first Century Military, The National Academies Press, Washington, DC, Appendix A, pp. 133-144 and Summary, pp. 1-6).

Minerals are critical for national and homeland security, and it is imperative that the country does not become overly dependent on foreign sources for these materials. The United States is already relying 100 percent on imports for 18 minerals in 2008. One method to ensure the supply of strategic minerals, especially in times of war, is to stockpile these materials. The concept has been in vogue since recorded time; the Egyptians used it 4,000 years ago as mentioned in Genesis. The idea was floated several times in the United States, and in 1917 by the War Industries Board during World War I. The Army and Navy Munitions Board was established in the War Department in 1922 for the procurement of munitions and supplies. The Naval Appropriations Act of 1938 authorized the development of an inventory of strategic materials, with funds allocated to purchase these items. The Strategic Materials Act of 1939 set the foundation for a National Defense Stockpile (NDS), with $100 million being authorized for buying strategic raw materials. By October 1940 only a fraction of the items on the list had been stockpiled. Throughout World War II the U.S. depended on its robust industrial base to meet national defense requirements. Numerous materials were imported in substantial quantities, and several agencies were involved in the effort. Of the 15 materials in the stockpile only three (3) were from domestic sources, all the rest were of foreign origin.

In 1946, the Strategic and Critical Materials Stock Piling Act was passed; consideration of the bill had started earlier, before the end of the war. There was considerable disputation on the purposes of the stockpile, civilian and/or strictly military, and on the allocation of power between the Executive Branch and Congress. The final law specified that no materials would be disposed without congressional approval (unless considered obsolete), and would also require Presidential approval. The National Security Act of 1947 created the National Security Resources Board to advise the President. The Korean War began in 1950, and the Defense Production Act was passed authorizing diversion of stockpile resources to military and essential programs. By the end of the year President Truman declared a national emergency and created the Office of Defense Mobilization and Defense Production Administration. During the Korean War (through 1953) the government released eight materials, mainly aluminum and copper, from the stockpile although large amounts of materials on order for the NDS were sidetracked to meet civilian requests. In 1953 President Eisenhower created the Office of Defense Mobilization, and abolished the Defense Production Administration and National Security Resources Board.

During the mid-1950s new scenarios for war started being considered based on the concept of a nuclear war. These Cold War strategies implied reduced amounts of materials for stockpiling. In 1963 an interdepartmental Disposal Committee was established to plan the disposal of the materials over the long term. In 1962 a shortage of cadmium developed and so that was released in four batches. In 1965 copper was sold because of a worldwide shortage. Thus it may be concluded that the NDS was being used as an economic stabilizer. The Materials Reserve and Stockpile Act of 1965 directed the various stockpiles to be combined and that the quantity of excess materials reduced. In February 1966 the President ordered the release of quinine sulfate for used in Vietnam against malaria. In 1969 nickel was released for defense production because of a strike at two major nickel mines. In 1973 the reevaluation of the stockpile by the National Security Council was completed and new goals developed. The same year the Office of Emergency Planning was abolished and its duties transferred to the U.S. General Services Administration (GSA). The President issued new guidance for the stockpile in 1976. The Strategic and Critical Materials Stockpiling Revision Act of 1979 changed the program again. The National Defense Stockpile Transaction Fund was created in the Treasury Department for monies received from the sales of stockpile materials. In November 1979 the President authorized the release of chrysotile asbestos, since the one operating mine in Canada was depleted and the only other mine in Zimbabwe was not producing. In 1981 President Reagan announced a major purchase for the stockpile because the nation was becoming vulnerable to sudden shortages.

The minerals production industry was essentially in decline during the early 1980s. There was a worldwide recession and many U.S. metal mines and processors suspended operations. Between 1984 and 1994 chromite ore and manganese were upgraded to ferroalloys. Other upgrades were also performed during the 1980s, and some silver was transferred to the Department of the Treasury for minting Liberty coins. Towards the end of the 1980s the nuclear threat from the Soviet Union decreased and major changes in the military started to take place.

In February 1988 the Secretary of Defense was designated to take over the National Defense Stockpile. All funds, personnel, property and records were transferred. However, the Secretary was to consult with other agencies prior to stockpile disposals and other important changes. The Department of Defense (DoD) guidelines for the stockpile started to change. New war scenarios were developed, most foreign sources were considered reliable, and by 2003 the requirements for strategic and critical materials were nearly reduced to zero. During 1988 and 1992 large quantities of materials in the NDS were disposed off, and in 1992 Congress authorized further reductions. The copper in the stockpile was liquidated in 1993 and 1994. The National Defense Authorization Act of 1993 amended Section 2 of the Strategic and Critical Materials Stockpiling Act to state that the stockpile was to be used for defense only and not economic or budgetary purposes. Under the National Defense Authorization of 1996 some titanium was transferred for use in lighter weight armor and tanks. Under a program beginning in FY 1997 some funds from NDS sales were allocated to the Foreign Military Sales Program. In FY 1999 monies were moved to the Federal Hospital Insurance Trust Fund and the Federal Supplementary Medical Trust Fund; funds were reserved to reclaim some radio frequencies from the military to civilian uses and provide for some military personnel benefit programs in FY 2000; some funds were put in the Spectrum Sales Program Transaction Fund by FY 2006; monies also went to the World War II Memorial and MILPERS Benefit Program Transaction Fund; transfers were also made into the General Fund of the Treasury.

Based on the above discussion, it is evident that stockpiling of materials is largely unproductive and complicated by the cumbersome procedures involved. Congressional and Presidential preferences over time tend to govern the system. A report produced by The National Academies in 2008 drew the following conclusions:

1. The design, structure, and operation of the National Defense Stockpile render it ineffective in responding to modern needs and threats.
2. The Department of Defense appears not to fully understand its needs for specific materials or to have adequate information on their supply.
3. A lack of good data and information from either domestic or offshore sources on the availability of materials impedes the effective management of defense-critical supply chains.
4. Owing to changes in the global threat environment and changes in the U.S. industrial base, the emergence of new demands on materials supplies, the ineffectiveness of the National Defense

Stockpile, and the resultant potential for new disruptions to the supply chains for defense-critical materials, the committee believes there is a need for a new approach in the form of a national defense-materials management system.

Since dependence on foreign sources is at best unpredictable and liable to alter without notice, it is paramount that the United States develops its own mineral resources to the greatest extent possible, especially if those deposits exist within its boundaries. This applies to copper as it does to other minerals.

REFERENCES

Aubema, a Division of Sankvik Mining and Construction, Germany, Sizer 4183.

Copper.org. Copper Facts

GeoBiotics, LLC, GEOCOAT, http://technology.infomine.com/biometmine/biopapers/biomet_geocoat.pdf

GeoBiotics, LLC, GEOLEACH, http://www.geobiotics.com/GeoL_GEOLEACH_Main.cfm

Geotech Ltd., VTEM Surveys, http://geotech.ca/index.php?option=com_content&task=view&id=33&Itemid=126

Greeley, Michael N. (1987), The Early Influence of Mining in Arizona, History of Mining in Arizona, Mining Club of the Southwest Foundation, Tucson, Arizona, Chapter 2, pp. 13- 50.

http://www.copper.org/resources/properties/db/CDAUsesSelectionServlet.jsp?alloy=Ordnance&View=View

Huckleberry, C.H. (2001), Historic Summary of Pima County, Draft Memorandum to Pima County Board of Supervisors, 17 pp, http://www.pima.gov/areainfo/PDF/HistoricSum.pdf

International Copper Study Group (2007), The World Copper Fact Book, 2007, 66 pp.

International Copper Study Group (2009), COCHILCO Report on Best Practices and Efficient Use of Water in the Mining Industry, June, 73 pp.

International Copper Study Group (2009), Press Release, May 20, Copper: Preliminary Data for February 2009.

Jablonski, Chris (2008), Laser scanning robot 3D-R1 used to map mines, Emerging Tech, April 10.

Lacy, John C. (1987), Early History of Mining in Arizona – Acquisition of Mineral Rights 1539-1866, History of Mining in Arizona, Mining Club of the Southwest Foundation, Tucson, Arizona, Chapter 1, pp. 1-12.

Liebherr, Mining Truck T282 B, Job Report, At Arizona Copper Mine, http://www.liebherr.com/catXmedia/me/Documents/1210d0eb-c98d-4e02-8fd5-150a35f1d2e4.pdf

Lindros, Jean (2006), Navigation with HNS – A Milestone in Hole Positioning, Mining and Construction, March, pp. 24-25.

M3 Engineering and Technology Corp. (2009), Rosemont Copper Project Updated Feasibility Study, volume 1, NI 43-101 Technical Report, January, 137 pp.+ Appendix A.

NanoSteel Company (2007), Press Release, NanoSteel Redefines Hardfacing with New Patented Weld Material, August 09.

National Academies (2008), Materials for a Twenty-first Century Military, The National Academies Press, Washington, DC, Appendix A, pp. 133-144.

National Academies (2008), Materials for a Twenty-first Century Military, The National Academies Press, Washington, DC, Summary, pp. 1-6.

Pima County History, http://jeff.scott.tripod.com/pimaco.html

Quantec Geoscience, Titan 24, http://www.quantecgeoscience.com/Tech/Titan24.php

Sandvik Automine, http://www.miningandconstruction.sandvik.com/Sandvik/6481/Internet/se03994.nsf/GenerateTopFrameset?ReadForm&menu=&view=http%3A//www.miningandconstruction.sandvik.com/Sandvik/6481/Internet/SE03993.NSF/NAUnique/9233D3AC03C9C1DE42256F7A003128CC%3FOpenDocument&banner=/Sandvik/6481/Internet/se03994.nsf/LookupAdm/BannerForm%3FOpenDocument

Thermo Scientific, NITON XRF Analyzers, http://www.niton.com/NITON-Analyzers-Products/xl3t.aspx

U.S. Geological Survey (2009), Mineral Commodity Summaries, Jan., pp. 50-51, http://minerals.usgs.gov/minerals/pubs/commodity/copper/mcs-2009-coppe.pdf

Wikipedia, Copper, http://en.wikipedia.org/wiki/Copper

Wikipedia, Ironwood National Forest, http://en.wikipedia.org/wiki/Ironwood_Forest_National_Monument

Wikipedia, Monel, http://en.wikipedia.org/wiki/Monel

An Assessment of the Economic Impacts of the Rosemont Copper Project

Arizona Department of Mines and Mineral Resources

July 2009

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An Assessment of the Economic Impacts of the Rosemont Copper Project

Executive Summary

This report summarizes the results of an economic impact analysis of the Rosemont Copper Project, an open-pit mining operation to be developed on a 15,000 acre site in Pima County about 30 miles southeast of Tucson. The analysis made use of an Arizona version of the REMI regional economic forecasting model to estimate the economic impacts of the Project for the Pima County/Santa Cruz County study area.

Key findings of the analysis:

Construction Phase

- Construction of the Project will generate an average annual increase of $82 million (all dollar-denominated figures refer to 2008$) in economic activity in the region (measured in terms of demand for goods and services from local suppliers) over a four-year engineering/construction period.
- The engineering/construction phase will provide a total of 2,570 person-years of employment for local workers.
- Wages and salaries and non-labor income (dividends, interest, rent, proprietors' income, and net profits) produced by the economic activity associated with the engineering/construction phase will provide an average of $29.5 million per year in additional income to area residents.
- The engineering/construction phase will generate $3.6 million per year in revenues over the engineering/construction period for local governments in the study area.
- Over the entire engineering/construction period, the impacts will total $328 million in additional demand for goods and services, $191 million in gross regional product, $118 million in personal income, and $14.6 million in local government revenues. State government revenues will be much larger – just the State's share transactions privilege tax on construction will be $7 million dollars – but total state government tax collections have not been estimated as part of this project, which focused on the Pima/Santa Cruz Counties region.

Production/Post-Production Phase

- Production activities will generate an average annual increase of $745 million per year in economic activity (measured in terms of incremental regional output) over a 20-year production period.
- Mine and mill operations will employ an average of 406 workers – with peak employment of 444 – and will support an average of nearly 1,600 other jobs – a total of approximately 2,000 additional jobs for area residents.
- Wages and salaries and non-labor income produced by the economic activity will provide an annual average of $119 million in additional income to area residents.
- Production activities will generate an average of $14 million per year in incremental revenues for local governments in the study area.
- Over the entire expected production/post-production period, the overall impacts will be $15.7 billion in additional output, $9.6 billion in gross regional product, $2.6 billion in personal income, and $306 million in local government revenues.
- State government revenues resulting from the production/post-production phase will be much larger – just the State's severance tax collections alone will be more than $100 million dollars – but total state government tax collections have not been estimated as part of this project, which focused on the Pima/Santa Cruz Counties region.
- The Rosemont Copper Project would have lasting positive effects on the economy of the study area. Permanent changes to the regional economy would occur as a result of the increased levels of economic activity associated with the development and operation of the Rosemont mine. These changes would result in residual economic impacts in the Pima/Santa Cruz Counties area. Even five years after the end of production at the mine, economic activity would be $75 million per year higher and area residents' income $37 million per year more than if the Rosemont Copper Project had never existed.

THE ROSEMONT COPPER PROJECT

This report summarizes the results of an economic impact analysis of the Rosemont Copper Project, an open-pit mining operation to be developed on a 15,000 acre site in Pima County about 30 miles southeast of Tucson.

At prices of $1.75/lb. for copper, $15.00/lb. for molybdenum, and $10.00/ounce for silver, combined proven and probable sulfide mineral reserves total nearly 546 million tons grading 0.45 percent copper, 0.015 percent molybdenum, and 0.12 ounces/ton silver. Proven and probable oxide mineral reserves total about 70 million tons grading 0.17 percent copper. Contained metal in the sulfide mineral reserves (proven and probable) is estimated to be 4.93 billion pounds of copper, 161 million pounds of molybdenum, and 65 million ounces of silver. Contained metal in the proven and probable oxide mineral reserves is estimated to be 241 million pounds of copper (M3 Engineering and Technology Corp.).

The total cost of developing the site for mining and construction of the processing facilities will be $897 million (2008$). When in operation, employment will average 406 per year, and total annual production costs, as reported in the updated feasibility study will average $301 million per year during the 20-year production period. The mining operation is projected to produce more than 200 million pounds of copper per year. In addition to copper, it is also projected to produce an average of 4.7 million pounds of molybdenum and 2.7 million ounces of silver per year.

The results of the economic impact analysis indicate that the engineering/construction phase will generate an average annual increase of $82 million in economic activity in the region (measured in terms of demand for goods and services from local suppliers) and will provide a total of 2,570 person-years of employment for local workers during a four-year engineering/construction period. The jobs and non-labor income (dividends, interest, rent, proprietors' income, and net profits) produced by the economic activity will also provide an average of $29.5 million in additional income to area residents and $3.6 million in incremental revenues to local governments in the study area. Over the entire engineering/construction period, the impacts will total $328 million in additional demand for goods and services, $191 million in gross regional product, $118 million in personal income, and $14.6 million in local government revenues. State government revenues will be much larger, but total state government tax collections associated with the engineering/construction phase have not been estimated as part of this project, which focused on the Pima/Santa Cruz Counties region.

Production activities will generate an average annual increase of $745 million in economic activity (measured in terms of incremental regional output) and will support an average of 2,000 jobs for area residents. The wages and salaries and non-labor income produced by the economic activity will provide an average of $119 million in additional income to area residents and $14 million in incremental revenues to local governments in the region. Over the entire expected life of the Project, the overall impacts will be $15.7 billion in additional output, $9.6 billion in gross regional product, $2.6 billion in personal income, and $306 million in local government revenues. State government revenues resulting from the Project will be much larger, but total state government tax collections have not been estimated as part of this project, which focused on the Pima/Santa Cruz Counties region.

1. Economic/Financial Overview

The following discussion is based upon economic and financial information contained in the *Rosemont Copper Project Updated Feasibility Study* (M3 Engineering and Technology Corp.). All dollar-denominated figures in this report are stated in terms of 2008$.

The total cost of construction is estimated to be $897 million. The cost figures for the construction and development of the site for mining as reported in the feasibility study are summarized in Table 1. Expenditures for goods and services, payrolls, and tax payments associated with the engineering/construction phase will total $880.6 million over a four-year period. (Table 2 lists the total and yearly expenditures for the engineering/construction phase.)

The productive life of the Rosemont Copper Project is projected to be 20^+ years. Based on the cost analysis presented in the feasibility study, the total costs associated with the production/post-production phase of the Project, including reclamation and costs related to closure of the mine will total over $6 billion. Table 3 summarizes the cost figures for a representative year during the production phase as reported in the feasibility study. The total cost figure translates to $5.1 billion in expenditures or approximately $252 million per year over the 20-year production period. Table 2 lists the total and yearly expenditures during the production/post-production phase of the Project. These figures include spending associated with the mining operations, processing of the ore, maintenance/replacement of facilities and equipment, reclamation, administration, taxes, and other outlays, but do not include accounting cost components such as salvage value and deprecation.

Table 1: Rosemont Copper Project - Construction Costs
(From Table 1-40 - Initial Capital Cost Estimate)
(Millions of 2008$)

Cost Category	
Site Development	8.5
Mine	214.6
Oxide Plant	53.6
Sulfide Plant	327.3
Power/Water Systems	82.0
Ancillary Facilities	26.9
Total Direct Cost	712.7
Indirect Costs (Field mobilization, EPCM, taxes, commissioning, spare parts, contingency funds, etc.)	184.4
Total Costs	897.2

Column may not add to totals due to rounding.

Source: Rosemont Copper Project Updated Feasibility Study, 2009

Table 2: Rosemont Copper Project - Total Expenditures by Year
(Millions 2008$)

	Engineering/Construction Phase	Production/Post-Production Phase
Total	880.6	5,138.2
Annual Average*	220.2	252.2
Year		
Pre-Production		
PP3	60.1	
PP2	272.5	8.7
PP1	488.9	37.6
Production		
1	59.1	231.5
2		275.6
3		262.9
4		276.9
5		279.5
6		281.3
7		280.4
8		261.8
9		255.7
10		263.1
11		274.4
12		240.4
13		260.1
14		261.2
15		252.5
16		235.4
17		211.8
18		213.1
19		221.1
20		205.7
Post-Production		
21		42.9
22		3.9
23		0.9

*Annual average value for the Production/Post-Production Phase refers to years 1 - 20 when full production activity will occur.
Columns may not add to totals due to rounding.

Source: Computed from information in the Rosemont Copper Project Updated Feasibility Study, 2009

Table 3: Rosemont Copper Project - Annual Production Costs
(From Table 1-53)
(Millions of 2008$)

Cost Category	For Year 2
Mine Operations	70.1
Processing - Mill	91.5
Processing - SXEW	18.4
Other Operating Costs	9.0
Shipping, Refining, and Smelting	62.4
Taxes/Royalty	30.8
Pre-production Mining Costs	2.9
Reclamation Costs	0.8
Other Costs/Salvage Value	-2.1
Depreciation	173.4
Total Production Costs	457.1

Column may not add to total due to rounding.

Source: Rosemont Copper Project Updated Feasibility Study, 2009

2. Economic Impacts

Economic impacts are measured as changes in economic activity attributable to an event or policy change. Economists distinguish between direct impacts and total impacts. The direct impacts are changes in the economy that are the direct result of the event or policy change. In this study, the event being analyzed is the Rosemont Copper Project and the direct impacts of the construction and operation of the Project will be the purchases of goods and services from suppliers in the study area, the wages and salaries paid to mine employees, the jobs provided to area workers, and the taxes and other payments to area governments. The total impacts of the Project will be the final changes in all of the diverse parts of the area economy after all of the indirect effects generated by the direct impacts have worked their way through the economy.

Estimates of the direct impacts and the total impacts have been produced by very different methods. The direct impacts have been calculated from information in the *Rosemont Copper Project Updated Feasibility Study* in combination with other data from secondary sources. The total economic impacts of the Rosemont Copper Project were estimated using an Arizona version of the REMI regional economic forecasting model. This computer model was developed by Regional Economic Models Inc. for use by a consortium of Arizona state agencies, including Arizona State University. It is a county-based model, and the study area specified for the analysis of the Project was the combined region of Pima and Santa Cruz Counties. The estimates of the direct impacts were used as inputs to the estimation process, and the REMI model generated detailed estimates of the total economic impacts. The methodology and data used to develop the estimates of the direct impacts and the operation of the REMI model is described in the Technical Appendix.

2.1 Direct Impacts

2.1.1 Engineering/Construction Phase

Total spending associated with this phase will be $880.6 million. However, much of the equipment and specialized services to be purchased are not produced within the study area. The total expenditures for goods and services from local suppliers in Pima and Santa Cruz Counties (including the local share of the value of equipment ordered through local suppliers but produced elsewhere) are estimated at $190.8 million. Annual spending levels over the four-year engineering/construction period are shown in Table 4. Most of the local spending is focused in the construction, mining support, and business services sectors.

2.1.2 Production/Post-Production Phase

Total spending associated with the production/post-production phase (including reclamation and mine closure activities) will be more than $5.1 billion over a 25-year period. These expenditures will produce the following direct economic impacts within the Pima and Santa Cruz Counties study area (The annual figures for each of these measures are shown in Table 4):

- $1.5 billion in purchases of goods and services from local suppliers.
- An average of 406 jobs and $438 million in wages and salaries paid to area workers.
- $84 million in revenues to area local governments.

Table 4: Rosemont Copper Project - Direct Impacts by Year
Pima/Santa Cruz Counties Study Area
(Millions 2008$)

	Engineering/ Construction Expenditures	Production/Post-Production Expenditures				
		Total	Non-Labor Expenditures	Wages & Salaries	Local Government Revenues	Employment
Total	190.8	2,027.7	1,505.7	437.8	84.3	
Annual Average*	47.7	97.4	73.1	20.2	4.0	406
Year						
Pre-Production						
PP3	12.8					
PP2	59.1	10.1	4.8	5.4		158
PP1	105.6	37.1	19.9	17.2		341
Production						
1	13.2	93.0	68.1	20.9	3.9	421
2		102.8	77.9	20.9	4.0	422
3		100.2	75.4	21.0	3.8	426
4		100.2	75.2	21.1	3.9	426
5		101.5	76.6	21.1	3.7	426
6		102.8	77.9	21.1	3.8	426
7		100.8	75.8	21.1	3.9	426
8		97.0	72.0	21.1	3.9	426
9		99.8	74.5	21.1	4.2	426
10		102.0	76.6	21.1	4.3	426
11		106.2	80.1	21.9	4.2	444
12		99.2	73.5	21.9	3.8	444
13		102.9	77.0	21.9	4.0	444
14		102.8	76.8	21.9	4.2	444
15		100.8	74.8	21.9	4.2	444
16		93.7	71.6	17.9	4.1	354
17		84.7	63.9	16.5	4.3	326
18		84.7	64.0	16.4	4.3	326
19		86.8	66.3	16.3	4.2	326
20		85.6	65.1	16.5	4.0	326
Post-Production						
21		31.9	16.8	11.5	3.6	326
22		1.1	1.1			
23		0.1	0.1			

*Annual average values for the production/post production phase refer to years 1 - 20 when full production activities will occur.
Numbers may not add to totals due to rounding.

Source: Computed from information in the results from the REMI regional economic forecasting model

2.2 Total Impacts

The following discussion summarizes the results from the REMI model. The total impacts of the Project are measured in terms of:

- Output – The dollar value of all goods and services produced in the region.
- Gross Regional Product – The dollar value of all goods and services produced for final demand in the region. It excludes the value of intermediate goods and services purchased as inputs to final production.
- Personal Income – The total income received by residents of the region from all sources.
- Total Employment – the number of full- and part-time jobs by place of work.
- Local Government Revenues – taxes and other payments received by area governments, including county, city/towns, school districts, etc.

2.2.1 Engineering /Construction Phase

The development of the Rosemont Copper Project site over a four-year engineering/construction period will produce substantial benefits to the Pima and Santa Cruz Counties region. It will generate an average annual increase of $82 million in economic activity in the region (measured in terms of demand for goods and services from local suppliers) and will provide a total of 2,570 person-years of employment for local workers. The wages and salaries and non-labor income (dividends, interest, rent, proprietors' income and net profits) produced by the economic activity will provide an average of $29.5 million in additional income to area residents and $3.6 million in incremental revenues to local governments in the region. Over the entire engineering/construction period, these impacts are equivalent to $328 million in additional demand for goods and services, $191 million in gross regional product, $118 million in personal income, and $14.6 million in local government revenues (Table 5). Total state government revenues have not been estimated as part of this project, which focused on the Pima/Santa Cruz Counties region.

The economic impacts of the engineering/construction phase of the Rosemont Copper Project would not be confined to the mining and construction industries. The overall economic impacts (taking into account the combination of the direct and indirect effects) would be felt across all

Table 5: Rosemont Copper Project - Engineering/Construction Phase - Total Impacts by Year
Pima/Santa Cruz Counties Study Area
(Millions 2008$)

	Output	Gross Regional Product	Personal Income	Employment	Local Government Revenues
Total	327.6	190.9	118.0		14.6
Annual Average	81.9	47.7	29.5	640	3.6
Year					
Pre-Production					
PP3	20.6	11.8	7.0	170	0.9
PP2	97.4	56.0	33.3	770	4.2
PP1	176.7	102.2	60.8	1,370	7.7
Production					
1	32.8	20.8	17.0	260	1.7
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Post-Production					
21					
22					
23					

Output is the dollar value of all goods and services produced in the region, including intermediate goods as well and value added (compensation and profit).
Gross regional product is the dollar value of all goods and services produced for final demands. It excludes intermediate goods and services.
Personal income is the total income received by residents from all sources.

Columns may not add due to rounding.

Source: Results from the REMI regional economic forecasting model.

sectors of the regional economy. The strongest impacts would be on the mining, construction, manufacturing, trade, and business services sectors. Appendix tables A1, A2, and A3 show the incremental private-sector economic activity in each of 19 major industries in terms of output, employment, and earnings respectively.

2.2.2 Production/Post-Production Phase

The economic benefits for Pima and Santa Cruz Counties associated with the operation of the Rosemont Mine will be much larger in scale than those produced by its construction. Production activities will generate an average annual increase of $745 million in economic activity (measured in terms of incremental regional output) and will provide an average of 2,000 jobs for area residents. The wages and salaries and non-labor income produced by the economic activity will provide an average of $119 million in additional income to area residents and $14 million in incremental revenues to local governments in the study area. (All measured over the 20-year production period.) Over the entire production/post-production period, these impacts are equivalent to $15.7 billion in additional output, $9.6 billion in gross regional product, $2.6 billion in personal income, and $306 million in local government revenues (Table 6). Total state government revenues have not been estimated as part of this project, which focused on the Pima/Santa Cruz Counties region.

The economic impacts of the production/post-production phase of the Rosemont Copper Project would not be confined to the mining industry. The overall economic impacts (taking into account the combination of direct and indirect effects) would be felt across all sectors of the area economy. The strongest impacts would be on the mining, construction, manufacturing, trade, and business services sectors. Appendix tables A4, A5, and A6 show the incremental private-sector economic activity in each of 19 major industries in terms of output, employment, and earnings respectively.

Table 6: Rosemont Copper Project - Production/Post-Production Phase - Total Impacts by Year
Pima/Santa Cruz Counties Study Area
(Millions 2008$)

	Output	Gross Regional Product	Personal Income	Employment	Local Government Revenues
Total	15,696.1	9,593.8	2,649.7		306.0
Annual Average*	745.1	454.8	118.7	2,000	13.9
Year					
Pre-Production					
PP3					
PP2	63.3	36.7	19.5	430	2.0
PP1	162.3	93.6	49.8	1,050	5.3
Production					
1	615.4	366.9	85.7	1,800	10.2
2	808.7	493.8	97.5	1,960	11.6
3	680.4	407.6	105.3	2,060	12.3
4	757.0	458.7	109.5	2,080	12.5
5	681.0	409.9	114.0	2,090	13.0
6	747.4	454.3	117.9	2,110	13.3
7	765.3	465.5	120.2	2,100	13.7
8	772.3	470.0	121.2	2,070	13.8
9	768.2	468.1	124.2	2,100	14.3
10	801.7	488.0	128.0	2,130	14.9
11	769.6	468.4	129.6	2,170	15.3
12	646.3	391.2	128.0	2,090	14.9
13	739.5	449.1	130.9	2,120	15.2
14	791.0	481.4	133.5	2,140	15.8
15	825.9	501.9	134.4	2,120	15.9
16	767.4	475.8	123.4	1,890	14.7
17	763.1	477.0	117.8	1,770	14.0
18	777.5	485.5	116.6	1,770	14.0
19	751.8	469.5	117.5	1,730	14.2
20	673.2	413.7	117.9	1,710	14.2
Post-Production					
21	348.9	214.9	103.7	1,430	11.5
22	120.5	83.0	56.2	570	5.3
23	98.3	69.2	47.3	440	4.1

Output is the dollar value of all goods and services produced in the region, including intermediate goods as well and value added (compensation and profit).
Gross regional product is the dollar value of all goods and services produced for final demands. It excludes intermediate goods and services.
Personal income is the total income received by residents from all sources.

* Annual average values refer to years 1 - 20 when full production activity will occur.

Columns may not add due to rounding.

Source: Results from the REMI regional economic forecasting model.

3. Concluding Observations

3.1 Population Changes

Unlike most other regional economic impact models, REMI is a dynamic model that produces integrated multiyear forecasts and accounts for dynamic feedbacks among its economic and demographic variables. As such, it provides forecasts of the demographic impacts of the development and operation of the Rosemont mine in addition to forecasts of economic variables. The results of the analysis indicate that net migration into the study area will increase by 200 – 300 per year in the early years of operation and then lessen, with an annual average net migration figure of about 70 over the entire 20-year production period. This increase in net migration would mean that the population of the study area would be approximately 1,500 larger after five years and 2,400 larger by the end of the production period compared with a situation in which the Rosemont Copper Project had not been developed.

3.2 Residual Impacts

Results from the REMI model forecast for years after the closure of the mine show that the Rosemont Copper Project would have lasting effects on the area economy over and above the impacts during its 26-year "active" period. Permanent changes to the business community, to the labor market, to local governments would occur as a result of the increased levels of economic activity induced by the development and operations of the Rosemont mine, and these changes would result in residual economic impacts in the Pima and Santa Cruz Counties area. Even five years after the end of production at the mine, the forecast results indicate that the level of economic activity would be $75 million per year higher and area residents' income $37 million per year higher than if the Rosemont Copper Project had never existed.

REFERENCES

Arizona Department of Commerce (2009) *2008 Arizona Workforce Employment Report.*

Arizona Joint Legislative Budget Committee (2009) *revenuehistory-fy08actual.pdf.*

Arizona Department of Revenue (2008) *FY2008 Annual Report.*

Global Insight (2009) *U. S. Economic Outlook: February 2009.*

M3 Engineering & Technology Corp. (2009) *Rosemont Copper Project Updated Feasibility Study.*

Regional Economic Models Inc. (2007) *REMI Policy Insight 9.5: Users Guide.*

Tetra Tech Inc. (2008) *Mined Land Reclamation Plan.*

Treyz, George (1993) *Regional Economic Modeling: A Systematic Approach to Economic Forecasting and Policy Analysis.* Kluwer Academic Press.

U. S. Bureau of Economic Analysis (2009) *State Personal Income and Employment Database.* (www.bea.gov/regional/index.htm#state)

U. S. Bureau of Economic Analysis (2007) *U.S. Benchmark Input-Output Accounts.*

U. S. Census Bureau (2009) *State and Local Government Finances Database.* (www. census.gov/govs/www/estimate.html)

U. S. Bureau of Labor Statistics (2009) *Quarterly Census of Employment and Wages Database.* (www.bls.gov/cew)

WestLand Resources Inc. (2007) *Mine Plan of Operations: Rosemont Project.*

TECHNICAL APPENDIX

A1. Economic Impact Analysis Using the REMI Model

This study used an Arizona-specific version of the REMI regional forecasting model to produce numeric estimates of the economic impacts associated with the construction, operation, and closure of the Rosemont mine. The general method for estimating impacts using the REMI model involves 4 steps:

1. Preparation of a baseline or control forecast for the study area – this baseline scenario provides a forecast of the future path of the study area's economy based on a combination of the extrapolation of current economic conditions and an exogenous forecast of relevant national economic variables without any changes in public policy or other external factors.
2. Development of a policy scenario – this policy scenario describes the direct effects that the event(s) – in this case the construction, operation, and closure of the Rosemont mine would have on the area economy.
3. Preparation of a forecast simulation of the area economy based on the policy scenario – this alternative forecast provides a forecast of the future path of the area economy incorporating the effects of the changes specified in the policy scenario.
4. Comparison of the baseline and policy scenario forecasts – the differences between the future values of each variable in the forecasts provide numeric estimates of the nature and magnitudes of the economic impacts of Rosemont Copper Project on the study area.

A2. The REMI Model

REMI is an economic-demographic forecasting and simulation model developed by Regional Economic Models Inc. REMI is designed to forecast the impact of public policies and external events on an economy and its population. The REMI model is recognized by the business and academic community as the leading regional forecast/simulation tool available. A complete explanation of the model and discussion of the empirical estimation of the parameters/equations are given in *Regional Economic Modeling: A Systematic Approach to Economic Forecasting and Policy Analysis* (Treyz) and *Policy Insight 9.5: Model Documentation* (REMI).

The specific REMI model used for this analysis was Policy Insight Model Version 9.5 of the Arizona economy leased from Regional Economic Models Inc. by a consortium of State agencies, including Arizona State University, for economic forecasting and policy analysis.

A3. Updating of the Baseline or Control Forecast

The 9.5 version was delivered with national and local datasets containing data through 2005 and also with national and local baseline forecasts prepared by Regional Economic Models Inc. The REMI model incorporates procedures for updating the datasets and the baseline forecasts with more recent data. The research team performed these procedures to prepare an updated baseline forecast for the Arizona economy for this study. In practice, the methodology requires first updating the national baseline forecast since forecast values of national economic variables are important inputs to the state forecast.

The national forecast was updated by using 2006 and 2007 data from the U.S. Bureau of Economic Analysis, compatible estimates of the 2008 employment numbers based on data from the U.S. Bureau of Labor Statistics, and forecast data for the 2009–2017 period from the latest available Global Insight national forecast (February 2009). The baseline forecast of the Arizona model was updated based on employment data for 2006 and 2007 from the U. S. Bureau of Economic Analysis, compatible estimates for 2008 based on data from the Arizona Department of Commerce, and revenue and expenditure data from the U.S. Census Bureau's Government Finance database, supplemented with data from the Arizona Department of Revenue and the Arizona Joint Legislative Budget Committee.

A4. Definition of the Study Area

The site on which the Rosemont Copper Project is being developed is located in Pima County southeast of the Tucson urbanized area and near the border with Santa Cruz County. REMI is a county-based model, so that the study area must be defined in terms of one or more Arizona counties. Given the relative size and sophistication of the Pima County economy relative to that of Santa Cruz County, most of the economic activity associated with the Project is likely to occur in Pima County. One alternative would have been to choose Pima County as the study area. At the same time, the site is so close to Santa Cruz County that spillover effects would certainly occur – in particular, some of the employees are likely to live in the smaller county. For this reason, the combined two-county region has been chosen as the study area.

A5. Definition of the Study Period

Unlike most other regional economic impact models, REMI is a dynamic model that produces integrated multiyear forecasts. The analysis of the economic impacts of the Rosemont Copper Project has employed this feature of the model. The feasibility study provides annual information relating to both capital and operating costs for the projected lifetime of the Project. The timeline for the Project in the study includes three pre-production years (designated years PP3 through PP1 in this report), a production period of 20 years (designated years 1 through 20), and a post-production period of three years (years 21 through 23). The first year of the post-production period (Year 21) includes some production activity during the first part of the year. The economic impact analysis of the construction phase provides estimates of the impacts over the four-year engineering/construction period specified in the feasibility study (year PP3 to year 1). The analysis of the production/post-production phase encompasses a 25-year period (years PP2 through year 23).

The REMI model requires specification of calendar year time periods for its forecast process. Based on a timeline on the Rosemont Copper Project website, the study period starting date (PP3) was assumed to be 2009.

A6. Calculation of the Direct Impacts

All of the estimates of the direct impacts of the Rosemont Copper Project were based on the economic and financial information contained in the *Rosemont Copper Project Updated Feasibility Study* (M3 Engineering and Technology Corp.). .

The REMI model requires input data in very specific formats. In particular, the data must conform to the 70 economic sectors in the model. In many cases the economic data provided in the feasibility study was not sufficiently detailed to be used directly as inputs for the REMI model. Detailed data from the direct requirements table in the *U.S. Benchmark Input-Output Accounts* (U. S. Bureau of Economic Analysis) were used to convert the information into a form usable by the model. The direct requirements coefficients for each industry specify the dollar amount of inputs from each supplying industry needed to produce a dollar of industry output.

Information from two other reports relating to the Rosemont Copper Project was also used to supplement the information in the feasibility study:

- Data relating to reclamation costs from the *Mined Land Reclamation Plan* (Tetra Tech Inc).
- Information relating to various aspects of construction and operation from the *Mine Plan of Operations* (WestLand Resources Inc).

A7. Local Government Revenues

Estimates of revenues received by area local governments from Rosemont Copper operations were based on tax information contained in the *Rosemont Copper Project Updated Feasibility Study.* The share of state transactions privilege tax, severance tax, and income tax collections distributed to the area local governments was calculated from data in the Arizona Department of Revenue *FY2008 Annual Report*.

Estimates of revenues received by area local governments as a result of the incremental economic activity induced by Rosemont Copper operations and/or construction activities were based on ratios of tax collections per dollar of gross regional product calculated from data obtained from the U.S. Census Bureau's *State and Local Government Finances database*.
Since the economic impact analysis was focused on the Pima/Santa Cruz Counties region, no estimates of total State government revenues associated with the Project were calculated.

Appendix Table A1: Total Economic Impacts
Engineering/Construction Phase of the Rosemont Copper Project
Output by Industry
Pima County/Santa Cruz County Study Area
(Millions of 2008 $)

Industry/Year	Total	Annual Average	PP3	PP2	PP1	1
Total Non-Farm Private Sector	327.6	81.9	20.6	97.4	176.7	32.8
Forestry, Fishing, Other	0.0	0.0	0.0	0.0	0.0	0.0
Mining	0.2	0.1	0.0	0.1	0.1	0.0
Utilities	3.2	0.8	0.2	0.9	1.6	0.5
Construction	79.1	19.8	4.8	22.6	42.1	9.6
Manufacturing	91.2	22.8	6.0	28.2	50.3	6.6
Wholesale Trade	6.6	1.6	0.4	1.9	3.6	0.7
Retail Trade	16.3	4.1	0.9	4.6	8.6	2.1
Transp, Warehousing	2.0	0.5	0.1	0.6	1.1	0.2
Information	5.3	1.3	0.3	1.5	2.8	0.7
Finance, Insurance	8.4	2.1	0.5	2.6	4.5	0.8
Real Estate, Rental, Leasing	30.9	7.7	1.9	9.1	16.3	3.5
Profess, Tech Services	51.9	13.0	3.5	15.9	28.5	4.1
Mngmt of Co, Enter	1.9	0.5	0.1	0.6	1.1	0.1
Admin, Waste Services	7.2	1.8	0.4	2.1	3.9	0.8
Educational Services	0.9	0.2	0.1	0.3	0.5	0.1
Health Care, Social Asst	9.4	2.3	0.5	2.6	4.8	1.5
Arts, Enter, Rec	1.7	0.4	0.1	0.5	0.9	0.2
Accom, Food Services	6.5	1.6	0.4	2.0	3.5	0.7
Other Services (excl Gov)	4.9	1.2	0.3	1.4	2.6	0.6

Output is the dollar value of all goods and services produced in the region, including all intermediate goods as well and value added (compensation and profit).

Source: Results from the REMI regional economic forecasting model.

Appendix Table A2: Total Economic Impacts
Engineering/Construction Phase of the Rosemont Copper Project
Private Non-Farm Employment by Industry
Pima County/Santa Cruz County Study Area

Industry/Year	Annual Average	PP3	PP2	PP1	1
Private Non-farm Employment	613	161	743	1,318	230
Forestry, Fishing, Other	0	0	0	0	0
Mining	1	0	1	2	0
Utilities	1	0	1	2	1
Construction	165	41	192	352	74
Manufacturing	93	25	117	205	24
Wholesale Trade	9	2	11	20	3
Retail Trade	48	12	56	101	23
Transp, Warehousing	4	1	5	8	1
Information	5	1	6	10	2
Finance, Insurance	11	3	14	24	3
Real Estate, Rental, Leasing	25	6	30	53	11
Profess, Tech Services	127	35	158	277	36
Mngmt of Co, Enter	4	1	5	9	1
Admin, Waste Services	31	8	38	67	12
Educational Services	5	1	6	10	2
Health Care, Social Asst	27	7	31	56	14
Arts, Enter, Rec	11	3	13	23	4
Accom, Food Services	30	8	36	63	11
Other Services (excl Gov)	17	4	20	36	8

Employment includes full-time and part-time jobs by place of work. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are excluded. Public sector and farm workers are excluded.

Source: Results from the REMI regional economic forecasting model.

Appendix Table A3: Total Economic Impacts
Engineering/Construction Phase of the Rosemont Copper Project
Earnings by Place of Work by Industry
Pima County/Santa Cruz County Study Area
(Millions of 2008 $)

Industry/Year	Total	Annual Average	PP3	PP2	PP1	1
Total, Non-Farm Private Sector	327.6	81.9	20.6	97.4	176.7	32.8
Forestry, Fishing, Other	0.0	0.0	0.0	0.0	0.0	0.0
Mining	0.2	0.1	0.0	0.1	0.1	0.0
Utilities	3.2	0.8	0.2	0.9	1.6	0.5
Construction	79.1	19.8	4.8	22.6	42.1	9.6
Manufacturing	91.2	22.8	6.0	28.2	50.3	6.6
Wholesale Trade	6.6	1.6	0.4	1.9	3.6	0.7
Retail Trade	16.3	4.1	0.9	4.6	8.6	2.1
Transp, Warehousing	2.0	0.5	0.1	0.6	1.1	0.2
Information	5.3	1.3	0.3	1.5	2.8	0.7
Finance, Insurance	8.4	2.1	0.5	2.6	4.5	0.8
Real Estate, Rental, Leasing	30.9	7.7	1.9	9.1	16.3	3.5
Profess, Tech Services	51.9	13.0	3.5	15.9	28.5	4.1
Mngmt of Co, Enter	1.9	0.5	0.1	0.6	1.1	0.1
Admin, Waste Services	7.2	1.8	0.4	2.1	3.9	0.8
Educational Services	0.9	0.2	0.1	0.3	0.5	0.1
Health Care, Social Asst	9.4	2.3	0.5	2.6	4.8	1.5
Arts, Enter, Rec	1.7	0.4	0.1	0.5	0.9	0.2
Accom, Food Services	6.5	1.6	0.4	2.0	3.5	0.7
Other Services (excl Gov)	4.9	1.2	0.3	1.4	2.6	0.6

Earnings by place of work is the sum of wage and salary disbursements, supplements to wages and salaries, and proprietors' income.

Source: Results from the REMI regional economic forecasting model.

Appendix Table A4: Total Economic Impacts - Production/Post-Production Phase of the Rosemont Copper Project - Output by Industry
Pima County/Santa Cruz County Study Area
(Millions of 2006 $)

Industry/ Year	Total	Annual Ave.*	PP2	PP1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Total Non-Farm Private Sector	16,281.2	772.2	182.1	312.4	674.9	659.4	718.6	801.2	724.0	784.3	797.7	814.7	812.6	838.4	790.6	687.5	777.1	821.2	808.2	765.9	780.1	801.2	771.4	615.6	171.0	92.3	79.0
Forestry, Fishing, Other	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mining	9327.4	483.9	68.2	104.3	437.5	605.2	459.6	532.3	445.6	502.2	515.8	522.8	506.2	523.6	484.3	369.7	450.7	493.2	498.0	471.4	467.9	503.9	472.7	392.4	55.7	0.7	0.5
Utilities	911.3	42.8	9.1	41.3	46.4	45.4	44.5	45.6	46.6	45.3	43.5	44.7	45.1	45.9	46.1	45.9	45.8	45.9	44.6	40.6	40.3	40.4	41.3	11.8	2.0	1.6	1.3
Construction	655.6	32.4	15.9	31.9	40.6	44.3	45.0	44.5	43.5	41.7	39.5	37.9	36.7	35.1	33.2	32.0	31.2	30.3	25.9	21.6	13.1	18.0	17.5	10.7	-6.7	-15.0	-18.8
Manufacturing	728.6	31.5	5.7	15.9	15.9	20.5	19.7	22.1	23.6	25.2	25.8	28.4	32.0	36.1	34.0	36.8	38.3	39.3	38.6	38.7	38.4	40.1	41.0	35.4	27.5	25.1	23.5
Wholesale Trade	332.7	14.9	4.1	8.0	9.7	11.3	12.0	13.5	13.8	14.3	13.8	14.8	16.0	18.0	16.5	18.0	18.1	17.5	16.4	14.7	14.8	16.0	16.0	12.5	8.5	7.6	6.9
Retail Trade	518.9	23.1	6.8	12.8	15.1	16.9	18.0	19.1	20.3	21.1	21.7	22.8	24.0	24.9	25.0	26.2	27.1	27.7	26.2	25.4	25.5	26.0	26.3	23.0	14.0	12.1	10.9
Transp, Warehousing	315.0	14.8	2.3	13.0	17.2	14.0	14.8	13.2	14.5	14.8	16.1	16.3	17.0	16.2	13.6	15.6	16.6	16.8	15.4	15.5	15.9	15.1	13.3	4.7	1.2	1.0	0.9
Information	300.8	13.1	2.7	5.0	6.2	7.3	8.2	9.1	10.0	10.8	11.4	12.3	13.2	14.0	14.4	15.2	15.9	16.5	16.3	16.2	16.3	16.6	16.9	15.6	11.5	10.1	9.1
Finance, Insurance	235.0	10.4	6.3	9.9	8.9	9.3	9.3	9.6	9.9	10.0	10.0	10.4	10.8	11.1	11.0	11.4	11.8	12.0	10.8	10.3	10.4	10.7	10.9	8.7	4.2	3.8	3.6
Real Estate, Rental, Leasing	764.4	34.8	15.8	27.1	29.9	32.0	32.8	33.9	34.9	35.3	35.3	36.2	37.4	38.0	37.2	38.3	38.0	39.2	35.4	33.3	33.0	33.3	33.4	27.5	11.0	8.4	6.8
Profess, Tech Services	523.8	23.2	6.2	13.5	14.5	17.1	17.1	18.6	19.7	20.7	21.2	22.5	24.3	25.9	25.3	26.4	27.7	27.8	26.8	26.3	26.0	26.5	26.7	22.6	15.3	13.3	11.9
Mngmt of Co, Enter	228.5	10.5	6.6	7.5	7.7	8.7	8.9	9.3	9.5	9.8	9.3	9.6	10.0	10.3	10.5	10.8	11.2	11.4	11.3	11.4	11.7	12.8	13.2	13.0	2.1	1.0	1.0
Admin, Waste Services	179.6	8.0	2.4	4.9	5.7	6.2	6.5	6.8	7.2	7.4	7.5	7.9	8.3	8.7	8.6	9.0	9.3	9.4	8.9	8.6	8.6	8.8	8.9	7.5	4.6	4.0	3.6
Educational Services	22.5	1.0	0.4	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.0	0.6	0.5	0.5
Health Care, Social Asst	325.9	14.0	3.8	6.6	7.6	8.6	9.3	10.1	10.9	11.6	12.3	13.1	13.9	14.6	15.0	15.8	16.6	17.2	16.7	16.7	17.0	17.5	17.9	16.9	12.9	12.3	11.8
Arts, Enter, Rec	45.8	2.0	0.9	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.0	2.1	2.2	2.2	2.2	2.3	2.3	2.4	2.2	2.1	2.1	2.1	2.1	1.9	0.9	0.8	0.8
Accom, Food Services	133.3	5.9	2.6	4.7	5.1	5.4	5.5	5.7	5.8	5.9	6.0	6.1	6.3	6.4	6.3	6.5	6.7	6.7	6.1	5.8	5.8	5.8	5.8	5.0	2.6	2.3	2.1
Other Services (excl Gov)	130.7	5.8	2.0	3.9	4.4	4.7	4.9	5.1	5.3	5.5	5.6	5.8	6.1	6.3	6.2	6.5	6.7	6.8	6.4	6.2	6.2	6.3	6.4	5.3	3.1	2.8	2.6

Output is the dollar value of all goods and services produced in the region, including all intermediate goods as well and value added (compensation and profit).

*Annual average values refer to years 1 - 20

Source: Results from the REMI regional economic forecasting model.

Appendix Table A5: Total Economic Impacts - Production/Post-Production Phase of the Rosemont Copper Project - Private Non-Farm Employment by Industry
Pima County/Santa Cruz County Study Area

Industry/ Year	Annual Ave*	PP2	PP1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Total Non-Farm Private Sector	1,796	423	1,034	1,722	1,861	1,936	1,927	1,938	1,944	1,926	1,889	1,903	1,931	1,924	1,846	1,870	1,882	1,860	1,635	1,514	1,476	1,474	1,458	1,190	420	305
Forestry, Fishing, Other	4	0	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	1	0	0
Mining	358	130	341	397	395	399	397	398	396	394	394	394	394	376	377	376	376	376	286	256	256	256	258	256	-3	-2
Utilities	52	2	13	57	63	61	58	59	59	56	53	54	53	53	53	51	50	50	47	42	41	41	41	11	1	1
Construction	235	42	133	261	325	347	346	334	320	301	279	264	251	236	219	209	200	192	160	130	113	104	100	56	-52	-101
Manufacturing	43	5	17	46	40	51	41	43	43	42	39	41	47	54	43	45	46	43	39	39	35	37	37	26	15	13
Wholesale Trade	50	6	23	43	49	54	54	58	56	56	51	53	55	60	52	55	54	50	45	38	38	40	38	28	18	15
Retail Trade	170	31	80	145	162	173	175	179	181	181	179	181	184	185	179	181	181	179	163	153	148	146	144	120	68	56
Transp, Warehousing	67	4	13	76	97	76	78	67	71	71	75	73	75	69	56	63	66	64	58	57	57	53	45	14	3	3
Information	28	5	10	17	20	23	24	25	27	28	28	30	31	32	32	32	33	33	32	30	30	30	29	26	16	16
Finance, Insurance	41	23	41	59	48	47	45	44	44	42	41	41	42	42	40	41	41	40	35	32	32	32	32	24	11	10
Real Estate, Rental, Leasing	88	21	50	84	90	94	94	94	95	94	93	94	96	96	92	94	95	94	84	78	76	77	76	63	24	18
Profess, Tech Services	165	25	59	127	132	150	146	154	160	163	163	169	179	187	178	183	188	185	174	168	163	163	162	133	86	73
Mngmt of Co, Enter	53	48	53	57	57	61	60	59	58	57	52	52	52	52	51	51	51	50	48	46	46	49	49	47	6	2
Admin, Waste Services	100	16	42	82	91	97	97	100	102	102	101	104	107	109	106	108	110	109	101	95	93	94	93	75	43	36
Educational Services	19	4	9	15	16	17	17	17	18	18	18	19	20	21	21	22	23	23	21	20	21	21	22	19	10	9
Health Care, Social Asst	123	18	46	78	86	93	98	108	109	114	117	123	130	134	135	141	146	150	142	139	141	143	145	134	31	86
Arts, Enter, Rec	38	9	23	35	37	39	39	40	40	40	40	41	42	42	41	42	43	43	38	36	35	36	36	31	14	12
Accom, Food Services	96	21	51	85	90	94	94	96	97	97	97	98	101	102	98	101	103	102	92	87	86	86	85	71	35	31
Other Services (excl Gov)	65	12	28	52	56	59	60	62	64	65	65	67	68	70	69	71	72	72	67	64	63	64	63	53	32	29

Employment includes full-time and part-time jobs by place of work. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are excluded.
Public sector and farm workers are excluded.

*Annual average values refer to years 1 - 20.

Source: Results from the REMI regional economic forecasting model.

Appendix Table A6: Total Economic Impacts - Production/Post-Production Phase of the Rosemont Copper Project - Earnings by Place of Work by Industry
Pima County/Santa Cruz County Study Area
(Millions of 2008$)

Industry/ Year	Total	Annual Ave.*	PP2	PP1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Total Non-Farm Private Sector	2,283.8	105.3	23.4	57.8	95.2	104.4	108.6	110.1	111.8	112.8	112.2	110.4	111.4	113.5	113.6	108.3	111.0	112.3	111.4	96.1	91.0	88.9	88.4	88.9	72.2	21.7	13.3
Forestry, Fishing, Other	1.8	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Mining	583.0	26.4	3.6	24.5	28.3	28.3	28.3	28.4	28.6	28.6	28.6	28.7	28.9	29.0	27.9	28.1	28.2	28.4	28.6	21.9	19.8	19.9	20.1	20.4	20.4	-0.3	-0.2
Utilities	107.4	5.2	0.2	1.3	5.6	6.2	5.9	5.7	5.8	5.8	5.5	5.2	5.3	5.3	5.3	5.3	5.2	5.1	5.1	4.9	4.4	4.3	4.3	4.3	1.2	0.1	0.1
Construction	231.1	11.4	2.1	6.5	12.5	15.6	16.6	16.6	16.1	15.5	14.6	13.5	12.8	12.2	11.5	10.7	10.2	9.8	9.4	7.9	6.4	5.6	5.1	4.9	2.8	-2.6	-5.1
Manufacturing	133.1	6.2	0.6	2.0	5.5	5.4	6.6	6.0	6.3	6.4	6.3	5.9	6.2	6.8	7.5	6.3	6.6	6.9	6.5	6.0	5.9	5.4	5.6	5.6	3.9	1.9	1.2
Wholesale Trade	102.3	4.7	0.4	1.6	3.1	3.7	4.2	4.4	4.9	4.8	4.9	4.6	4.9	5.2	5.7	5.1	5.5	5.4	5.2	4.8	4.2	4.1	4.4	4.4	3.3	2.0	1.6
Retail Trade	177.8	8.0	1.2	3.0	5.5	6.5	7.1	7.5	7.8	8.0	8.2	8.2	8.4	8.6	8.8	8.7	8.9	9.0	9.1	8.4	8.0	7.9	7.9	7.9	6.7	3.6	2.8
Transp, Warehousing	93.0	4.5	0.3	0.9	4.6	6.0	4.8	5.0	4.4	4.7	4.7	5.0	4.9	5.1	4.7	3.9	4.4	4.6	4.6	4.1	4.1	4.1	3.8	3.3	1.1	0.1	0.0
Information	77.1	3.4	0.4	0.9	1.7	2.1	2.4	2.7	2.9	3.1	3.2	3.3	3.5	3.7	3.8	3.8	4.0	4.1	4.2	4.0	3.9	3.9	3.9	3.9	3.5	2.4	2.0
Finance, Insurance	68.6	3.1	1.3	2.4	3.6	3.2	3.3	3.3	3.3	3.3	3.2	3.1	3.1	3.2	3.2	3.1	3.2	3.2	3.2	2.8	2.6	2.6	2.6	2.6	2.0	0.8	0.6
Real Estate, Rental, Leasing	54.0	2.5	0.6	1.3	2.3	2.5	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.7	2.7	2.6	2.6	2.6	2.6	2.3	2.1	2.0	2.0	2.0	1.6	0.5	0.3
Profess, Tech Services	242.3	10.9	1.6	3.8	7.9	8.5	9.7	9.6	10.2	10.6	10.8	10.8	11.2	11.8	12.4	11.8	12.1	12.5	12.4	11.7	11.2	10.9	11.0	10.9	9.0	5.5	4.4
Mngmt of Co, Enter	83.0	3.6	2.5	2.8	3.1	3.2	3.5	3.5	3.6	3.6	3.7	3.4	3.5	3.6	3.7	3.7	3.7	3.8	3.8	3.8	3.7	3.8	4.1	4.2	4.1	0.5	0.1
Admin, Waste Services	73.8	3.4	0.5	1.4	2.7	3.1	3.4	3.4	3.5	3.6	3.6	3.5	3.6	3.6	3.7	3.5	3.6	3.6	3.6	3.3	3.1	3.0	3.0	3.0	2.4	1.2	0.9
Educational Services	11.0	0.5	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.2	0.1
Health Care, Social Asst	150.2	6.6	1.0	2.5	4.3	5.1	5.6	6.0	6.3	6.5	6.7	6.8	6.9	7.1	7.2	7.2	7.3	7.5	7.6	7.2	6.9	6.8	6.9	6.9	6.3	4.1	3.5
Arts, Enter, Rec	14.2	0.6	0.1	0.3	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.5	0.2	0.2
Accom, Food Services	43.0	2.0	0.5	1.1	1.8	2.0	2.1	2.1	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	1.8	1.7	1.6	1.6	1.6	1.3	0.5	0.4
Other Services (excl Gov)	47.1	2.1	0.4	0.9	1.7	1.9	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.2	2.3	2.3	2.3	2.1	2.0	2.0	2.0	2.0	1.6	0.8	0.6

Earnings by place of work is the sum of wage and salary disbursements, supplements to wages and salaries, and proprietors' income.

Annual average values refer to years 1 - 20.

Source: Results from the REMI regional economic forecasting model.