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A COMPREHENSIVE EXAMINATION OF NEVADA'S MINING, QUARRYING, AND OIL AND GAS EXTRACTION INDUSTRY SECTOR'S VALUE NETWORK AND SUPPLY CHAIN

UNIVERSITY OF NEVADA, RENO

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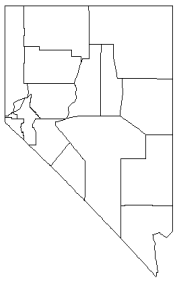

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1.0 Introduction and Overview

Overview

This University Center for Economic Development technical report presents a comprehensive summary of a value network and supply chain mapping project of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector completed by graduate students in the Masters of Business Administration program in the College of Business at the University of Nevada, Reno. Eleven total graduate students participated in this semester-long project, completed during the Spring 2022 academic semester. This effort was divided into four separate parts. Part 1 focused on exploring the historical development and evolution of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector and the evolving use of rare earth metals, precious metals, and industrial minerals in value-added production. Part 2 focused one evaluating existing supply chains and value networks in this industry sector in other parts of the United States and in other parts of the world. Part 3 involved completing a comprehensive value network and supply chain mapping project of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector using Input-Output (I/O) Analysis. Part 4 of this effort included a comprehensive assessment of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector in regard to the overall strength, balance, and resiliency found within the industry's value network and supply chain, evaluating the impacts that the COVID-19 global pandemic has had on the industry's value network and supply chain, and recommendations for closing identifying 'gaps' in the industry's value network and supply chain through targeted community and economic development strategies.

For each of the four individual parts of this comprehensive value network and supply chain mapping project of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector, the eleven participating graduate students, working as one large group, prepared a separate white paper summarizing their analysis and results. For Part 1, Part 2, and Part 3 of the semester-long project, a separate in-class presentation was completed and, for Part 4, students facilitated a half-day Nevada mining industry value network and supply chain symposium held on Monday, May 9, 2022. Section 2.0 of this University Center for Economic Development technical report presents an edited version of the first white paper for Part 1, *Historical Overview of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector*, and Section 3.0 presents an edited version of the second white paper for Part 2, *Evaluating National and International Mining, Quarrying, and Oil and Gas Extraction Industry Sector Value Networks and Supply Chains*. Section 4.0 of this University Center for Economic Development technical report presents an edited version of the third white paper for Part 3, *Development of a Comprehensive Value Network and Supply Chain Map of the Mining, Quarrying, and Oil and Gas Industry Sector in Nevada*, and Section 5.0 presents an edited version of the fourth and final white paper

for Part 4, *Identifying Value Network and Supply Chain Gaps and Developing Community and Economic Development Recommendations*.

While an analysis of the value network and supply chain for Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector is presented for the entire state of Nevada, this analysis was also presented for each of the existing eight regional economic development authorities in order to support community-level and regional economic development efforts. As of the time of publication of this University Center for Economic Development technical report, the eight existing regional economic development authorities in Nevada are:

- Economic Development Authority of Western Nevada (Washoe County)
- Churchill Economic Development Authority (Churchill County)
- Lincoln County Regional Development Authority (Lincoln County)
- Las Vegas Global Economic Alliance (Clark County)
- Nevada 95-80 Regional Development Authority (Humboldt County, Pershing County)
- Northern Nevada Regional Development Authority (Carson City, Douglas County, Lyon County, Mineral County, Storey County)
- Northeastern Nevada Regional Development Authority (Elko County, Eureka County, Lander County, White Pine County)
- Southwest Central Regional Economic Development Authority (Esmeralda County, Nye County)

Funding for this comprehensive examination of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector's value network and supply chain was provided by a U.S. Economic Development Administration Coronavirus Aid, Relief, and Economic Security (CARES) Act grant that the University Center for Economic Development received in 2020. The University Center for Economic Development is a U.S. Economic Development Administration recognized university center. It is the mission of the University Center for Economic Development, part of the College of Business at the University of Nevada, Reno, to foster economic development throughout state by making the extensive resources of the University of Nevada, Reno available to organizations and areas that can benefit from job and income creation and job retention efforts.

2.0 Historical Overview of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

This section of this University Center for Economic Development technical report presents an edited version of the initial white paper developed for Part 1, *Historical Overview of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector*. Part 1 of this initial analysis of the value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector included the following elements:

- A comprehensive timeline showing the evolution of mining operations in Nevada. This timeline incorporates major advances in the approaches and technology used in mining certain types of ore and how mining has spread across the state.

- A detailed overview of the regulatory environment of Nevada's *Mining, Quarrying, and Oil and Gas Extraction* industry sector. This includes a relatively high-level overview of relevant federal, state, and local government laws and regulations and overview of relevant fiscal and taxation policies that mining operations are subject to within the state of Nevada.

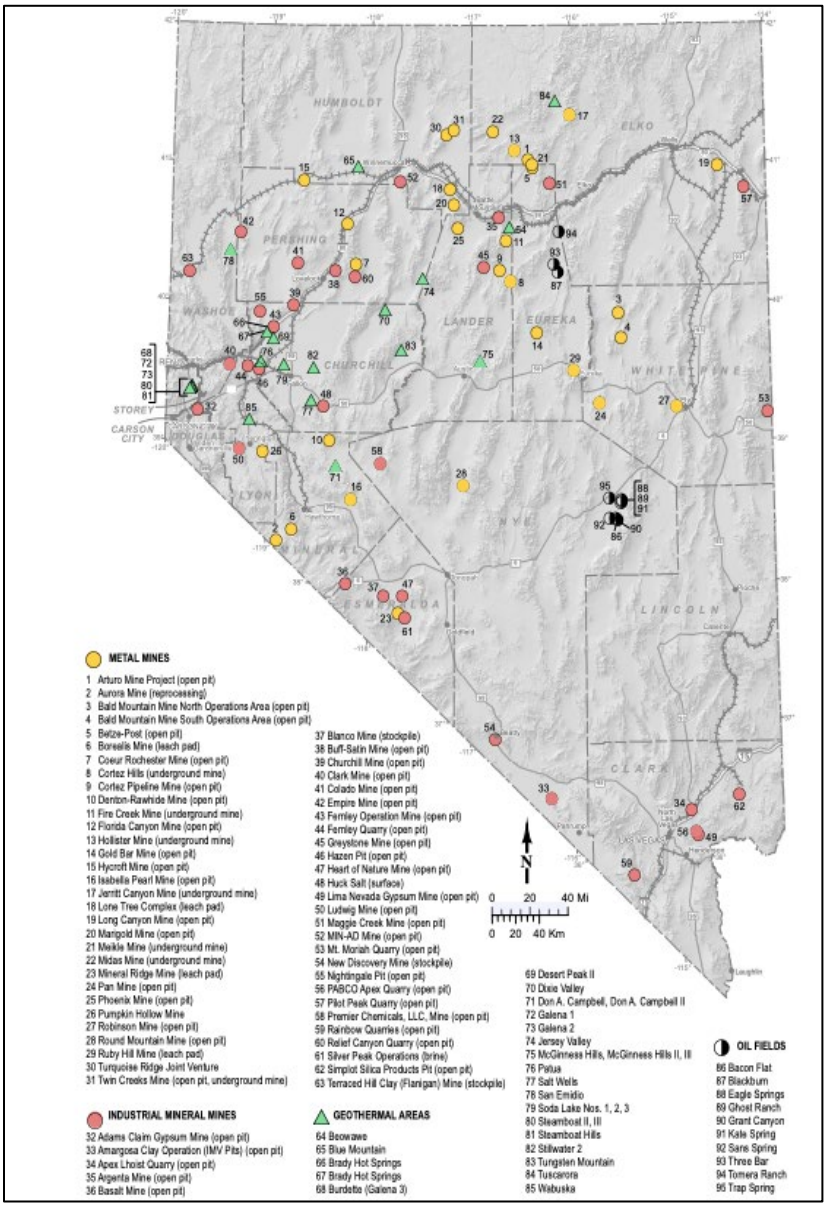
- An overview of county-by-county mining operations within the state. Included is a broad estimate of general economic impact (total estimated employment), the number and type of mines operating by county, and estimates of the type and amount of ore that is currently being produced by county within the state.

- A comprehensive SWOT (Strengths, Weaknesses, Opportunities, and Threats) Analysis of Nevada's *Mining, Quarrying, and Oil and Gas Extraction*.

As both an industry sector and economic activity, mining operations in Nevada predates Nevada's statehood. Since the first mines were opened in the Nevada territory, mining has become and remains a critically important part of Nevada's economic base is a critical driver of community and economic activity for many of the state's local communities and regions. Mining in Nevada is a critical source of employment, a major source of state level and local level public tax dollars, and continues to support new business creation and attraction and existing business retention and expansion efforts in a variety of directly and indirectly related industry and occupation sectors. The Mining, Quarrying, and Oil and Gas industry sector, as of 2020, represents approximately 1.0 percent of the Nevada workforce (U.S. Bureau of Labor Statistics, n.d.) but accounts for nearly 6.0 percent of statewide economic output in Nevada (Economic Impact Summary, Nevada Mining Association, n.d.), with an even greater economic impact for rural Nevada where most of the state's existing mining operations take place as evident in Figure 2.1. According to the USGS Mineral Commodity Summaries 2022, Nevada produced 10.3% of

the value of nonfuel mineral commodities in the United States in 2021, worth approximately $9.4 billion, second only to Arizona.

Figure 2.1 – Major Mines, Oil Fields, and Geothermal Areas
State of Nevada
2020



Source: From Nevada Legislative Counsel Bureau. (2021, April 14). Nevada's Population Change. https://nvlcb.maps.arcgis.com/apps/dashboards/a71ca9f86a68450f8b7d51b8fd9621c8

2.1 Historical Timeline of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

The historical timeline and development of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector can be divided into four general periods beginning with early mining within the state pre-statehood to Nevada's eventual admission as the 36th state of the United States. This pre-statehood to statehood period would be followed by the gradual evolution of mining in Nevada throughout most of the 20th Century, followed by mining activities during and immediately following World War II, and concluding with recent and more contemporary approaches to the extraction and production of precious metals and industrial minerals within the state.

2.1.a Early Mining in Nevada, Pre-Statehood to Statehood

While modern mining operations in Nevada did not begin until 1849, there were still mining activities within what would become the state of Nevada prior to Anglo-American settlement. Native Americans in the Great Basin mined for a variety of substances like obsidian, quartz, jasper, and turquoise (Nevada Mining Association, n.d. b). Prehistoric workings of these small mining operations have been discovered in Crescent District in Clark County and served as guides for future mining explorations (Horton & Lincoln, 1964).

What could be classified as 'modern-day mining' began in 1849 after gold was found at the mouth of Gold Canyon in present-day Dayton, Nevada located in Lyon County. It was not until 1855 when the first placer mine was founded in southern Nevada after Mormon settlers worked their way back to Nevada from California. The beginning attempts of smelting deposits of lead ore were, however, unsuccessful, resulting in the ore being transported to modern-day Las Vegas where a makeshift furnace was initially constructed to smelt the ore. This process began the crude smelting operations in Nevada (Horton & Lincoln, 1964). In 1859, the discovery of the Comstock Lode was made making a significant shift in the focus on early mining in Nevada and subsequent generational mining that would evolve throughout the state.

The miners that remained in Gold Canyon after the initial discovery of gold in 1849 had worked their way to Six-Mile Canyon. National recognition came when a heavy black mineral was found by the workers, was later assayed, and silver sulfide was then discovered. Upon the discovery, the "Washoe Rush" began and thousands of prospectors and individuals migrated to Nevada (Horton & Lincoln, 1964). The square set system of mine timbering was invented at the Comstock Lode by Philip Deidesheimer as a way of stabilizing below grade silver ore mines. The Ophir Mine in Virginia City had grown so large that previous mining and mineral extraction methods could not continue (University of Nevada, Reno, n.d.). Deidesheimer's method facilitated largescale silver ore extraction and processing to continue while not compromising the mine's structural integrity. This "honeycomb" method was implemented in other silver ore mines located throughout the state of Nevada and throughout other parts of the United States (Horton & Lincoln, 1964). The Comstock Lode led prospectors to search for "true fissure veins" near the surface, leaving sizable metal deposits in non-vein areas often overlooked (Hardesty, 2010).

After the ore was mined from the Comstock Lode, it was refined using a variation of the Patio Process in the 1860's (Horton & Lincoln, 1964). After extraction from the Earth, the silver ore was crushed down into a mud-like substance, added to a mercury mixture, and heated in copper containers to remove individual compounds (Encyclopedia Britannica, n.d.). The Washoe Method replaced the copper containers with iron tanks although, in southern Nevada, other mining companies could not implement the Washoe method of pan amalgamation. The Reese River mining district would eventually develop a new process in 1869 that used a chloridizing roast before utilizing the pan amalgamation. This process proved to be more successful for ores in the area. The mining operations of silver had contributed to Nevada's eventual statehood in 1864 and even to the end of the Civil War. Telegraph lines were set up between Virginia City, parts of California, and Salt Lake City, Utah. Legislative efforts proved successful as Nevada's first seated State Senator passed a law recognizing the rules and rights of miners, providing the means to secure a title to land for mining (Horton & Lincoln, 1964).

The Trinity District in Humboldt County had the distinction of being the first mining district with a smelting operation. While this was not the first smelting operation in Nevada, it was larger than the smaller smelting operation that had been established in Las Vegas in 1855. Smelting in Nevada continued until 1879 (Horton & Lincoln, 1964). The Early Discovery Period of mining in Nevada came to a close as various mining districts were discovered and established in Mineral County, including Candelaria, Pine Grove, Mineral Hill, and Paradise Valley. The Early Prosperity Period began with the debut of the Central Pacific Railroad which would eventually lead to a vast interconnected transportation network between established and new mining districts and growing cities. While no new districts were established in the Early Prosperity Period, silver bullion production continued to increase exponentially.

The Early Period of Decline of Nevada's mining industry began in 1881 and ended in 1891. Production decreased notably but not enough to match the period of depression that followed (Horton & Lincoln, 1964). From 1892 to 1899 there was a nationwide economic depression in the United States contributed to a sharp and prolonged decline in mining operations. By the end of the 19th Century and into the early part of the 20th Century, Nevada would eventually emerge a major producer of gold, silver and copper for the military through World War I. Other critical minerals used to support war production efforts that were mined in Nevada included tungsten, manganese, uranium and vanadium.

2.1.b A New Century in Mining

In 1900, mining throughout Nevada quickly expanded with the discovery of silver as part of the Mizpah Mine in Tonopah, Nevada (Western Mining History, 2020). During this early part of the beginning of the 20th Century, several new counties and towns, known as boomtowns, were formed despite the general decrease in mining activity in Tonopah decreased as known ore deposits were quickly depleted. Rawhide mines would eventually produce both gold and silver, while places like Rhyolite and Goldfield became large producers and suppliers of gold for the entire country. The Goldfield Consolidated Mining Company was established in 1906 and other

districts like Ely and Yerington produced copper and lead respectively throughout this first decade of the 20th Century (Horton & Lincoln, 1964).

In 1908, the Mackay School of Earth Sciences and Engineering was founded in honor of a Comstock miner named John W. Mackay (Nevada Mining Association, n.d. b) at the University of Nevada. Also known as Mackay Mines, the school endowed scholarships for miners to advance in the trade. Into the second decade of this new century, other Nevada counties, mining districts and communities like Clark, Lincoln, Mineral, Hawthorne, Esmeralda, Pershing, Humboldt and Lovelock continued to attract settlers. Mining quickly became the primary economic activity for each of these developing areas. The Tonopah Belmont Mine Fire, that eventually killed 17 individual miners, would eventually transform mining safety efforts. This event, along with several other fatal mining accidents throughout the state, would lead to the formation of several independent associations with the general mission of protecting miner safety, including the Nevada Mine Operations Association of 1913 in Tonopah. The Nevada Mine Operations Association would later become the Nevada Mining Association, with its current headquarters located today in Reno, Nevada in Washoe County.

National and even global economic turbulence would again lead to a significant decline in statewide mining production, this time due to the Great Depression between 1930 and 1933. Existing mining efforts before the Great Depression included lead, zinc, silver, copper, and gold production from Yellow Pine District and silver and lead mining at Quartz Mountain in Nye County. A rise in the price of gold in 1933 led to a significant and swift recovery in Nevada's mining sector, especially in districts with active gold mining producers. High gold prices combined with low-cost mining operations gave rise to widespread precious-metal mining in Nevada. Open-pit operations had been used successfully for mining ore at that time. During this period, gold was Nevada's most valuable metal, accounting for approximately 41.0 percent of the total value of all metals mined and produced in Nevada. In 1935, White Pine County contributed the most to Nevada's mineral wealth. The growing demand for copper, lead, and zinc in 1936 led to significant price increases but generally unfavorable economic conditions at the national level in 1937 slowed overall expansion and led to a general decrease in the production of gold and silver. Copper and zinc, however, experienced a slight increase in total production. Following these changes, in 1938, all metal production declined significantly due to ongoing national and global economic uncertainty.

2.1.c Mining During and Immediately Following the Second World War

As World War II began in 1939, Nevada's mineral production had increased by almost 30.0 percent. Nevada mines produced tungsten, barite, lead, and zinc during that time, providing the nation with the needed materials to produce critical wartime infrastructure. This increase in activity continued through until 1940, especially at Northumberland Mining Company, Summit King Mines, and Combined Metal Reduction. Old-tailing cyanidation, the primary method for precious metals recovery, was eventually terminated by this time but connected bucket dredging, dragline excavators, small-scale hand mining, and placer drift mining remained in operation.

A significant increase in general mining activity throughout the state of Nevada occurred in 1940 as the Northumberland Mining began full-scale operation of its 280-ton cyanide plant and Summit King Mines began operating its 250-ton cyanide mill. These new large-scale operations led to the eventual termination of the large-scale working of old tailing piles in the rest of the state. With increased demand for tungsten, Nevada-Massachusetts Company built a tungsten plant in Pershing County in 1941. Nevada continued to produce various metals at a high level up until 1942 when the War Production Board's Order L-208 forced most gold mines to close and all custom cyanide mills were shut down. In 1943, the majority of gold produced throughout the state of Nevada was a by-product of copper mining (Horton & Lincoln, 1964).

The basalt mine in Mineral County, Dicalite Division, was discovered in 1905, but it only shipped occasionally until 1928, increasing in the 1940's. Manganese production peaked in 1944, primarily in Clark County, White Pine County, and Pershing County, as overall demand for wartime related materials rose. Nevada was the national leader in tungsten production by 1946. During this period, the effects of World War II had weakened, high demand for metal and high prices on mineral and metal commodities had declined, and gold and silver mining returned to steady pre-war production levels. This "peaceful mining period" was ultimately short lived and ended by the Korean War in 1950, resulting in a drop in gold and silver production to a point where Summit King Mines, the second-largest silver producer in Nevada, discontinued operations. High prices and high demand for copper led to the highest production levels of copper in Nevada. A notable event in 1954 was the development of Nevada's first oil well by Shell in Eastern Nevada.

An increase in production of all commodities except gold and tungsten occurred in 1956 by a significant economic depression would eventually curtail growth of Nevada's mining industry sector in 1957, which caused some projects to be terminated and total employment throughout the sector to be reduced. While precious and industrial metal and mineral prices had reached historical lows by 1960, copper and iron exploration throughout the state had increased significantly by 1961. In 1964, copper became Nevada's premier produced mineral, accounting for over 60.0 percent of total statewide mining production and Nevada's first Portland cement facility was established to support activity in industrial mineral extraction and production. Iron was eventually mined from Eureka County, Humboldt County, and Pershing County throughout the 1960's (Horton & Lincoln, 1964).

In 1965, the first gold bar was extracted from the Carlin Trend in northeastern Nevada and led to the eventual development of one of the premier goldfields in the world. Because of the extremely fine grain size of its gold particles, referred to as "invisible gold," Carlin been overlooked by previous prospectors. A few gold deposits of what would later become known as the Carlin-type were found in the late 1800's and early 1900's but their significance was not recognized until the Carlin discovery in 1961 and the eventual opening of the Carlin mine in 1965. The deposits of the Carlin Trend and other Carlin-type deposits have catapulted Nevada to one of the largest gold-producing states, making the United States a major producer and net exporter of gold (Coope, 1991). Large-scale mining, heap leaching, and automation would ultimately become commonplace at various levels in the mining, milling, and assaying processes.

The northeastern Nevada region continues to be one of the most productive mining areas in state and in the world.

In 1970, percussion drilling would become one of the most common techniques for the sampling challenge presented in metal and mineral exploration and eventual largescale production and extraction. The drill, which worked exceptionally well, operated only with compressed air and at a depth of approximately 130 feet. By the end of 1971, most mercury mines in Nevada had closed and mercury was only produced as a by-product of mining operations occurring at the Carlin gold mine. Despite this, Nevada became the first state to produce mercury in 1974 with the opening of the McDermitt Mercury Mine (Horton & Lincoln, 1964).

2.1.d Recent and Contemporary Mining in Nevada

The price of gold rise to approximately $850 an ounce in 1980 and, in 1981, new technology had facilitated a new gold rush in the Nevada (The New York Times, 1981). This technological breakthrough in metal and mineral extraction included a process in which precious metals could be separated from rock in an isolation process. Nevada would significantly benefit from this new expansion of metal and mineral mining by 1985 and the state's mining and natural resource extraction industry sector would continue to boom with new job creation opportunities and the continued discovery of more gold and silver deposits using continuously improving extraction methods. Mining and natural resource extraction operations contributed significantly to Nevada's economy, employing nearly 6,000 people in 1985 alone (Tingley, J. V., 2000).

Despite the overall growth of the state's mining and natural resource extraction industry sector during the 1980's, mining has been overshadowed by casino and tourism sector growth in the state's more urban counties including Carson City, Clark County, Douglas County, and Washoe County. The mining and natural resource extraction industry sector has, however, remained a primary driver of economic activity and principal source of employment for several of Nevada's more rural counties including Elko County, Eureka County, Humboldt County, Lander County, and White Pine County. In 1986, the laws to protect mining land and rare earth metals in Nevada were significantly revised by the United States Congress. The Great Basin National Park Act of 1986 was passed by the United States Congress and signed by President Ronald Reagan, designating 76,000 acres near Wheeler Peak as a national park. In 1987, Nevada became the nation's leading producer of silver, for the first time since the Comstock era. In 1988, the Rochester Mine was the largest silver producer in the United States. In 1990, for 11 years straight, the record of annual gold production was broken in the Nevada. An estimated 85.0 percent of Nevada's mineral production was gold, which contributed to approximately 61.0 percent of total gold production for the entire United States and nearly 8.0 percent to global gold production (Tingley, Horton & Lincoln, 1993).

Copper and by-product mercury were the only base metals recovered by the end of 1992. During this time, Nevada's industrial mineral sector grew and the state produced a wide range of products including barite, gypsum, diatomite, lithium carbonate, magnesite, perlite, building stone, cement-making limestone, sand, and gravel. Gold production in 1992 reached a record of 6.5 million ounces, which accounted for nearly 85.0 percent of the state's non-fuel valley (Price,

2005). Exploration of precious metals remained generally stable until the end of the decade, after decreasing between 1989 and 1992. Total gold production in Nevada peaked in 1998 at 8.9 million ounces and has been steadily declining since. Because of the low price of gold in recent years, a number of mines have closed or have been placed on care and maintenance status and overall exploration operations have been significantly reduced. An increase in state and federal laws governing mining and natural resource extraction operations, and growing uncertainty about long-term access to federal lands for the purpose of mining and mineral extraction, have each contributed to the general decline in overall exploration. Silver output peaked in 1997 at nearly 25.0 million ounces and has continued to decline since (Price, 2005).

Nevada remains the world's second-largest gold producer, with published gold reserves of approximately 143.0 million ounces at the end of 1999. A portion of these reserves may never be mined but reserves that are economical to mine are likely sufficient enough to keep Nevada's gold mining industry viable for another 15 to 25 years. Nevada's total silver deposit reserves were estimated to be over an estimated 235.0 million ounces at the end of 1999 (Nevada Bureau of Mines and Geology, 2001). During the 1990s, industrial mineral production fluctuated with a gradual increase near the conclusion of the decade. In 2000, Barrick Gold were the second largest single private-sector producer in-terms of gold output in the United States, with 2.45 million ounces being produced by Barrick Gold from Nevada-based mines. Barrick Gold's Betze-Post Mine in Eureka County became Nevada's top gold producer and the Meikle Mine in Elko County had the highest total production levels among underground gold mines in the United States in 2000. In 2000 alone, Nevada produced almost $395 million worth of industrial minerals, a 3.0 percent increase since 1999 (Howard, 2000). In 2000, sand and gravel aggregate was the second most valuable mineral produced. Nevada's gold production, valued at nearly $3.0 billion, accounted for almost 83.0 percent of the United States domestic gold production total and helped the United States become the world's second largest gold producer in 2005 (UNR, 2005).

In 2008, the total value of all mined commodities achieved an all-time high in Nevada's mining and natural resource extraction industry sector. The value of Nevada's mining and natural resource extraction industry sector was approximately $6.1 billion, up $0.7 billion from 2007 (UNR, 2008). By the end of 2010, Nevada's reported gold reserves at or near currently operational mines that can be mined profitably under current economic conditions (UNR, 2010) and, in-terms of total production value, copper came in second to gold in 2013 (UNR, 2013). Exploration activities and finance are intimately linked to general macroeconomic conditions and commodity prices, just as are gold deposits. Exploration activity throughout the state of Nevada continued to decline in 2015, owing mostly to falling gold prices nationally and globally (UNR, 2015). Publicly disclosed reserves for 2019 had the biggest active mines amounting to around 58.0 million ounces of gold (Visher & Patterson, 2021). Current reserves are estimated to be sufficient to sustain gold production under similar economic conditions without any reserve replenishment.

Nevada's economy has always relied on mining and it continues to do so today. The United States Bureau of Land Management Nevada solid minerals program includes locatable minerals such as gold and silver. Nevada is the only state that produces lithium, where it is useful in a

wide variety of emerging technologies. With over 180,000 active mining claims, 198 permitted mining plans of operations, and 282 active exploration notices, Nevada leads the nation with the largest mining program in the United States Bureau of Land Management (Visher & Patterson, 2021).

2.2 Regulatory Environment of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

This sub-section provides an overview of federal and state legal and regulatory concerns governing Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector as well as relevant fiscal and taxation policies. Mining companies in Nevada are subject to an extensive federal and state regulatory system that requires permitting and compliance for the full life cycle of the mine as well as after closure.

2.2.a Federal Mining-Related Regulations

When prospectors first began settling in the western United States in search of riches, they self-regulated with their own "miner's code" due to the absence of government in the west. Miners would "stake" claims and those claims could be "jumped" if they were not properly staffing and working the staked land (Hupp, 2016). While still technically illegal on a federal level, open mining was common in the western United States. As mining claims throughout the western United States increased, the *General Mining Act of 1872* was signed into law. As stated by the Nevada Legislature, "Approximately 87 percent of Nevada is federally managed and thus federal mining law is especially relevant in Nevada" (Nevada Legislature, 2010). The *General Mining Act of 1872* allows individual United States citizens or corporations to prospect on federal public domain lands, stake claims, and obtain exclusive rights to hard rock mineral deposits on discoveries they make. The General Mining Act of 1872 was an act originally created to promote the development of mineral resources of the United States. The law is currently restricted to certain "locatable" materials as defined by the United States Department of the Interior as (1) recognized as a mineral by the standard experts, (2) not subject to disposal under some other law, and (3) make the land more valuable for mining than for farming (Bureau of Land Management, n.d.a). *The Mineral Leasing Act of 1920* (MLA) controls leasing of public land for coal, oil, natural gas and other minerals. Prior to this act, these minerals were under the purview of the General Mining Act of 1872 (Ballot Pedia, n.d.).

The *National Historic Preservation Act of 1966* (NHPA) established a program to preserve historic and archeological sites in the United States as listed in the National Register of Historic Places. The Native American Historic Preservation Office must be given a chance to comment on mining operations which have acted alongside federal agencies and may impact structures listed in the National Register of Historic Places. Mining often takes place in the same location as historic mines and therefore endangers remnants of local heritage (U.S. Environmental Protection Agency, 1994). The *Endangered Species Act of 1973* (ESA) requires federal agencies, in consultation with the United States Fish and Wildlife Service and/or the National Oceanic and Atmospheric Administration Fisheries Service to ensure that actions they authorize,

fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. Mining operations must comply with the formal consultation processes to evaluate effects on the surrounding environment. If it is found that a threatened or endangered species may be affected by a new mining operation, an endangered species assessment will be required as well (Environmental Protection Agency, n.d.b). The *Federal Land Policy and Management Act of 1976* provides the United States Bureau of Land Management with the authority for public land planning and management and the land use must be coordinated with applicable and appropriate federal, state, and local agencies. The United States Bureau of Land Management is further tasked with ensuring compliance with applicable pollution control laws and can take necessary action to prevent "unnecessary or undue degradation" of public lands (Bureau of Land Management, n.d.c).

The Federal Mine Safety and Health Act of 1977 was passed by the United States Congress in order to protect the health and safety of coal and other mine workers. The main intention of the Federal Mine Safety and Health Act of 1977 was to set mandatory standards for the health and safety of mine workers and their families. As part of this law, an independent Federal Mine Safety and Health Review Commission was established in order to pursue the necessary enforcement actions. Among other regulations, the Federal Mine Safety and Health Act of 1977 requires that four annual inspections for underground mines and two annual inspections for surface mines be completed (U.S. Department of Labor, n.d.).

2.2.b State of Nevada Mining-Related Regulations

Nevada specific mining-related regulations can be divided into three general areas, the first including general regulation of mining activities and operations and the second governing the closure of existing mines. The third and final general area of Nevada specific mining-related regulations involves reclamation processes that are implemented post-closure of an existing mining operation.

Regulation

The primary environmental regulatory body in Nevada's mining industry is the Bureau of Mining Regulation and Reclamation, created in 1989 within the Nevada Division of Environmental Protection (Butler, 2013). It is the mission of the Bureau of Mining Regulation and Reclamation to "ensure that Nevada's waters are not degraded by mining operations and that the lands disturbed by mining operations are reclaimed to safe and stable conditions to ensure a productive post-mining land use". The Bureau of Mining Regulation and Reclamation is comprised of three branches including (1) Regulation, (2) Closure, and (3) Reclamation (Mining, n.d). Primary oversight and regulation is also provided by the Nevada Division of Minerals. The Nevada Division of Minerals is responsible for production and development of the state's mineral resources including geothermals, minerals produced by the mines, drilling, wells, oversight of dangerous conditions, bond pools, oil, and gas (Nevada Legislature, 2010).

As illustrated in Figure 2.2, the federal government owns and manages approximately 85.0% of Nevada's lands, meaning most operations must obtain state permits and approval from the United States Bureau of Land Management for mining or exploration that disturbs more than five acres of land. In order to obtain approval, this requires submissions of a plan of operations and preparation of an Environmental Assessment or Environmental Impact Statement subject to public comment. The plan needs to show compliance with the National Environmental Policy Act, the Endangered Species Act, and the National Historic Preservation Act (Butler, 2013).

Figure 2.2 – Federal Lands and Recognized Native American Colonies, Communities, and Reservations
State of Nevada

Source: From Federal land policy in Nevada. Ballotpedia. (n.d.). https://ballotpedia.org/Federal_land_policy_in_Nevada#:~:text=The%20federal%20government%20owns%2081.07,nation%20in%20federal%20land%20ownership

Water in Nevada is managed by the Nevada Division of Water Resources through prior appropriation and beneficial use. Prior appropriation grants priority water appropriation to senior water rights, where "first in time, first in right" (Weldon, n.d.). Beneficial uses include mining, irrigation, recreation, commercial, industrial, and municipal use. Beneficial use also

includes the principle of "use it or lose it" to prevent speculative holding of water rights (Water Law and Issues in Nevada: An Overview, 2019). Every mine must obtain a water pollution control permit (WPCP), subject to public review and notice requirements, from the Bureau of Mining Regulation and Reclamation prior to construction of any mining, milling, or beneficiation process activity and must be renewed every five years. For operations that will discharge pollutants to surface water, they must obtain a National Pollutant Discharge Elimination System (NPDES) permit from the Nevada Division of Environmental Protection Bureau of Water Pollution Control (BWPC). For operations that discharge dredged or fill materials into water of the United States, they must obtain a permit from the United States Army Corps of Engineers as part of the Clean Water Act (Butler, 2013). Mining operations must also obtain construction and operating permits from the Nevada Division of Environmental Protection's Bureau of Air Pollution Control (BAPC) (Butler, 2013).

Closure

The Bureau of Mining Regulation and Reclamation also has a closure branch in charge of managing the final closure of mine properties to confirm sites are properly stabilized and do not pose any future risk to the environment. Operations must submit a final closure plan two years prior to anticipated mine closures and a final closure report once the activities in the plan have been completed (Closure Branch, n.d.).

Reclamation

A reclamation plan to demonstrate how the disturbed land will be returned to stable and productive post-mining land use (i.e. suitable for livestock grazing or for use as a wildlife habitat) must be submitted in order to obtain a permit from the Bureau of Mining Regulation and Reclamation's Reclamation Branch. To protect both the environment and Nevada taxpayers, operators must also provide a financial guarantee, or bond, before mining operations can take place providing enough money for the Nevada Division of Environmental Protection to hire contractors to restore the land if the mining operation goes bankrupt (Butler, 2013).

2.2.c Federal Mining-Related Tax Policies

Production of hard rock minerals on federal lands is governed by the *General Mining Act of 1872* and does not require the payment of royalties to the federal government. Development of oil and gas on federal lands is governed primarily by the *Mineral Leasing Act of 1920*. When oil is produced in "paying quantities" a 12.5 percent royalty fee is generally collected for onshore operations. For federal oil and gas leases, royalties are assessed on the gross value of production minus allowable deductions. Some leaseholders pay between $1.50 and $2.00 an acre (Bahouth, 2021). The revenue sharing system is set up to generally provide states with approximately 50.0 percent share of revenues collected (rents, bonuses, and royalties), and 40.0 percent goes to the Federal Reclamation Fund, which primarily supports irrigation and hydropower projects overseen by the Bureau of Reclamation (Reclamation fund: How revenue works, 2022) and 10.0 percent goes to the Federal Treasury (Taylor III, n.d.).

Mining companies do pay a corporate income tax although they are allowed tax subsidies based on the mining stage they are in, as recognized by the United States Internal Revenue System as either exploratory, development, production, or reclamation. Mining companies can deduct expenses related to the exploration and development of mines, such as surveying the land, ascertaining the quantity and quality of minerals, and developing the necessary infrastructure for production. Once a mining company has shifted into the production phase, the mining company is allowed a depletion allowance (US Department of Treasury, 2006). *Depletion Allowance*, a form of depreciation, permits a mining company to deduct a portion of its gross annual income when calculating its federal income tax, either on a fixed percentage basis (percent depletion method) depending on the deposit type as illustrated in Figure 2.3 or on a units-of-production basis (cost depletion method) and the larger resulting calculation of the two methods is used.

Figure 2.3 – Percentage Depletion Allowance by Mineral Deposit Type

Type of Deposit	Percentage Depletion
Sulfur, uranium, and, iif from deposits in the United States—anorthosite, clay, laterite, and nephelite syenite (to the extent that alumina and aluminum compounds are extracted therefrom), asbestos, bauxite, celestite, chromite, corundum, fluorspar, graphite, ilmenite, kyanite, mica, olivine, quartz crystals (radio grade), rutile, block steatite talc, and zircon, and ores of the following metals: antimony, beryllium, bismuth, cadmium, cobalt, columbium, lead, lithium, manganese, mercury, molybdenum, nickel, platinum and platinum group metals, tantalum, thorium, tin, titanium, tungsten, vanadium, and zinc.	22%
Gold, silver, copper, iron ore, and certain oil shale, if from deposit in the United States	15%
Metal mines (not above), rock asphalt, vermiculite, ball clay, bentonite, china clay, sagger clay, and clay used or sold for purposes dependent on its refractory properties	14%
Asbestos, brucite, coal, lignite, perlite, sodium chloride, and wollastonite	10%
Clay and shale used or sold for use in making sewer pipe or bricks or used or sold for use as sintered or burned lightweight aggregates	7.50%
(A)gravel, peat, pumice, sand, scoria, shale, and stone (B)clay used, or sold for use, in the manufacture of drainage and roofing tile, flower pots, and kindred products; and (C)if from brine wells—bromine, calcium chloride, and magnesium chloride.	5%
All other minerals, including, but not limited to, aplite, barite, borax, calcium carbonates, diatomaceous earth, dolomite, feldspar, fullers earth, garnet, gilsonite, granite, limestone, magnesite, magnesium carbonates, marble, mollusk shells (including clam shells and oyster shells), phosphate rock, potash, quartzite, slate, soapstone, stone (used or sold for use by the mine owner or operator as dimension stone or ornamental stone), thenardite, tripoli, trona, and (if paragraph (1)(B) does not apply) bauxite, flake graphite, fluorspar, lepidolite, mica, spodumene, and talc (including pyrophyllite)	14%

Source: From Legal Information Institute. (n.d.). 26 U.S. Code § 613 - percentage depletion. Legal Information Institute. https://www.law.cornell.edu/uscode/text/26/613

Depletion allowance reflects the declining production of reserves over time. The depletion allowance may not exceed 50.0 of net income (US Department of Treasury, 2006). Lastly, during the reclamation phase, mining companies are allowed to deduct expenses for reclamation and closing in the current year, prior to actually taking any action on reclamation and closing (US Department of Treasury, 2006).

2.2.d State of Nevada Mining-Related Tax Policies

The Nevada Mining Oversight and Accountability Commission was created by Nevada Senate Bill 493 of the 2011 Session of the Nevada Legislature. The Nevada Mining Oversight and Accountability Commission is comprised of seven members who are appointed by the Governor, per Nevada Revised Statute Chapter 514A. The Commission has oversight of compliance with Nevada law relating to the activities of each state agency, board, bureau, commission, department or division with respect to the taxation, operation, safety and environmental regulation of mines and mining in Nevada. The Nevada Department of Taxation serves as staff to the Nevada Mining Oversight and Accountability Commission (State of Nevada Department of Taxation, n.d.).

The *Net Proceeds of Minerals Act* was added to the Nevada Constitution in 1989 and limits mining taxes to no more than 5.0 percent of net proceeds (Kersten, 2012). Per Nevada Revised Statute Chapter 363 Section 120, in order to calculate the net proceeds, mining is allowed 12 deductions (Appendix A: Allowable Deductions to Calculate Net Proceeds, per NRS 362.120). According to the Nevada Current, out of the 30 operating gold mines in Nevada in 2019, 14 of them declared enough deductions to zero out their state mining tax bill. The rate of tax is determined by the ratio of the net proceeds to gross yield and is on a sliding scale from 2.0 percent to 5.0 percent.

From this taxed amount, a portion of the overall tax liability is based on the local county rate where the mine is located, and the balance up to the constitutional limit of 5.0 percent is the state portion of the tax going to the state's general fund. According to the Nevada Department of Taxation Net Proceeds of Minerals Bulletin, of the approximately $9.1 billion in actual gross proceeds of minerals in 2020, only about 2.0 percent in taxes were paid, or approximately $179 million, with about half for the state and half for the county as illustrated in Figure 2.4. There are currently three state joint resolutions (AJR1, AJR2, and SJR1) proposing to increase the tax rate from its current 5.0 percent cap (Girnus, 2020).

The *Nevada Commerce Tax* applies to the Mining, Quarrying, and Oil and Gas Extraction industry sector and is calculated by subtracting $4 million from the gross revenue of the business in a taxable year and then multiplying that remaining amount by 0.051 percent (NRS: Chapter 363C - Commerce Tax, n.d.). *Nevada Assembly Bill 495*, aimed at bolstering the state's education system, would impose a new excise tax on companies with more than $20 million in gross revenue. If the revenue of that firm were between $20 million and $150 million, the tax rate would be 0.75 percent and, if above $150 million, the rate would be 1.1 percent. This could amount to as much as $150 million per year in additional annual taxes (Sieroty, 2021).

Figure 2.4 – Net Proceeds of Minerals by Operation
State of Nevada
Calendar Year 2020

CALENDAR YEAR 2020 NET PROCEEDS OF MINERALS - OPERATORS TAX

# Operators	Industry	2020 Actual Gross Proceeds	2020 Actual Net Proceeds	2020 Actual County Tax Due	2020 Actual State Debt Due	2020 Actual State GF Due	2020 Actual Total Tax Due
29	Gold/Silver	8,413,415,346.61	3,419,352,088.89	82,519,882.09	5,812,898.55	82,586,710.07	170,919,490.71
1	Copper	371,040,787.00	46,716,209.00	1,630,395.69	79,417.56	625,997.20	2,335,810.45
20	Geothermal	143,118,572.17	94,373,096.83	2,715,893.73	160,434.27	0.00	2,876,328.00
5	Gypsum	41,371,950.00	2,335,683.00	72,225.44	3,970.66	9,754.88	85,950.98
13	OIL	7,329,877.00	1,522,862.28	42,808.16	2,588.87	19,050.79	64,447.82
35	Other	177,981,572.90	60,889,681.75	1,734,369.48	103,512.46	1,090,754.16	2,928,636.10
103	**Total**	**9,154,258,106**	**3,625,189,622**	**88,715,575**	**6,162,822**	**84,332,267**	**179,210,664**
	Gold/Silver	91.91%	94.32%	93.02%	94.32%	97.93%	95.37%
	Copper	4.05%	1.29%	1.84%	1.29%	0.74%	1.30%
	Geothermal	1.56%	2.60%	3.06%	2.60%	0.00%	1.60%
	Gypsum	0.45%	0.06%	0.08%	0.06%	0.01%	0.05%
	OIL	0.08%	0.04%	0.05%	0.04%	0.02%	0.04%
	Other	1.94%	1.68%	1.95%	1.68%	1.29%	1.63%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Other represents the following minerals

BARITE, BASALT, BENTONITE, CLAY, DIATOMACEOUS EARTH (D.E.), DOLOMITE, FLUORSPAR, IRON, LIMESTONE, LITHIUM, MAGNESITE, OPALS, PERLITE, POZZOLAN, RHYOLITE, SALT, SILICA, TRACE MINERALS, TURQUOISE

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Source: State of Nevada Department of Taxation. (2021, August 4). Net proceeds of minerals archived files. Net Proceeds of Minerals Bulletin 2020-2021. *https://tax.nv.gov/LocalGovt/PolicyPub/ArchiveFiles/Net_Proceeds_of_Minerals/*

2.3 Mining Operations in Nevada

This sub-section explores Nevada's county-by-county mining operations by examining the general economic impact of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector in addition to the types and quantities of metals or minerals extracted. This sub-section also expands on total employment of Nevada's mining industry, education levels, and median wages.

2.3.a Employment Economic Impact

In rural Nevada, the mining and natural resource extraction industry sector is one of the largest industry sectors, if not the top-performing industry, in most counties. As of 2020, almost 15,000 people were directly employed by mining throughout the state of Nevada. The average pay between various counties is over $100,000 and, according to the Nevada Governor's Office of Economic Development, likely closer to $123,000. Lincoln County and Washoe County were the only counties that have had fewer mining jobs since a decade ago, which is expected since mining has decreased nationwide since 2010. However, while the nation's mining and natural resource extraction industry sector has lost approximately 5.0 percent in-terms of total employment since 2010, the mining and natural resource extraction industry sector in Nevada has grown over 20.0 percent in-terms of total employment in the same time frame while still managing to pay wages that are in excess of the national and state average for wages as illustrated in Table 2.1.

Table 2.1 – Industry Summary for the Mining, Quarrying, and Oil and Gas Extraction Industry Sector
State of Nevada
2020

Total Employment (2020)	Percent Change (2010 to 2020)	Average Earnings per Job (2020)
14,932 (Nevada) 152.0% above the National Average	Nevada: 21.0% National: -4.8%	Nevada: $123,789 National: $128,341

Source: Nevada Governor's Office of Economic Development (2021)

The two counties with the largest populations, Clark County and Washoe County, have very few people employed in the Mining, Quarrying, and Oil and Gas Extraction industry sector as a percentage of total employment. However, counties such as Eureka County and Lander County, are almost completely dependent on the mining and natural resource extraction industry sector as a source of private-sector employment, with 70.0 percent and 92.0 percent of total employment accounted for by this industry sector. The mining and natural resource extraction industry sector in both Eureka County and Lander County also provide some of the highest wages for the state. As Table 2.2 illustrates, the highest average pay for workers in the mining and natural resource extraction industry sector is in Lyon County where only 4.0 percent total employment countywide is accounted for by the Mining, Quarrying, and Oil and Gas Extraction industry sector (State of Nevada Commission, n.d.a).

Even though the Mining, Quarrying, and Oil and Gas Extraction industry sector is the single largest source of private sector employment in Eureka County and the Mining, Quarrying, and Oil and Gas Extraction industry sector pays the highest average wages in Eureka County relative to all other Nevada counties and to the state of Nevada as a whole, the most common level of education is only a high school diploma for this county. In 2019, approximately 47.0% of Eureka County permanent residents had a high school education level. This was higher than

Some College for either Clark County and Washoe County where the state's two four-year universities, the University of Nevada, Las Vegas and the University of Nevada, Reno, are located and an estimated 33.0 percent and 34.0 percent of each county's permanent residential population have at least *Some College* as the highest educational attainment level (U.S. Department of Agriculture, 2021).

Table 2.2 – Total Employment and Average Wage Paid for the Mining, Quarrying, and Oil and Gas Extraction Industry Sector by County
State of Nevada
2010 and 2020

County	Total Employment (2010)	Total Employment (2020)	Average Wage Paid (2020)
Carson City	18	20	$61,808
Churchill County	<10	39	$67,556
Clark County	293	525	$85,446
Douglas County	34	37	$90,751
Elko County	1,962	2,297	$119,910
Esmeralda County	75	90	$90,065
Eureka County	3,851	3,901	$138,490
Humboldt County	1,772	1,846	$132,552
Lander County	1,634	2,090	$126,885
Lincoln County	12	<10	N/A
Lyon County	111	357	$140,833
Mineral County	19	177	$91,718
Nye County	969	1,169	$114,534
Pershing County	335	693	$105,237
Storey County	62	123	$93,080
Washoe County	278	242	$119,239
White Pine County	824	1,322	$112,485
Total	**12,249**	**14,928**	**$105,662 (Average)**

Source: State of Nevada Commission on Mineral Resources, Division of Minerals. (n.d.-a). Abandoned mine lands (AML). https://minerals.nv.gov/Programs/AML/AML/

2.3.b Mining Operations

For the entire state of Nevada, there were 95 major mining and natural resource extraction, production, and procurement operations in 2020. Of 95 extraction, production, and procurement operations, 32 are industrial mineral mines, 31 are metal mines, 22 are geothermal production areas, and ten are oil fields (Visher, Patterson 2021). In 2020, seven of the 63 metal and mineral mines reported no active mining production.

Of the 17 counties in Nevada, 15 had at least one active major mining operation in 2020. The highest concentration of mining and natural resource extraction, production, and procurement

activity was in Elko County with 11 total operations, followed by Lander County with eight total operations, Pershing County with seven total operations, and Churchill County and Humboldt County each with six active operations. Five additional counties, Clark County, Eureka County, Esmeralda County, Lyon County, and Nye County, each had five active operations in 2020. Four counties, including Lincoln County, Storey County, Washoe County, and White Pine County, had just one active operation.

2.3.c Mineral Production by County

The mining industry continues to drive economic activity throughout the state of Nevada. Continued increases in the price of gold, silver, copper, and other precious metals has supported continued growth of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector. With Nevada leading the nation in Nevada, mining and natural resource operations throughout the state continue to produce high qualities of various precious metals and industrial minerals. Mining activity in Nevada in just 2020 resulted in nearly $8.2 billion of gold extracted.

While each county has and continues to play a crucial role in the success of the industry, three counties, Elko County, Eureka County, and Lander County, lead statewide production activities. While counties like Churchill County and Lincoln County primarily mine salt and perlite as seen in Table 2.3, Elko County, Eureka County, and Lander County primarily mine gold, silver, and copper, commodities with significantly high prices. This is not to say that mining operations that do not extract these three commodities are less valuable. With the exclusion of gold, the other 14 commodities mined throughout the state of Nevada make up approximately 50.1 percent of the estimated total value from mining and natural resource extraction operations. Commodities such as lithium are also becoming increasingly popular given this rare earth metal's use across a variety of existing and emerging industry sectors.

Elko County had 11 existing mining and natural resource extraction operations in 2020, producing gold, silver, copper, limestone, molybdenite, and quartzite. Additionally, the 867,929 ounces of gold mined in 2020 in Elko County accounted for 18.7 percent of all gold mined in the state. Elko County was also the leader of copper mining an estimated 110.0 million pounds of copper ore extracted in 2020. While Elko County is responsible for over $1.0 billion of revenue, mines and natural resource extraction operations in Eureka County and Lander County were also significant producers of various precious metals and industrial minerals.

Similar to Elko County, mines and natural resource extraction operations in Lander County produced significant quantities of gold, silver, and copper as well as barite ore. Mines and natural resource extraction operations in Lander County in 2020 accounted for 21.7 percent of all gold ore produced statewide, accounted for approximately 20.8 percent of all silver ore produced statewide, and accounted for approximately 27.2 percent of statewide copper ore produced. Given that gold accounts for nearly 92.5 percent of Nevada's estimated total mining and natural resource extraction output value, Lander County's output in gold alone accounts for nearly 20.0 percent of the estimated dollar value of all gold ore extracted statewide. However, Eureka County produced the most gold ore in 2020 in-terms of total amount produced.

Table 2.3 – Nevada Major Mine Production: Barite, Molybdenite, Quartzite, Salt, Magnesium, Dolomite, Silica, Perlite 2020									
County	**No. of Mines**	**Barite (tons)**	**Molybdenite (tons)**	**Quartzite (tons)**	**Salt (tons)**	**Magnesium (tons)**	**Dolomite (tons)**	**Silica (tons)**	**Perlite (tons)**
Carson City	0	0	0	0	0	0	0	0	0
Churchill	6	0	0	0	15,042	0	0	0	0
Clark	5	0	0	0	0	0	321,000	570,097	0
Douglas	0	0	0	0	0	0	0	0	0
Elko	11	0	426,538	3,490	0	0	0	0	0
Esmeralda	5	0	0	0	0	0	0	0	0
Eureka	5	0	0	0	0	0	0	0	0
Humboldt	6	0	0	0	0	0	0	0	0
Lander	8	138,238	0	0	0	0	0	0	0
Lincoln	1	0	0	0	0	0	0	0	2,715
Lyon	5	0	0	0	0	0	0	0	0
Mineral	4	0	0	0	0	0	0	0	0
Nye	5	0	0	0	0	0	321,000	0	0
Pershing	7	0	0	0	0	0	0	0	0
Storey	1	0	0	0	0	0	0	0	0
Washoe	1	0	0	0	0	0	0	0	0
White Pine	1	0	0	0	0	0	0	0	0
Total	**71**	**138,238**	**426,538**	**3,490**	**15,042**	**124,088**	**321,000**	**570,097**	**2,715**

Source: From Visher, M., and Patterson, L., 2021, Major mines of Nevada 2020 – mineral industries in Nevada's economy: Nevada Bureau of Mines and Geology Special Publication P-32, 28 p

Eureka County has five existing mines and natural resource extraction operations that produce gold and silver. Eureka County's 1.3 million ounces of gold mined in 2020 accounts for nearly 28.3 percent of total statewide gold ore production and for approximately 26.4 percent of the state's estimated total dollar value output. Nevada's 17 counties and their efforts in extracting gold, silver, copper, lithium, and other commodities, as illustrated in Table 2.4, has produced an estimated total dollar value output of approximately $9.0 billion in metal and mineral production (Visher, Patterson 2021).

Table 2.4 – Nevada Major Mine Production: Gold, Silver, Copper, Lithium, Gypsum, Limestone, Specialty Clay, Diatomite, and Pozzolan 2020										
County	**No. of Mines**	**Gold (oz)**	**Silver (oz)**	**Copper (lbs)**	**Lithium (lbs)**	**Gypsum (tons)**	**Limestone (tons)**	**Specialty Clay (tons)**	**Diatomite (tons)**	**Pozzolan (tons)**
Carson City	0	0	0	0	0	0	0	0	0	0
Churchill	6	0	0	0	0	0	398,055	0	73,969	0
Clark	5	0	0	0	0	1,564,218	1,206,000	0	0	0
Douglas	0	0	0	0	0	0	0	0	0	0
Elko	11	867,929	36,660	0	0	0	0	0	0	0
Esmeralda	5	2,800	1,358	0	6,902,966	9,131	0	0	3,759	
Eureka	5	1,309,761	36,660	0	0	0	0	0	0	0
Humboldt	6	811,243	187,456	0	0	0	0	0	37,075	0
Lander	8	1,003,928	1,272,180	41,957,856	0	0	0	0	0	0
Lincoln	1	0	0	0	0	0	0	0	0	0
Lyon	5	293	10,757	2,667,827	0	271,976	19,731	4,889	0	30,634
Mineral	4	52,930	188,906	0	0	0	0	0	0	0
Nye	5	314,199	933,702	0	0	0	0	186,800	0	0
Pershing	7	79,084	3,216,348	0	0	510,549	73,475	0	258,922	0
Storey	1	0	0	0	0	0	0	0	83,243	0
Washoe	1	0	0	0	0	0	0	4,889	0	0
White Pine	1	190,496	64,555	0	0	0	0	0	0	0
Total	**71**	**4,632,663**	**6,129,426**	**154,264,931**	**6,902,966**	**2,355,874**	**3,220,860**	**196,578**	**456,968**	**30,634**

Source: From Visher, M., and Patterson, L., 2021, Major mines of Nevada 2020 – mineral industries in Nevada's economy: Nevada Bureau of Mines and Geology Special Publication P-32, 28 p

2.4 Strengths, Weaknesses, Opportunities, and Threats Analysis of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

This sub-section provides an assessment of the strengths, weaknesses, opportunities, and threats of Nevada's Mining, Quarrying and Oil and Gas Extraction industry sector. As previously mentioned, the Mining, Quarrying, and Oil and Gas Extraction industry sector is an important economic sector for the entire state of Nevada and is a critical driver of overall economic activity, source of private sector employment, and source of public revenues for several of Nevada's individual counties. The analysis presented in this sub-sector identifies major internal

and external factors that might affect future performance of Nevada's Mining, Quarrying and Oil and Gas Extraction industry sector.

2.4.a Strengths

While there are many individual strengths associated with Nevada's Mining, Quarrying and Oil and Gas Extraction industry sector, four specific strengths were identified as part of this analysis, including:

- *Skilled Workforce:* Nevada has a long history of mining operations and has seen a fair share of boom to bust in this industry. With such a strong background, Nevada has developed a highly skilled workforce that meets the rigorous needs of this sector. The University of Nevada, Reno's Mackay School of Earth Sciences and Engineering has academic programs to train future miners. Such ties to local universities have built strong, mutually beneficial partnerships.

- *Top Mining Destination:* In February 2021, the renowned Fraser Institute named Nevada as the world's top mining destination. The Fraser Institute reached this conclusion based on two indices, the first being Best Practices Mineral Potential, based on geologic potential, and the second being the Policy Perception Index which measures the effects of government policies (Jamasmie, C., 2021). This has led to a high level of interest in investment and exploratory activities.

- *Support for Rural Counties:* Nevada's counties are geographically spread far and wide where mining and natural resource extraction is the main source of economic growth in most rural areas. Mining companies have a positive influence over rural counties given how much land they own, the number of individuals that they employ, and their contribution to general economic activity in those areas.

- *Safe Work Practices:* Nevada's Mining, Quarrying and Oil and Gas Extraction industry sector follows strict guidelines when it comes to worker safety. With a culture of providing a safe work environment and health awareness, the industry has successfully navigated and mitigated the impacts of the ongoing COVID-19 global pandemic. Many mining companies operate at a global scale and have dealt with other global crises, resulting in Nevada's Mining, Quarrying and Oil and Gas Extraction industry sector being more prepared to handle disruptions than other industry sectors within the state (Sattarvand, 2021).

2.4.b Weaknesses

While there are many individual weaknesses associated with Nevada's Mining, Quarrying and Oil and Gas Extraction industry sector, four specific weaknesses were identified as part of this analysis, including:

- *Workforce:* Recently, Nevada has seen a surge in overall mining and natural resource extraction activity. Based on current employment, it is evident that there are not enough workers to meet existing and future labor demand. Programs through local colleges and universities have helped alleviate some of this concern but a significant gap between labor demand and labor supply in Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector still exists.

- *Toxic Waste Production:* Mining, beneficiation, and extraction processes produce toxic waste with high amounts of heavy metals that leach into surrounding soil and water (Fashola et al., 2016). Hazardous abandoned mines are found throughout Nevada (State of Nevada Commission on Mineral Resources, n.d.) where mercury and other substances were not properly disposed of from initial mining in the 1800's. This poses a risk to the environment, the health of the workforce, and to the health of the community at large. As Nevada's population increases, the potential of exposing a community's population to harmful side effects of past mining and natural resource extraction activities is much higher today.

- *Impact on the Environment:* Mining operations permanently change the local landscape and can have a significant negative impact on area flora and fauna. Recently, in Esmeralda County, Tiehm's buckwheat plant, as shown in Figure 2.5, was declared endangered and protected in an area of approximately 910 acres near the nation's largest lithium deposit. While the United States Fish and Wildlife has attributed the growing concern over the loss of the Tiehm's buckwheat plan to local squirrels, Australia-based ioneer, responsible for this project, was also noted for impacting nearly 17,000 flowers that environmentalists claim are not found anywhere else on Earth (Scheyder, E 2022).

Figure 2.5 – Tiehm's Buckwheat Plant

Source: Scheyder, E. (2022, February 3). Rare flower to get protected zone near ioneer's Nevada lithium mine. https://www.reuters.com/business/environment/us-regulators-preserve-acreage-near-ioneers-lithium-mine-site-2022-02-02/

- *Negative Public Image:* With mining and natural resource extraction being associated with potential environmental harm and the possibility of mine sites in Nevada being on land that is of historical and cultural significance for various Native American Tribes and indigenous peoples, there has been measured push back from local communities on certain mining projects. Although the exact location is being disputed, local Native American Tribes and indigenous peoples have claimed that The Thacker Pass Lithium deposit region is the site of a massacre that happened in 1865, involving the killing of 31 members of the Paiute Tribe. This region is also used by existing indigenous peoples for food harvesting, sacred ceremonies, and herbal medicines. In order to protect this land, there have been protests against this project (Flin, B., 2021). For Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector and for individual firms operating within this industry sector, these events have painted a negative picture despite the positive economic impact mining and natural resource extraction operations have had for communities located throughout the state.

2.4.c Opportunities

Four specific opportunities were identified as part of this analysis, including:

- *High Demand for Rare Minerals:* Rare earth elements are needed for value-added production activities in the electronics, automotive, defense, and aerospace industries. Permanent magnets used in computers, cell phones, automobiles and other products are said to be the single, largest end-use for these elements (Government of Canada, n.d.).

- *Discovery of New Mineral Reserves:* One of the nation's largest known lithium deposits is located in Thacker Pass. A new extraction method using sulfuric acid is expected to help spark the Nevada's next "gold rush" of lithium production (Kapoor, M., 2021).

- *Government Support for Critical Minerals:* The Biden Administration has taken steps to rebuild the nation's rare earth elements supply chain. China has monopolized the global market for rare earth elements in recent years with artificially created low prices and low costs of labor. The new infrastructure bill, signed by President Biden in November 2021, and a large analysis of domestic supply chains seeks to improve sourcing and begin competition in the market (Subin, S. 2021).

- *Russia - Ukraine Crisis:* The Russia-Ukraine conflict, which began in February 2022, has contributed to the continued increase in the of raw materials. Russia has historically been a major exporter of oil and natural gas. Disruptions to the supply of oil and natural gas from Russian markets due to global sanctions on the import-export of Russian sourced oil and natural gas has already increased the demand for energy sources and rare earth elements from other countries.

2.4.d Threats

Six specific threats were identified as part of this analysis, including:

- *Demand Greater than Production:* The demand for rare earth elements may exceed production capabilities as demand for these elements increases over time. Demand for rare earth elements has doubled in the past 15 years to nearly 125,000 tonnes and is expected to reach 315,000 tonnes by 2030 (Pozo-Gonzalo, 2021). This could lead to missed opportunities and may drive-up commodity prices. Specifically, dysprosium used for the production of permanent magnets reflects a volatile market due to unmatched supply and demand (Mission 2016, n.d.).

- *New Mining Royalties:* The United States House of Representatives Committee on Natural Resources currently supports legislation to modernize hard rock mining in the United States. Mining and natural resource extraction companies are expected to pay a royalty on publicly owned minerals that are mined, strengthening environmental and reclamation standards, protecting special places such as areas without surface road access and wild and scenic rivers from mining, and devoting resources to cleaning up the long legacy of abandoned mine lands (Natural Resources Committee, n.d.).

- *New Mining Standards:* In 2018, the Initiative for Responsible Mining Assurance has proposed a standard for responsible mining. The Initiative for Responsible Mining Assurance's IRMA-STD-001 is based on four core principles, including (1) Business Integrity, (2) Planning and Managing for Positive Legacies, (3) Social Responsibility, and (4) Environmental Responsibility (IRMA, 2018).

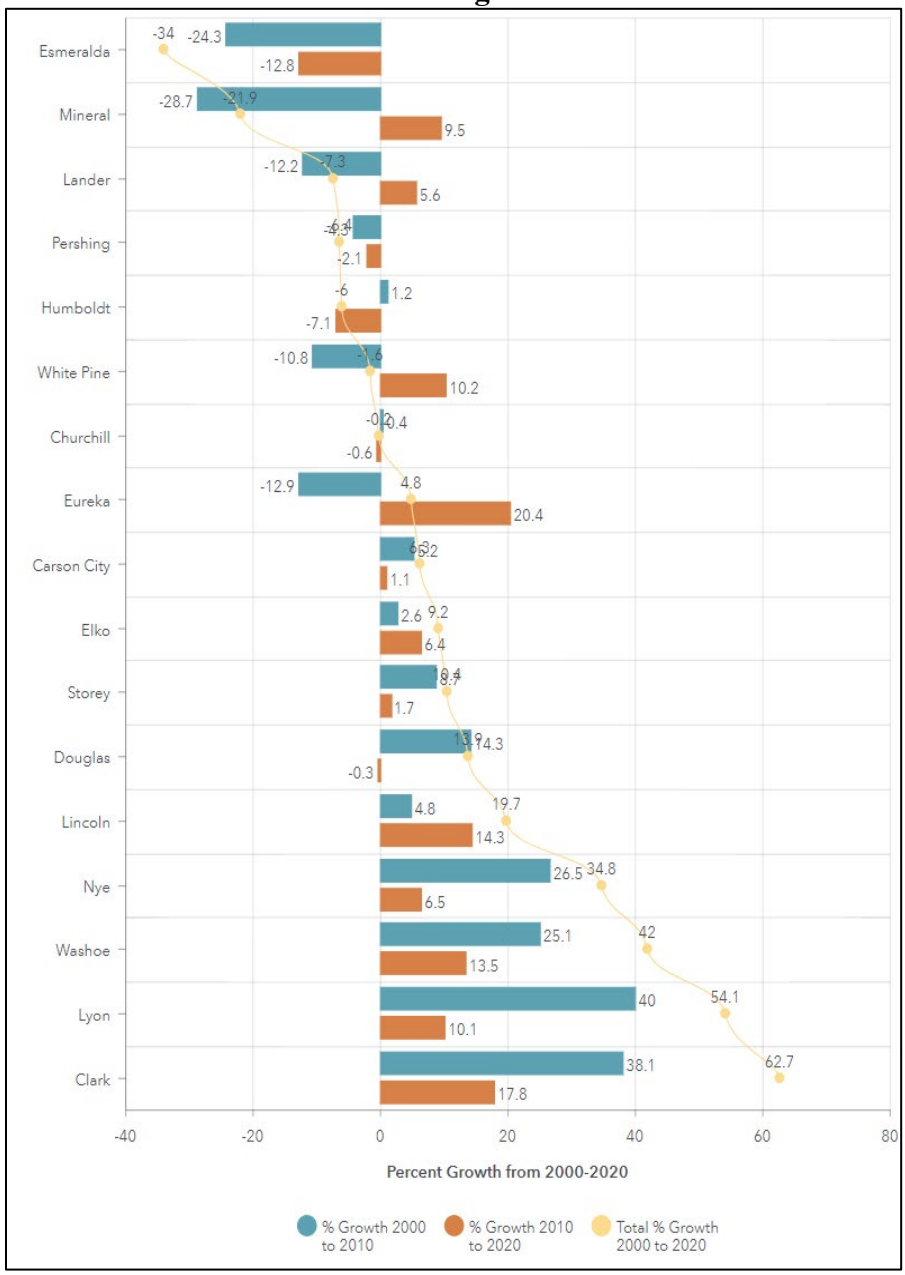
- *Population Decline and Taxation in Rural Nevada:* Populations in several of Nevada's rural communities has continued to decline as younger population groups move to larger, more urban metropolitan communities as evident in Figure 2.6. Tax changes are also hurting rural counties. Previously, tax revenue from mining and natural resource extraction operations located within the state of Nevada was shared between counties and the state. In Humboldt County alone, mining net proceeds were responsible for nearly 20.0 percent of the county's total public revenue. However, with newly proposed changes, the state of Nevada would collect 7.75 percent of all gross proceeds from operations within the state's Mining, Quarrying, and Oil and Gas Extraction industry sector.

- *Inflation:* Continued high rates of inflation nationwide is also a potential threat to Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector. Rising operational costs, including wages, equipment, and raw materials needed for production, have and will continue to decrease overall revenue and profitability from private sector mining and natural resource extraction operations. In order to offset these rising costs and continued inflationary pressures, mining and natural resource extraction operators may end up cutting costs by reducing overall production levels in order to remain competitive.

- *Global Supply Chain Disruptions:* Despite the lessons learned during the global COVID-19 pandemic, any future disruption to global supply chains can and will affect already fragile supply chains. Since mining and natural resource extraction in Nevada still

largely imports talent (labor) and goods and services (needed to support mining and natural resource extraction operations, there will be a heavy price to pay under these circumstances.

Figure 2.6 – Total Population Growth Rates for Nevada Counties
State of Nevada
2000 through 2020



Source: Nevada Legislative Counsel Bureau. (2021, April 14). Nevada's Population Change. https://nvlcb.maps.arcgis.com/apps/dashboards/a71ca9f86a68450f8b7d51b8fd9621c8

References for Section 2.0, White Paper for Part 1 *Historical Overview of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector*

Bahouth, B. (2021, January 31). *What could an oil and gas lease moratorium mean for Nevada*. Sierra Nevada Ally. https://www.sierranevadaally.org/2021/01/31/what-could-an-oil-and-gas-lease-moratorium-mean-for-nevada/

Ballot Pedia (n.d.). *Mineral Leasing Act of 1920*. https://ballotpedia.org/Mineral_Leasing_Act_of_1920

Bureau of Land Management. (n.d.-a). *About Mining and Minerals*. https://www.blm.gov/programs/energy-and-minerals/mining-and-minerals/about

Bureau of Land Management. (n.d.-b). *Collecting on Public Lands*. https://www.blm.gov/sites/blm.gov/files/documents/files/collecting_on_publiclands.pdf

Bureau of Land Management.(n.d. -c). *The Federal Land Policy and Management Act of 1976*. https://www.blm.gov/sites/blm.gov/files/AboutUs_LawsandRegs_FLPMA.pdf

Butler, J. (2013, April). *Environmental Regulation of Nevada's Mining Industry*. Nevada Lawyer. https://www.nvbar.org/wp-content/uploads/NevLawyer_April_2013_Environmental_Regulation.pdf

Clarke, K. (2006, April 21). National Mining Association. *Bureau of Land Management - Energy and Non-Energy Mineral Policy*. http://www.nma.org/pdf/072606_blm.pdf

Closure Branch. Nevada Department of Environmental Protection. (n.d.). https://ndep.nv.gov/land/mining/closure

Coope, J. A. (1991). Nevada Bureau of Mines and Geology. *Carlin Trend Exploration History: Discovery of the Carlin deposit*. University of Nevada, Reno, Mackay School of Mines.

Encyclopedia Britannica, inc. (n.d.). *Patio process.* https://www.britannica.com/technology/patio-process

Environmental Protection Agency. (n.d.-a). *The Origins of EPA*. https://www.epa.gov/history/origins-epa

Environmental Protection Agency. (n.d.-b). *Summary of the Endangered Species Act*. https://www.epa.gov/laws-regulations/summary-endangered-species-act

Environmental Protection Agency. (n.d.-c). *Summary of the Toxic Substances Control Act*. https://www.epa.gov/laws-regulations/summary-toxic-substances-control-act

Environmental Protection Agency. (n.d.-d). *What is the National Environmental Policy Act?* https://www.epa.gov/nepa/what-national-environmental-policy-act

Environmental Protection Agency. (n.d.-e). *Summary of the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)*. https://www.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act

Environmental Protection Agency. (n.d.-f). *Overview of the Clean Air Act and Air Pollution*. https://www.epa.gov/clean-air-act-overview

Environmental Protection Agency. (n.d.-g). *Superfund: CERCLA Overview*. https://www.epa.gov/superfund/superfund-cercla-overview

Fashola, M. O., Ngole-Jeme, V. M., & Babalola, O. O. (2016, November 13). *Heavy metal pollution from Gold Mines: Environmental Effects and bacterial strategies for resistance*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5129257/

Flin, B. (2021, December 2). '*Like putting a lithium mine on Arlington cemetery': the fight to save sacred land in Nevada*. The Guardian. https://www.theguardian.com/us-news/2021/dec/02/thacker-pass-lithium-mine-fight-save-sacred-land-nevada

Girnus, A. C. (2020, August 3). *The legislature passed 3 mining proposals. Now what?* Nevada Current. https://www.nevadacurrent.com/2020/08/03/the-legislature-passed-3-mining-proposals-now-what/

Government of Canada (n.d.). *Rare Earth Elements*. Government of Canada. 22, from https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/rare-earth-elements-facts/20522

Hardesty. (2010). *Mining Archaeology in the American West: A View from the Silver State*. University of Nebraska Press.

Horton, R.C. & Lincoln, F. C. (1964). *Outline of Nevada mining history. Part 1. An outline of the mining history of the State of Nevada (1855-1992)*. Mackay School of Mines, University of Nevada.

Hupp, T. (2016) *Water Risks in the Mining Sector.* Columbia Center on Sustainable Investment. https://www.theresahuppauthor.com/blog/2016/05/25/development-of-mining-codes-in-the-california-gold-rush/

IRMA (2018, June). *IRMA Standard for Responsible Mining*. Responsible Mining. https://responsiblemining.net/wp-content/uploads/2018/07/IRMA_STANDARD_v.1.0_FINAL_2018-1.pdf

Jamasmie, C. (2021). *Nevada is the world's new top mining destination*. The Northern Miner. https://unr.idm.oclc.org/login?url=https://www.proquest.com/newspapers/nevada-is-worlds-new-top-mining-destination/docview/2511918312/se-2?accountid=452

Kapoor, M. (Feb 18th, 2021). *Nevada lithium mine kicks off a new era of Western extraction*. High Country News. https://www.hcn.org/issues/53.3/indigenous-affairs-mining-nevada-lithium-mine-kicks-off-a-new-era-of-western-extraction

Kersten Communications Inc. for the Progressive Leadership Alliance of Nevada (PLAN). (2012, June). *Fool's Gold: Why Nevada's Net Proceeds of Minerals Tax Is Not A Real Tax*. http://www.planaction.org/wp-content/uploads/Final-Mining-Report-June-2012.pdf

Mining (n.d.). *Mining*. Nevada Department of Environmental Protection. https://ndep.nv.gov/land/mining

Mining history (n.d.). *Mining History*. Nevada Bureau of Mines and Geology. http://www.nbmg.unr.edu/mining/MiningHistory.html

Mission 2016 (n.d.). *Mission 2016: The Future of Strategic Natural Resources*. https://web.mit.edu/12.000/www/m2016/finalwebsite/problems/ree.html

Natural Resources Committee. (n.d.). *Energy and mineral resources: The House Committee on Natural Resources.* https://naturalresources.house.gov/subcommittees/energy-and-mineral-resources

Nevada Bureau of Mines and Geology. (2001, November). *Nevada's mineral production in 2000*. http://www.nbmg.unr.edu/_docs/Newsletters/nl38.htm

Nevada Governor's Office of Economic Development (2021), *Nevada's Mining Sector.* https://goed.nv.gov/wp-content/uploads/2021/07/mining.pdf

Nevada Mining Association. (n.d.-a). *Economic impact summary.* Nevada Mining Association. https://www.nevadamining.org/wp-content/uploads/2018/01/NMA-Brief05-Economic-Impact-Summary.pdf

Nevada Mining Association. (n.d.-b). *Mining's History In The Silver State*. Nevada Mining Association. https://www.nevadamining.org/new-history-page/

Nevada Legislature (2010, December 7). *Overview of Mining*. Nevada Legislature Presession Issue Briefings.

Nevada Legislature (n.d.) *Background Paper 87-1. Mining in Nevada in the 1980's*. https://www.leg.state.nv.us/Division/Research/Publications/Bkground/BP87-01.pdf

NRS: Chapter 362 - Taxes on patented mines and proceeds of minerals. (n.d.). https://www.leg.state.nv.us/nrs/nrs-362.html

NRS: Chapter 363C - Commerce Tax. (n.d.). https://www.leg.state.nv.us/nrs/nrs-363C.html

Papke, K. G., & Davis, D. A. (2019). *Mining Claim Procedures for Nevada Prospectors and Miners.* Nevada Bureau of Mines and Geology.

Pozo-Gonzalo, C. (2021, April 15). *Demand for rare-earth metals is skyrocketing, so we're creating a safer, cleaner way to recover them from old phones and laptops. The Conversation*. https://theconversation.com/demand-for-rare-earth-metals-is-skyrocketing-so-were-creating-a-safer-cleaner-way-to-recover-them-from-old-phones-and-laptops-141360#:~:text=The%20annual%20demand%20for%20rare,enormous%20pressure%20on%20global%20production.

Price, J (2005, April 23) *Geology of Nevada*. Nevada Mining. https://www.nevadamining.org/wp-content/uploads/2018/01/Geology_of_Nevada_23April2005.pdf

Reclamation fund: How revenue works. How revenue works | Natural Resources Revenue Data. (n.d.). https://revenuedata.doi.gov/how-revenue-works/reclamation/

Sattarvand, J. (2021, April 7). *Knock-on effects of covid-19 on the mining industry*. Nevada Today. https://www.unr.edu/nevada-today/news/2021/covid-effects-on-mining

Scheyder, E. (2022, February 3). *Rare flower to get protected zone near ioneer's Nevada lithium mine*. https://www.reuters.com/business/environment/us-regulators-preserve-acreage-near-ioneers-lithium-mine-site-2022-02-02/

Sieroty, C. (2021, July 5). *Mining for taxes: Raising State Revenues in Nevada*. Nevada Business Magazine. https://www.nevadabusiness.com/2021/07/mining-for-taxes-raising-state-revenues-nevad

State of Nevada Commission on Mineral Resources, Division of Minerals. (n.d.-a). *Abandoned mine lands (AML)*. https://minerals.nv.gov/Programs/AML/AML/

State of Nevada Commission on Mineral Resources, Division of Minerals. (n.d.-b) *Data Resources.* https://minerals.nv.gov/data/data/

State of Nevada Department of Taxation. (n.d.). Mining Oversight and Accountability Commission. https://tax.nv.gov/Boards/Mining_Oversight_and_Accountability/Mining_Oversight_and_Accountability_Commission/

Subin, S. (2021, April 17). *The new U.S. plan to rival China and end cornering of market in rare earth metals*. CNBC. https://www.cnbc.com/2021/04/17/the-new-us-plan-to-rival-chinas-dominance-in-rare-earth-metals.html

Taylor III, J. E., Steiner, E., Fryauff, K., Allen, C., Sherman, A., & Frank, Z. (n.d.). *A Spatial History of In-Lieu Programs for Western Federal Lands. Federal Mineral Leasing Act Payments*. Follow the Money. http://followthemoney.stanford.edu/pages/BLM_FML.html

The New York Times. (1981, April 22). *A gold rush in Nevada's Hills is spurred by New Technology.* https://www.nytimes.com/1981/04/22/business/a-gold-rush-in-nevada-s-hills-is-spurred-by-new-technonlgy.html

Tingley, J.V., Horton, R.C. & Lincoln, F.C. (1993). *Outline of Nevada Mining History 1992:* Nevada Bureau of Mines and Geology Special Publication MI-1992, p. 3-48

Tingley, J.V., (2000), *Major precious metals deposits, in The Nevada mineral industry 1999*: Nevada Bureau of Mines and Geology Special Publication MI-1999, p. 26-38

U.S. Bureau of Labor Statistics. (n.d.). *Nevada economy at a glance*. U.S. Bureau of Labor Statistics. https://www.bls.gov/eag/eag.nv.htm

U.S. Department of Agriculture (2021, February). *Completion Rates, 2015-2019, Completing College, Adults 25 and Over*. https://data.ers.usda.gov/reports.aspx?ID=17829

U.S. Department of Labor (n.d.). *1977 - Mine Safety and Health Administration (MSHA) created.* https://www.msha.gov/1977-%E2%80%93-mine-safety-and-health-administration-msha-created

U.S. Department of Treasury. (2006, November). *Internal Revenue Service Overview of the Mining Industry*. https://www.irs.gov/pub/irs-utl/mining_industry_overview_november_2006.pdf

U.S. Environmental Protection Agency. (1994, December). Technical Document Background for NEPA Reviewers: Non-Coal Mining Operations.

U.S. Geological Survey. (2022). *Mineral Commodities Summary 2022*. https://pubs.usgs.gov/periodicals/mcs2022/mcs2022.pdf

University of Nevada, Reno (UNR). (n.d.). *Science of the Comstock - Physics*. Nevada Bureau of Mines and Geology. http://www.nbmg.unr.edu/scienceeducation/ScienceOfTheComstock/Physics-Timbering.html

University of Nevada, Reno (UNR). (2005). *The Nevada Mineral Industry 2005*. http://epubs.nsla.nv.gov/statepubs/epubs/210988-2005.pdf

University of Nevada, Reno (UNR). (2008). *The Nevada Mineral Industry 2008*. http://epubs.nsla.nv.gov/statepubs/epubs/210988-2008.pdf

University of Nevada, Reno. (2010). *The Nevada Mineral Industry 2010*. http://epubs.nsla.nv.gov/statepubs/epubs/210988-2010.pdf

University of Nevada, Reno. (2013). *The Nevada Mineral Industry 2013*. http://epubs.nsla.nv.gov/statepubs/epubs/210988-2013.pdf

University of Nevada, Reno. (2015). *The Nevada Mineral Industry 2015*. http://epubs.nsla.nv.gov/statepubs/epubs/210988-2015.pdf

Water Law and Issues in Nevada: An Overview. (2019, December). https://www.leg.state.nv.us/Division/Research/Documents/water-overview-2019.pdf

Weldon, F. W. (n.d.). *History of water law in Nevada and ... - Nevada legislature*. https://www.leg.state.nv.us/Division/Research/Publications/Bkground/BP03-02.pdf

Western Mining History. (2020). *Nevada Mining Towns.* https://westernmininghistory.com/state/nevada/

Visher, M., and Patterson, L., 2021, *Major mines of Nevada 2020—Mineral Industries in Nevada's Economy*: Nevada Bureau of Mines and Geology Special Publication P-32. https://minerals.nv.gov/uploadedFiles/mineralsnvgov/content/Programs/Mining/MiningForms/MM2020_p032_text.pdf

3.0 Evaluating National and International Mining, Quarrying, and Oil and Gas Extraction Industry Sector Value Networks and Supply Chains

This section of this University Center for Economic Development technical report presents an edited version of the initial white paper developed for Part 2, *Evaluating National and International Mining, Quarrying, and Oil and Gas Extraction Industry Sector Value Networks and Supply Chains*. Part 2 of this analysis of the value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector included the following elements:

- Development of a comprehensive overview of the existing and evolving uses of rare earth metals, precious metals, and industrial minerals in value-added production in the downstream parts of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector's value networks and supply chains.

- An identification of 'hot spots' of production and direct and indirect economic activity associated with the mining and extraction of different types of ores and where they are located within the United States and across the globe.

- Development and provision of a comprehensive evaluation of the changing national and international commodity prices for different rare earth metals, precious metals, and industrial metals that are currently and have the potential to be mined and extracted here in Nevada.

The analysis presented in this section begins with a discussion of the demand and various applications of precious metals, rare earth metals, and industrial minerals in directly and indirectly related industry sectors downstream of mining. An identification of domestic and international 'hot spots' for the same metals and minerals and a discussion regarding the economic impact of mining operations, notable mining and extraction practices, and notable strengths of the supply chains of these selected regions is also presented. A summary of the benefits from the selected regions that could be applicable to the Nevada mining sector is provided along with an analysis of the gaps in the supply chains of the Nevada mining sector. Lastly, this section provides a comprehensive evaluation of changing national and international commodity prices, the degree of volatility, and the associated factors affecting the change in prices for minerals currently available in Nevada and potentially available to be mined and extracted in the future.

In general, the analysis presented in this section demonstrates that the overall demand for precious metals, rare earth metals, and industrial minerals is projected to see significant growth

due to increased use of these metals in technology-driven economic production. The demand for various metals will also vary based on fluctuating demand in downstream sectors. Domestic states, such as Arizona, Alaska, and California, and international countries, such as Chile, Canada, China, and Australia, are each important case studies with unique strengths and challenges that each represent unique opportunities for Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector. Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector will need to evaluate its accessibility to certain key equipment, parts, and supplies, as well as consider building out processing, recycling, and energy plants within the state in order to create a more resilient statewide mining and natural resource extraction supply chain. Leveraging the strengths of the existing four-year universities in Nevada and integrating the latest mining technology will play an important role in driving down total costs and attracting new labor talent. The price of copper, gold, and silver shows positive correlation with inflation, acting as a hedge against market uncertainty, while lithium appears to be primarily influenced by supply and demand.

3.1 Downstream Sectors of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

Mining was once conducted through panning and stone tools. Hydraulic mining was a popular method for some time but was quite a threat to the environment (Sierra College Press, 2009). Mining technology in Nevada continues to advance to protect not only the landscape but also those in the workforce. The University of Nevada, Reno's Mackay School of Earth Sciences and Engineering produces high quality graduates with significant training and research in mining optimization, robotics, engineering, and other measurements of the industry (Nevada GOED, 2019).

Through adherence to the many laws and regulations required to maintain a healthy landscape in Nevada, development of energy-efficient technologies has progressed. Unique technology such as automation and robotics have enhanced approaches like open-pit drilling. The University of Nevada, Reno's Autonomous Robots Labs are creating autonomous aerial robots to inspect underground mines (Nevada Business, 2019) and this research continues to help boost mining safety, productivity, and efficiency. The newest and best practices in mining have contributed to a more broad use of materials in the downstream directly and indirectly related sectors of the mining and natural resource extraction industry.

Mining operators are also seeking their own techniques and technology, submitting patents to keep development in-house. As automation increases, jobs are not decreasing but, instead, are evolving. Individual mining and natural resource extraction companies now employ those with more experience in computer science and engineering instead of manual labor. New, highly trained talent is sought after and individual workers are more eager to work with the newest technologies and techniques. All miners complete comprehensive, state-mandated mine health and safety training through the Nevada Department of Business and Industry Division of Industrial Relations, Mine Safety and Training, an entity of the Mine Safety and Health Administration of the United States (MSHA, 2022). It has been noted that transportation,

education, childcare and Internet broadband needs to be improved in order to attract additional talented miners who want to live in the rural areas where they agree to work. There is a growing opportunity to expand the supply chain in these fields to help support the development of this critical workforce. Mining executives in Nevada may look nationally and globally for guidance.

3.1.a Industry and Occupation Sectors through Demand-Sensing

As mining and natural resource extraction methods and technologies have advanced, the uses for metals have evolved and demand is increasing. From the pharmaceutical industry to technology used in everyday goods and services, precious metals, rare earth metals, and industrial metals have been fully incorporated into many manufacturing processes.

Precious Metals

Precious metals like gold and silver were once thought of only as currency. Now, they are used in common industries like jewelry and emerging technologies like medicines and space travel (Provident Metals, 2019). In 1890, Robert Koch discovered that gold-b compounds can stop the growth of tuberculosis bacteria. Today, more scientists are exploring the possibilities of using gold in cancer testing and HIV diagnosis. Cancer DNA can bind to gold (Rettner, 2018). The type of cancer that is being tested for does not matter because gold compounds can still bind to cancer cells. Researchers have also created a test using gold nanoparticles to detect various diseases. Depending on the color of the gold particles, the researcher can determine which type of cancer is present.

Gold is also used in the detection and treatment of HIV and other blood diseases. Scientists at the Fred Hutchinson Cancer Research Center in 2019 reported on work in improving gene therapy by simplifying the process by which instructions for gene-editing are sent to cells. Traditionally, an inactivated virus is used but, in this case, they have used a gold nanoparticle. Gold nanoparticles were used because the surface of the spheres that are about one-billionth the size of a grain of salt allows for other molecules to more easily adhere themselves (McElroy, 2019).

Traditionally, the United States National Aeronautics and Space Administration, or NASA, uses gold foil to cover their equipment. This is because gold is an excellent deflector of radiation. While in space, radiation from the sun directly penetrates objects and transfers heat but the gold acts as a reflector for the heat and does not tarnish in the harsh environment of space like silver and copper. Gold particles are also utilized in astronaut helmets as well as smaller electronic equipment (APMEX, n.d.).

Industrial Minerals

The demand for copper as an industrial metal has significantly increased as society continues to move slowly toward greater commercialization of electric vehicles. Electric vehicles use more than double the amount of copper of a traditional vehicle with an internal combustion engine. With sales of electric vehicles increasing domestically in the United States and in other critical

foreign markets, copper is becoming more sought out for the manufacturing of green vehicles. Each type of electric vehicle needs a specific amount of copper for conductivity. A hybrid electric vehicle needs approximately 85 pounds of copper. A plug-in hybrid electric vehicle can use upwards of 132 pounds of copper and a battery electric vehicle can use as much as 185 pounds of copper. As the vehicle moves away from dependence on internal combustion, the demand for copper will continue to increase. The charging stations needed to provide electricity and roadside charging services for electric vehicles also need copper, and, while the charging station itself may not need the copper, it is the connecting wires from the charging station to the electric vehicle that require it (Lynch, 2021).

Additionally, the demand for all major metals, except lead, is continuous to increase (Watari et al., 2021). The demand for all major metals, except lead, will increase continuously by the end of this century, with aluminum experiencing the largest growth rate, followed by copper at approximately 330.0 percent, zinc at 110.0 percent, and iron at 100.0 percent. As the global energy transition away from fossil fuels continues, some metals, such as aluminum, copper, nickel, and tin, are expected to experience increased demand.

Rare Earth Metals

Rare-earth elements, also known as rare-earth oxides or lanthanides, are a set of 17 nearly indistinguishable lustrous, silvery-white, soft metals. Rare refers to their even but scarce distribution worldwide which was noted after they were first discovered in the late 18th century. It takes large land areas to mine even a very small amount of rare earth metals.
In recent years, rare-earth elements have become increasingly integrated into new technologies, especially in the clean energy, military, and consumer electronics sectors. As a result, there are many applications for rare-earth elements, including permanent magnets, batteries, catalysts, and more (Garside, 2021). Growth in each of these sectors has increased the overall need for the constituent rare-earth elements.

Rare-earth elements are commonly used in rechargeable batteries for cars, computers, wind turbines, DVD players, televisions, lighting, and lasers. They are also used in various pieces of military equipment, including jet engines, missile guidance systems, anti-missile defense systems, satellites, and lasers (Reuters Staff, 2019). Night vision devices, for example, are manufactured with lanthanum. Many of the technological advancements in military technology are moving away from oil and towards rare earth metals. In an article by Russell Parman of the U.S. Army Aviation and Missile Command, Parman discusses how each F-35 Lightning II aircraft requires nearly 920 pounds of rare-earth elements in the production of just one fighter jet. With innovations in lasers and missile technology, the demand for rare-earth elements outweighs the supply of rare-earth elements in the United States (Parman, 2019).

Growth in the rare-earth elements industry is also being driven by economic and societal transitions to green energy sources; a faster transition would require 40-times more lithium consumption. Rare-earth permanent magnets are used in conventional and hybrid vehicles, and the increased demand growth of rare-earth elements is primarily driven by this market. The application of rare-earth magnets for wind turbines is another area of long-term growth. Besides

these various applications, rare-earth magnets are widely used in consumer and industrial electronics, such as smartphones, speakers, and hard disk drives, because of their high performance to size ratio and high magnetic strength.

By 2025, the global demand for rare-earth elements is forecast to increase to 304,678 metric tons from 208,250 metric tons in 2019. However, due to China's stranglehold on the global supply of rare-earth elements, there are serious supply chain concerns (NetworkNewsWire, 2021). The demand for rare-earth elements is characterized by the fact that it does not grow uniformly for individual rare-earth elements but rather is driven by growth in the markets for the derivative products of the individual rare-earth elements. For example, dysprosium demand is primarily driven by the increased production of wind turbines and motors used in clean energy (Hatch, 2012; DOE, 2011). Since different rare-earth elements do not appear in deposits separately and are mined and processed together, changes in the supply of one rare-earth elements generally influence the supply of rare-earth elements.

It is essential to consider the growth in demand for specific rare-earth elements as certain rare-earth elements are more common and will experience more significant growth as a result. Over time, different demand sectors can grow at different rates so that an rare-earth elements can become a larger (or smaller) proportion of total demand over time. In 2021, the prices for neodymium and praseodymium oxide, commonly used in magnets, will increase by more than 40.0 percent. As well as overall demand for dysprosium increasing by 53.0 percent, global demand for gadolinium and terbium will both increase by nearly 39.0 percent (NetworkNewsWire, 2021).

3.1.b Summary of Demand in Downstream Sectors

Through a global perspective, environmental policies to control pollution and the Evergrande real estate crisis have caused China's metal demand, as the world's largest metal consumer, to increase very little over the past several years. Overall, demand for some metals has suffered through the COVID-19 pandemic. For other metals, demand has increased, including the demand for tin used in electronics and photovoltaic installations.

Three broad elements will influence global mineral demand more broadly, including (1) mineral commodity applications, (2) the population that will consume these commodities, and (3) the standard of life that will decide how much each person consumes (Kesler, 2019). Mineral commodity markets can grow significantly as new minerals and applications are discovered. Strontium, for example, was not commonly utilized until the 1960s when it was discovered to be the most cost-effective way to prevent radiation from escaping from color television picture tubes (NASEM, 2008). This new market prompted significant exploration that resulted in the discovery of numerous new strontium deposits.

Although it is difficult to predict all of the new items that will be developed for use by society in the future, they will almost likely be made up of chemical elements and minerals from the Earth because no other source exists. Due to energy limits, the majority of these items will be made up of elements and minerals that can be derived from the Earth with low energy input (EIA, 2007).

As a result, minerals will continue to play a prominent role in society's goods and, as a result, in global manufacturing and agriculture. In principle, global mineral reserves are sufficient to meet global mineral demand for the next 50 years. Global mineral reserves are currently projected to be 20 to nearly 1,000 times bigger than current yearly production according to the commodity of interest. Diamonds and gold, which have been the subject of extremely successful global exploration efforts since 1992, have the least percentage of reserves relative to annual capacity.

Mineral exploration and reserves are affected by a variety of factors that vary significantly (Bateman, 1961). The geologic landscape can be changed by discoveries and fresh mapping, processing innovations can make poor ore more appealing, and changes in political, economic, and regulatory external environmental conditions can occur with a stroke of a pen. As a result, mineral resource estimations are transitory and must be amended on a regular basis to reflect these ongoing changes. The function and form of the majority of domestic products are owed to diverse minerals and mineral compounds. With the advancement of technology, the importance of various minerals in these products has shifted. Mineral criticality at any particular time is a snapshot, not a lasting constant, due to the "dynamism" of mineral importance across time. If a crucial mineral's supply is restricted, the direct domestic impacts on individual consumers, as well as the extractive and industrial industries that supply those products, can be evaluated.

3.2 Domestic and International Mining "Hot Spots" and Comparison with Nevada

This sub-section discusses domestic and international "hot spots" of industrial minerals (copper), precious metals (silver and/or gold), rare earth metals, and lithium specifically as it is particularly relevant to Nevada. The locations were selected based on mineral production level, political and environmental climate, and whether an understanding of the region provided any valuable insights for the future development of the value networks and supply chains of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector. For each of the selected regions, the economic impact of mining operations, notable mining and extraction practices, and notable strengths of the respective supply chains is discussed. Next, a summary of the benefits from each selected region that could be applicable to the Nevada mining sector is provided. Lastly, this sub-section concludes with an analysis of the gaps in the supply chains of the Nevada mining sector.

3.2.a Copper, Domestic and International "Hot Spots"

The states with the largest copper production are listed in order; Arizona, Utah, New Mexico, Nevada and Montana. These states account for 99 percent of domestic production (NMCR, n.d.). Arizona was the leading copper-producing state and accounted for an estimated 71 percent of domestic output. Due to its production levels, proximity to Nevada, and relatively similar climate, Arizona was chosen to evaluate. The top copper producers in the world are Chile, Peru, China, and the Democratic Republic of Congo (World Mining Data, n.d.). Unlike many countries in South America, Chile has been consistently ranked high on the political stability index (The Global Economy, 2020). Much like Nevada, the driest state in the United States, Chile is prone

to drought and much of the mining occurs in arid conditions, making it an attractive target for comparison.

Arizona

Table 3.1 presents a summary of the economic impact that the mining and natural resource extraction industry sector has in the state of Arizona.

Table 3.1 – Economic Impact of Mining Arizona		
Estimated Economic Impact	**Contribution to Gross Domestic Product (millions of U.S. Dollars)**	**Labor Income (millions of U.S. Dollars)**
Mining: Mine Workers: 17,673 Support Activities: 465 Transportation: 4,343 Total Direct Jobs: 22,482 Indirect & Induced Jobs: 43,184 **Total Direct & Indirect Jobs: 65,666**	Direct: $11,963 Indirect: $4,626 **Total: $16,589**	Direct: $1,508 Indirect: $2,010 **Total: $3,518**
Coal: Production: 7 million tons Electricity Generation: 32 percent Mine Workers: 531 Support Activities: 15 Transportation: 167 Total Direct Jobs: 713 Indirect & Induced Jobs: 4,844 **Total Direct & Indirect Jobs: 5,557**	Direct: $300 Indirect: $525 **Total: $825**	Direct: $100 Indirect: $278 **Total: $378**
Metal: Mine Workers: 13.474 Support Activities: 356 Transportation: 1,934 Total Direct Jobs: 15,764 Indirect & Induced Jobs: 28,882 **Total Direct & Indirect Jobs: 44,646**	Direct: $9,973 Indirect: $2,923 **Total: $12,896**	Direct: $1,028 Indirect: $216 **Total: $579**
Non-Metal: Mine Workers: 1,655 Support Activities: 59 Transportation: 1,536 Total Direct Jobs: 3,261 Indirect & Induced Jobs: 3,935 **Total Direct & Indirect Jobs: 7,195**	Direct: $399 Indirect: $311 **Total: $710**	Direct: $210 Indirect: $159 **Total: $369**

Source: *https://nma.org/map/arizona/*

Copper is an abundant and valuable product of Arizona (AZGS, 2018). According to the United States Geological Society Mineral Commodity Summaries 2022, Arizona produced an estimated 852,000 metric tons of copper. In terms of economic impact, according to information from the National Mining Association, the mining and natural resource extraction industry sector in Arizona supports 65,666 total direct and indirect jobs with a total contribution to statewide gross domestic product of approximately $16.6 billion. For metal mining specifically, the mining and natural resource extraction industry sector in Arizona employs an estimated 44,646 total individuals that contributes nearly $12.9 million to gross domestic product.

Arizona has two main types of copper deposits, including Porphyry Copper and volcanogenic massive sulfide copper (AZGS, 2018). Like Montana, Utah, and Nevada, Arizona uses both underground and open pit mines. In comparison, Nevada copper can be found in oxidized zones of copper deposits, in hydrothermal veins, in the cavities of basalt, and as pore fillings and replacements in conglomerates that have been in contact with hydrothermal solutions (Nevada Mining Association, 2022). Many mines in Nevada mine copper in a large open pit or from underground mining (Nevada Copper Corp, n.d.).

Arizona has a robust transportation network with nearly 130,000 miles of highways and nearly 2,000 miles of freight railway line. Class 1 carriers like BNSF Railway and Union Pacific Railroad operate almost 73.0 percent of Arizona's railway network while shortline carriers provide local service connections. Arizona also has more than 1.7 million square feet of built manufacturing, warehousing, and distribution space. With six international ports of entry, SkyBridge Arizona is the nation's first and only inland international air logistics and joint U.S-Mexico customs processing hub. The Unified Cargo Processing Program reduces processing time of incoming and outgoing shipments between the United States, Mexico and Latin America (ACA n.d).

Chile

Chile is the world's largest copper producer as of 2021. As part of the "lithium triangle" with Bolivia and Argentina, it holds most of the world's "economically extractable" lithium reserves (Alves, 2022). Copper production from Chile accounted for nearly 22.0 percent of global production in 2020 (ITA, 2022), as compared to Nevada which accounted for just 0.3 percent of global copper production (NVMA Copper Production, n.d.). The mining sector's contribution to Chile's gross domestic product has averaged 10.9 percent for the last two decades (ICA, 2017). Mining accounts for nearly half of Chile's product exports (OEC, n.d.). The mining industry also has a strong multiplier effect, contributing to the consumption of goods and services in other industries. The main indirect beneficiary of mining in Chie is the supplier industry which represents about $20 billion of the national economy. Mining created 388,754 jobs in 2016, accounting for approximately 5.4 percent of the national labor force (ICA, 2017).

Approximately 72.0 percent of Chilean mining operations are privately-owned while approximately 28.0 percent are state-owned and operated by Codelco, formed in 1976 through the nationalization of foreign-owned copper companies (IKI, 2021). Historically, Chile has had a substandard safety culture. The 2010 Chilean Mining Accident resulted in 33 miners being

trapped in a copper mine for over two months. The following year Chile ratified the International Labor Organization Convention No. 187 concerning Occupational Safety and Health (ILO, 2011). In an attempt to combat climate change, the largest mining companies in Chile have committed to reducing overall greenhouse gas emissions. By 2023, more than half of the mining industry's electricity supply is estimated to come from renewable energy sources (IKI, 2021). Chile has been experiencing a decade-long drought and many of the mining operations are located in the north, which includes the Atacama Desert, one of the driest place on Earth. As limited water resources are also be used for downstream agriculture and population centers, saltwater has been increasingly utilized by Chile's mining and natural resource extraction industry sector in the Atacama Desert region (Romo, 2015). Currently, there are eight desalination plants in operation with another 15 desalination plants planned to be built by 2031 (AX Legal, 2021). Chile's mining companies have also taken measures to reduce water loss by adding "thermofilm" liners to cover the heaps and using drippers (instead of sprinklers) for the solution application. Tailings management is another important aspect of Chilean mining (Romo, 2015). There are various initiatives to find value in the tailings, such as recovering trace minerals, filtering to recover water, and removing impurities that pose environmental risks (GBR, n.d.).

3.2.b Gold and Silver, Domestic and International "Hot Spots"

Gold and silver mining is one of the largest production area of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector. Nevada supplies gold and silver all over the world. In 2018, Nevada produced 173,000 kilos of gold (Garside, 2022a) and 247 metric tons of silver (Garside, 2021). The closest state comparison is Alaska, which produced just 20,600 kilos of gold (Garside, 2022a) and 465 metric tons of silver (Garside, 2021), making Alaska a good comparative case study. The top international gold producers in 2021 were China, Russia, Australia, the United States, and Canada (World Gold Council, 2021). Canada shares many geographic and political characteristics with the United States and Canadian production of 170.6 metric tons of gold is nearly equivalent to that of total United States gold production of 190.2 metric tons (Government of Canada, 2022). For these reasons, Canada is an excellent comparative case study for analysis of mining operations and supply chains.

Alaska

Alaska has ten major gold mines within the state that also produce silver (Alaska Mines, 2022). In comparison, most of the mines in Nevada produce minerals through open pit mining by using "heap leaching" of recovery while others use underground mining (Nuggets, 2018). While some mines in Alaska use open pit mining, others use underground mining where the ore is processed in a flotation miss that produces a gold-bearing concentrate (Alaska Mines, 2022). Alaska also prides itself in recreational mining for visitors (Alaska Centers, n.d.). The mining and natural resource extraction industry sector in Alaska employed an estimated 9,959 total individuals that contributed approximately $1.9 billion to statewide gross domestic product. For just metal mining, Alaska's mining and natural resource extraction industry sector employed an estimated 6,105 total individuals and added approximately $1.5 billion to gross domestic product as illustrated in Table 3.2

Table 3.2 – Economic Impact of Mining Alaska		
Estimated Economic Impact	**Contribution to Gross Domestic Product (millions of U.S. Dollars)**	**Labor Income (millions of U.S. Dollars)**
Mining: Mine Workers: 3,340 Support Activities: 154 Transportation: 1,001 Total Direct Jobs: 4,495 Indirect & Induced Jobs: 5,464 **Total Direct & Indirect Jobs: 9,959**	Direct: $1,281 Indirect: $604 **Total: $1,884**	Direct: $287 Indirect: $260 **Total: $547**
Coal: Production: 1 million ton Electricity Generation: 10 percent Mine Workers: 120 Support Activities: 8 Transportation: 40 Total Direct Jobs: 168 Indirect & Induced Jobs: 696 **Total Direct & Indirect Jobs: 864**	Direct: $23 Indirect: $90 **Total: $113**	Direct: $11 Indirect: $50 **Total: $61**
Metal: Mine Workers: 2,567 Support Activities: 118 Transportation: 762 Total Direct Jobs: 3,447 Indirect & Induced Jobs: 2,658 **Total Direct & Indirect Jobs: 6,105**	Direct: $1,118 Indirect: $348 **Total: $1,466**	Direct: $226 Indirect: $137 **Total: $362**
Non-Metal: Mine Workers: 653 Support Activities: 28 Transportation: 199 Total Direct Jobs: 880 Indirect & Induced Jobs: 2,100 **Total Direct & Indirect Jobs: 2,991**	Direct: $140 Indirect: $166 **Total: $305**	Direct: $50 Indirect: $73 **Total: $123**

Source: *https://nma.org/map/alaska/*

With nearly 586,412 square miles, Alaska is more than twice as big as the state of Texas but with a highly undeveloped road system. With harsh climate and varied topography, only 31.0 percent of these roads are paved. Modes of transportation include air, river, or sea. Alaska Air Cargo has been operating here for more than 80 years and its employees are well trained to deal with extreme weather events like fog, freezing temperatures, and high winds. Despite these severe and extreme conditions, Alaska has mastered transportation of oversized equipment and parts to support the state of Alaska's own Mining, Quarrying, and Oil and Gas Extraction industry sector (Supply Chain Minded, 2014).

Canada

Canada is the leading global producer of potash and is among the top five producers of aluminum, diamonds, gemstones, gold, indium, niobium, platinum group metals, titanium concentrate, and uranium (Government of Canada, 2021a). In 2020, Canada produced nearly 182 metric tons of gold, or 5.7 percent of global gold supply. Canada has the eight largest gold reserves at nearly 2.2 thousand metric tons (Government of Canada, 2022a). The direct contribution of Canada's minerals and metals sector to nationwide gross domestic product was approximately $70.0 billion, representing nearly 3 percent of total gross domestic product. The indirect effects from Canada's mining and natural resource extraction industry sector added an additional $37.0 billion to gross domestic product, for a total contribution of $107.0 billion. In 2020, Canada's mining and natural resource extraction industry sector directly employed 377,000 total individuals and indirectly employed another 692,000 total individuals. Minerals exports accounted for 21.0 percent of total exports (Government of Canada, 2022b).

Canada is home to the first "green", all-electric mine at the Borden Gold Mine site in the province of Ontario. The Borden Gold Mine will utilize electric equipment in lieu of diesel, reducing greenhouse gas emissions, improving worker safety, and reducing overall costs (Arangio, 2019). In 2004, the Mining Association of Canada created the "Towards Sustainable Mining" program that called for mining companies to develop a social and environmental conscience and has become a world-recognized standard adopted by other countries (Government of Canada, 2021b). Canada's leadership in mineral resource governance and sustainable development have helped build a "Canada Brand" that is recognized around the world. Leadership on social responsibility, access to capital markets, innovation and expertise on clean technology, have contributed to the brand (CMMP, n.d.).

3.2.c Rare Earth Metals, Domestic and International "Hot Spots"

The only notable site of production of rare earth metals in the United States is the Mountain Pass mine in southern California, making it the only state available for comparison and study. The United States currently produces just 1.3 percent of global rare earth metals. The top reserves of rare earth metals in the world are located in China, Vietnam, Brazil, Russia, and India (LePan, 2021). While none of these countries are ideal comparisons in terms of political structure and stability, China dominates the rare earth metals industry and will continue to be the primary competitor in the foreseeable future, and is thus a critical comparative case study for the mapping of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector value networks and supply chains.

California

The Mountain Pass Mine is located in San Bernardino County, California and produces more than 15.0 percent of worldwide production (Garside, 2022b). San Bernardino County has substantial portions of its employment dedicated to material moving, nearly 7.7 percent, transportation, approximately 5.8 percent, and construction and extraction, at nearly 5.9 percent of total countywide employment (Data US , n.d.). Production of electronics in San Bernardino

County amounts to nearly $379.0 billion dollars as well as an additional $25.0 billion in nonmetal minerals, and nearly $90.0 billion in precision instruments.

Table 3.3 – Economic Impact of Mining California		
Estimated Economic Impact	**Contribution to Gross Domestic Product (millions of U.S. Dollars)**	**Labor Income (millions of U.S. Dollars)**
Mining: Mine Workers: 11,112 Support Activities: 138 Transportation: 11,167 Total Direct Jobs: 22,418 Indirect & Induced Jobs: 76,712 **Total Direct & Indirect Jobs: 99,129**	Direct: $3,202 Indirect: $10,336 **Total: $13,538**	Direct: $1,294 Indirect: $6,060 **Total: $7,353**
Coal: Production: 0 million tons Electricity Generation: 6 percent Mine Workers: 93 Support Activities: 0 Transportation: 12 Total Direct Jobs: 105 Indirect & Induced Jobs: 18,600 **Total Direct & Indirect Jobs: 18,705**	Direct: $9 Indirect: $2,885 **Total: $2,893**	Direct: $7 Indirect: $2,000 **Total: $2,007**
Metal: Mine Workers: 1,357 Support Activities: 21 Transportation: 763 Total Direct Jobs: 2,142 Indirect & Induced Jobs: 14,302 **Total Direct & Indirect Jobs: 16,443**	Direct: $340 Indirect: $1,684 **Total: $2,024**	Direct: $157 Indirect: $1,154 **Total: $1,310**
Non-Metal: Mine Workers: 9,662 Support Activities: 117 Transportation: 10,392 Total Direct Jobs: 20,171 Indirect & Induced Jobs: 43,810 **Total Direct & Indirect Jobs: 63,982**	Direct: $2,858 Indirect: $5,768 **Total: $8,621**	Direct: $1,130 Indirect: $2,906 **Total: $4,036**

Source: *https://nma.org/map/california/*

The Mountain Pass Mine is operated by MP minerals, who is attempting to become a vertically integrated producer of rare earth metals to challenge Chinese dominance of the industry (Staff, 2020). In terms of economic impact from mining, the mining and natural resource industry sector in California created 99,129 direct and indirect jobs that added $13.4 billion to statewide gross domestic product with labor income estimated at nearly $7.4 billion. Non-metallic mining is more prominent in the state, and this part of California's mining and natural resources

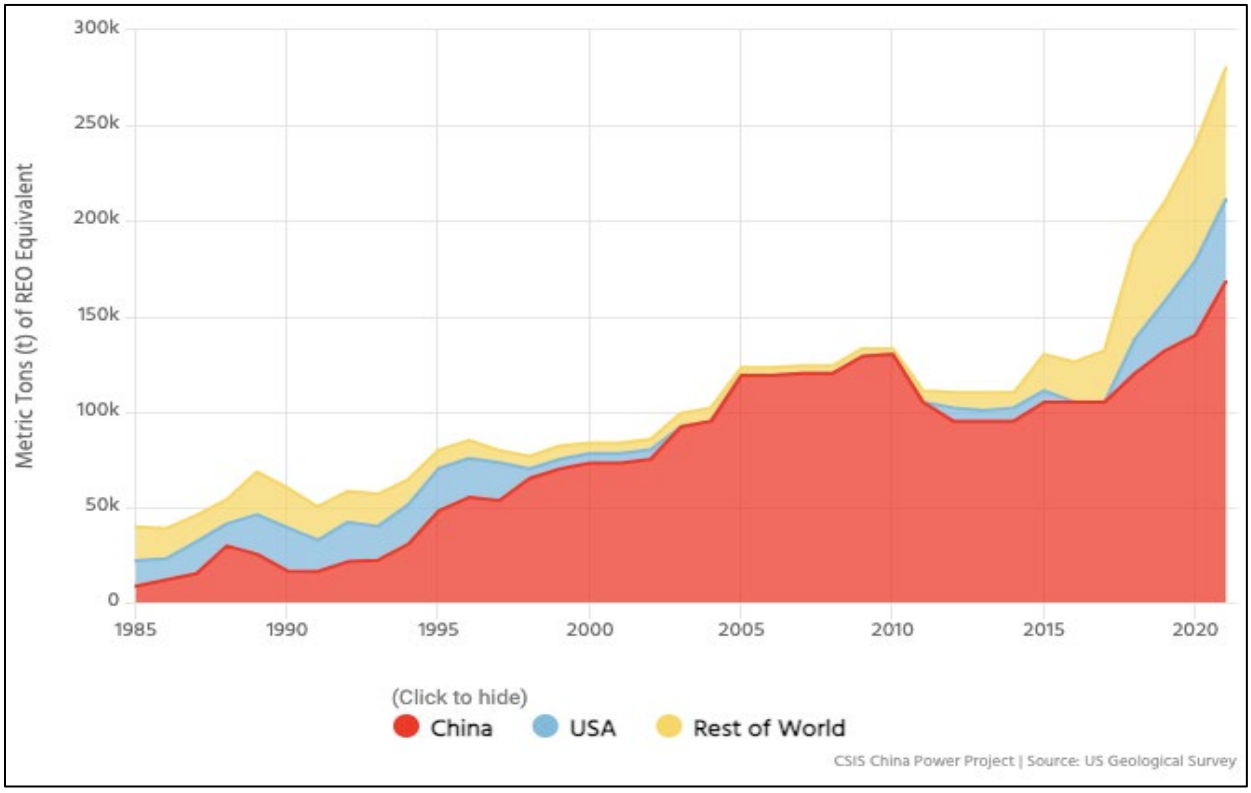
extraction industry sector accounts for nearly 63,982 total jobs, contributing $86 billion towards statewide gross domestic product, with a labor income of approximately $4.1 billion as illustrated in Table 3.3.

The Source Diverse, Source Local program, a public-private partnership to bolster supply chains in California through diversity, equity and inclusion, is expected to play a key role in meeting growing supply chain demands throughout the state. With strong corporate supply chain partners like Google, Prologis, Lockheed Martin, United, and UPS, California has benefited from core software and automation related technical solutions. The United States federal government has recognized this technical advantage and has chosen this state to establish an end-end domestic permanent magnet supply chain through investments in extraction, development, operation, and recycling of rare earth metals (The United States Government, 2022).

China

As seen on Figure 3.1, China is the world's largest producer of rare earth elements, along with other key mineral resources (Baker McKenzie, n.d.).

Figure 3.1 – Global Rare Earth Mining Production
China vs. United States vs. Rest of the World



Source: Rare earth mining production continues to expand in China, USA, and the rest of the world. From Does China pose a threat to global rare earth supply chains? ChinaPower. (2020, July 17). https://chinapower.csis.org/china-rare-earths/

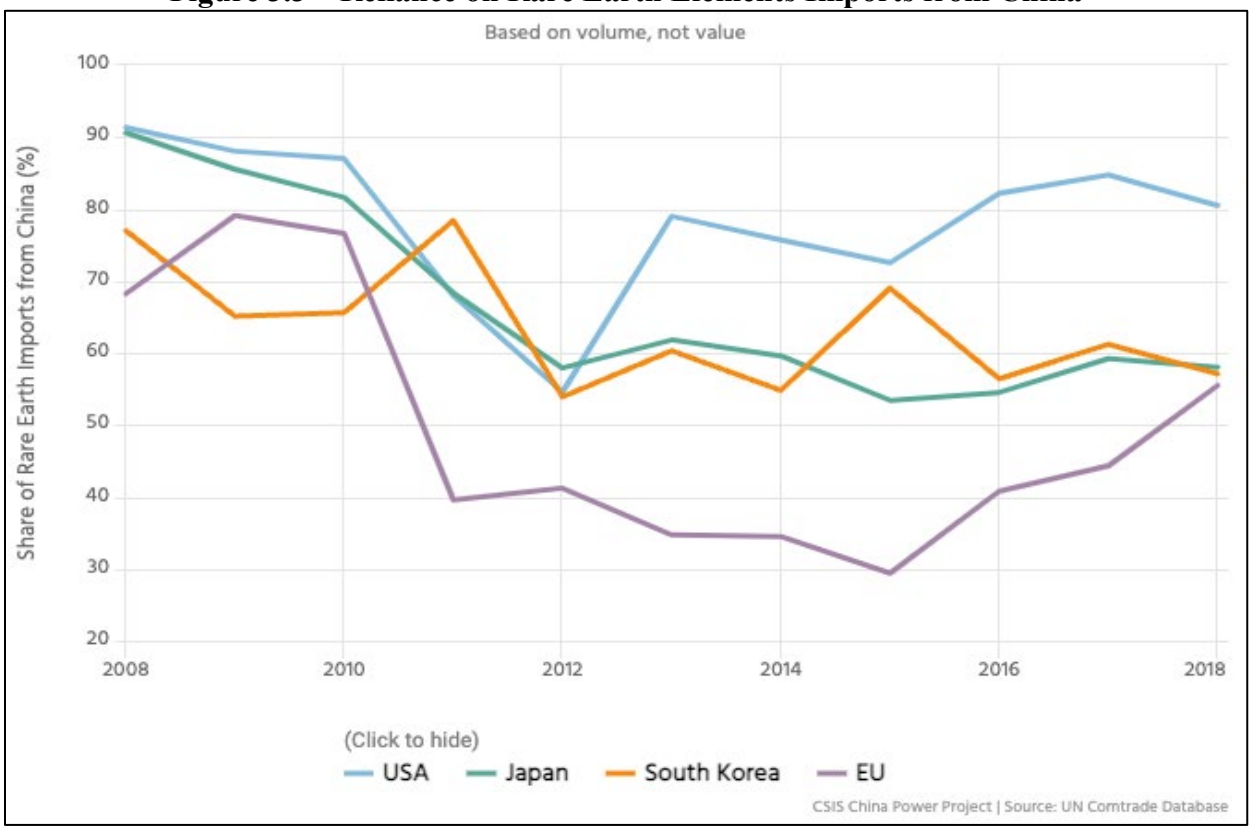
As of 2020, China had approximately 39.7 percent of the global rare earth elements reserves, approximately 58.0 percent of global production, 85.0 percent of refined rare earth elements (LePan, 2021), and 38.0 percent of total global reserves as seen in Figure 3.2. As seen in Figure 3.3, the Untied States relies on China for rare earth element imports. Little data is available on the total direct and indirect economic contribution of mining to the Chinese national economy. However, according to the China's National Bureau of Statistics, mining contributed around 5.2 percent to China's gross domestic product in 2010 (China's Mining Industry at Home and Overseas, 2014). The mining and natural resource extraction industry sector in China also supports secondary industries such as those supplying machinery and ancillary mining services. Products of the mining industry such as raw materials and refined products are traded on international markets, adding to China's foreign currency reserves. In 2011, the direct labor force in the mining industry was an estimated 6.11 million total individuals. Mining companies in China contribute to the local economy by developing infrastructure and contributing to local public services (China's Mining Industry at Home and Overseas, 2014).

Figure 3.2 – Global Reserves of Rare Earth Elements

Country	Mine Production 2020	Reserves	% of Total Reserves
China	140,000	44,000,000	38.0%
Vietnam	1,000	22,000,000	19.0%
Brazil	1,000	21,000,000	18.1%
Russia	2,700	12,000,000	10.4%
India	3,000	6,900,000	6.0%
Australia	17,000	4,100,000	3.5%
United States	38,000	1,500,000	1.3%
Greenland	-	1,500,000	1.3%
Tanzania	-	890,000	0.8%
Canada	-	830,000	0.7%
South Africa	-	790,000	0.7%
Other Countries	100	310,000	0.3%
Burma	30,000	N/A	N/A
Madagascar	8,000	N/A	N/A
Thailand	2,000	N/A	N/A
Burundi	500	N/A	N/A
World Total	**243,300**	**115,820,000**	**100%**

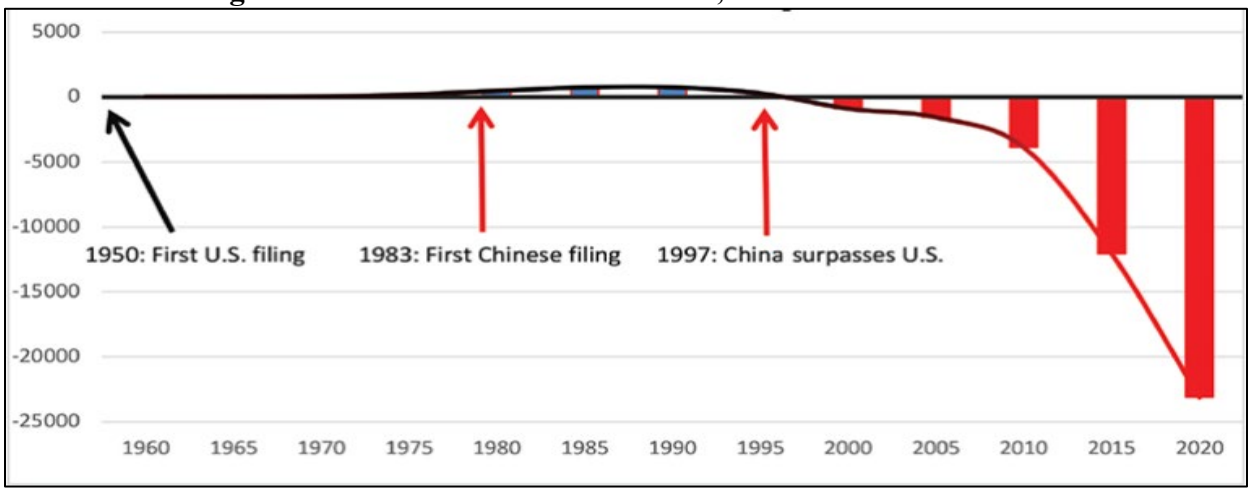
Source: Figure was obtained from LePan, N. (2021, November 23). Rare earth elements: Where in the world are they? Visual Capitalist. https://www.visualcapitalist.com/rare-earth-elements-where-in-the-world-are-they/

Figure 3.3 – Reliance on Rare Earth Elements Imports from China



Source: The US dependence has declined since 2017. From Does China pose a threat to global rare earth supply chains? ChinaPower. (2020, July 17). https://chinapower.csis.org/china-rare-earths/

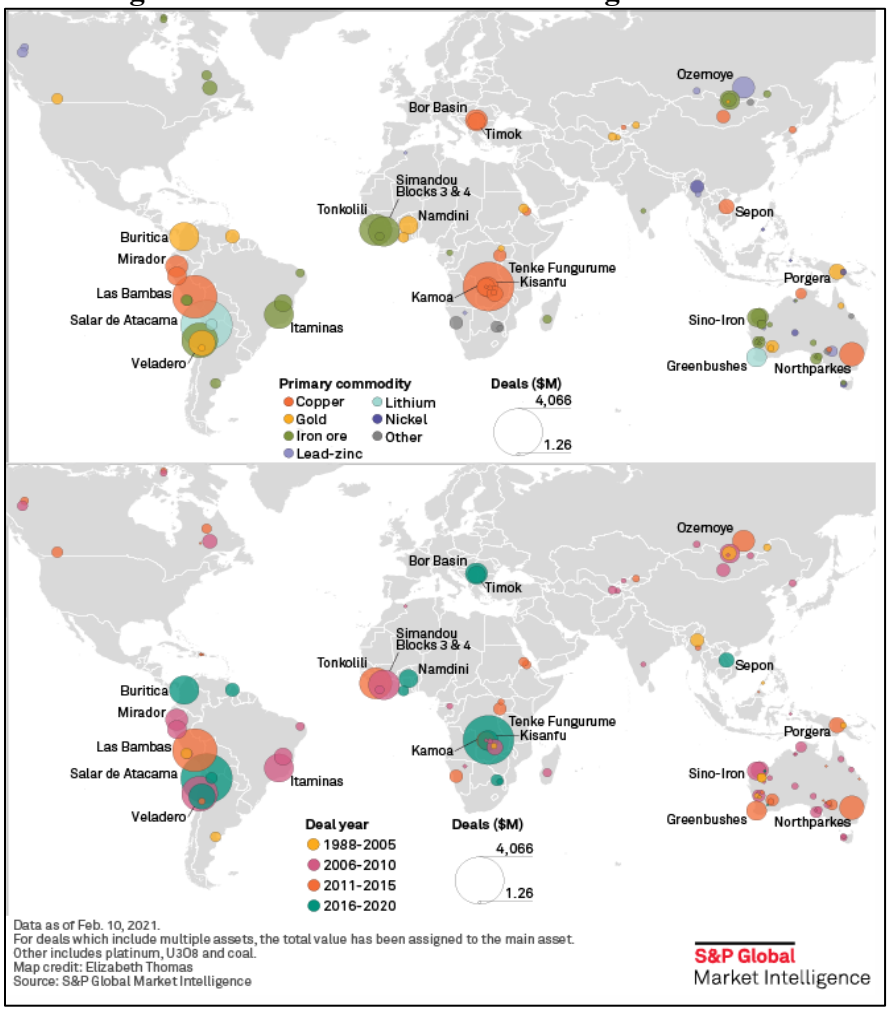
Figure 3.4 – Cumulative Paten Deficit, United States vs. China



Source: The shift began in the 1980s with changes in regulation of thorium-containing ores. From Kennedy, J. (2019, March 21). China Solidifies Dominance in Rare Earth Processing. National Defense. https://www.nationaldefensemagazine.org/articles/2019/3/21/viewpoint-china-solidifies-dominance-in-rare-earth-processing

In 1990, the Chinese government declared rare earth elements to be protected strategic minerals that prohibited foreign firms from mining rare earth elements or participating in processing projects within China except in joint ventures with Chinese firms. This enabled Chinese companies to gain foreign expertise while steadily cutting out foreign competition from the supply chain (China Power Team, 2020). To further control the sector, the Chinese national government continues to plan to form one of the world's largest rare earth elements companies, China Rare Earth Group (Skidmore, 2022). As seen in Figure 3.4, China has become the global leader in rare earth elements technology patent filings.

Figure 3.5 – Chinese Overseas Mining M&A Deals



Source: China has increased overseas mining investments in South America and Africa. From Yao, S., & Holden, J. (2021, March 12). Chinese foreign mining investment - China's private sector eyes low-cost regions. S&P Global. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/chinese-foreign-mining-investment-8212-china-s-private-sector-eyes-low-cost-regions-63066809

The shift in China's rare earth elements dominance started in the 1980s when ores containing thorium became highly regulated by the Nuclear Regulatory Commission and International Atomic Energy Agency. As China was not a signatory to these agreements, they were not beholden to the regulations (Kennedy, 2019).

China has continued to heavily invest abroad to further secure their own domestic and international supply chains as illustrated in Figure 3.5. China has a history of lax environmental laws and costs associated with breaking the law are sometimes lower than abiding by them (Greenovation Hub, 2014), resulting in many environmental concerns such as the Batou toxic lake.

3.2.d Lithium, Domestic and International "Hot Spots"

The largest producers of lithium in the world include Australia, Chile and China that collectively make up approximately 86.0 percent of the world's lithium production. As of 2020, the United States produced approximately 1.0 percent of global production (Bhutada, 2020). Given the exclusivity of lithium production, and the large untapped lithium capacity in Nevada, the state of Nevada is in a strong position to capitalize on growing global demand. As the world's largest producer of lithium and with a stable government, Australia was selected as a comparative case study.

Nevada

Albemarle's Silver Peak in Nevada produces an estimated 3,500 metric tons of lithium carbonate per year with the capacity to produce up to 6,000 metric tons (Albemarle Corp., 2018). Immediately east of Silver Peak, the Clayton Valley Lithium Project is an open-pit mine being developed with an estimated 1.3 million metric tons of lithium carbonate equivalent (MT, 2021). A proposal by Lithium Nevada Corporation to start mining a large lithium deposit in Thacker Pass, Nevada (Bahouth, 2021) with a total measured and indicated 13.7 million metric tons of lithium carbonate equivalent was recently approved (Lithium Americas, 2021). From an economic impact perspective, an estimated 55,248 total jobs are supported by Nevada's mining and natural resource extraction sector, contributing approximately $12.7 billion to statewide gross domestic product with a labor income of approximately $4.2 billion.

For metal mining alone, this part of Nevada's mining and natural resource extraction industry sector supports an estimated 18,575 direct jobs and an additional 20,470 indirect jobs that contribute approximately $10.8 billion to gross domestic product and a labor income of nearly $3.2 billion. For non-metal mining, this part of Nevada's mining and natural resource extraction industry sector supports an estimated 14,057 total jobs that contribute approximately $1.8 billion to gross domestic product and a labor income of nearly $796 million. Table 3.4 presents a comprehensive summary of the estimated economic impact of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector.

Table 3.4 – Economic Impact of Mining Nevada		
Estimated Economic Impact	**Contribution to Gross Domestic Product (millions of U.S. Dollars)**	**Labor Income (millions of U.S. Dollars)**
Mining: Mine Workers: 15,898 Support Activities: 2,073 Transportation: 7,091 Total Direct Jobs: 25,062 Indirect & Induced Jobs: 30,186 **Total Direct & Indirect Jobs: 55,248**	Direct: $9,417 Indirect: $3,323 **Total: $12,739**	Direct: $2,454 Indirect: $1,705 **Total: $4,159**
Coal: Production: 0 million tons Electricity Generation: 7 percent Mine Workers: 19 Support Activities: 0 Transportation: 0 Total Direct Jobs: 19 Indirect & Induced Jobs: 2,218 **Total Direct & Indirect Jobs: 2,147**	Direct: $2 Indirect: $184 **Total: $186**	Direct: $2 Indirect: $159 **Total: $161**
Metal: Mine Workers: 13,298 Support Activities: 1,733 Transportation: 3,543 Total Direct Jobs: 18,575 Indirect & Induced Jobs: 20,470 **Total Direct & Indirect Jobs: 39,044**	Direct: $8,382 Indirect: $2,382 **Total: $10,764**	Direct: $2,040 Indirect: $1,162 **Total: $3,202**
Non-Metal: Mine Workers: 2,581 Support Activities: 339 Transportation: 3,548 Total Direct Jobs: 6,468 Indirect & Induced Jobs: 7,589 **Total Direct & Indirect Jobs: 14,057**	Direct: $1,032 Indirect: $757 **Total: $1,789**	Direct: $412 Indirect: $384 **Total: $796**

Source: https://nma.org/map/nevada/

Australia

As seen in Figure 3.6, Australia is the world's largest lithium producer (ITA, 2021), producing an estimated 55.0 thousand metric tons (Basov, 2022). By comparison, the Thacker Pass project in Nevada is expected to produce an estimated 33.0 thousand tons of lithium annually and then double after four years (Dentzer, 2021). The mining and natural resource extraction industry sector is Australia's single largest economic sector. The Australian Bureau of Statistics estimated that the nation's mining and natural resource extraction industry sector was responsible for nearly 10.4 percent of national gross domestic product between 2019 and 2020. The mining

and natural resources extraction industry sector in Australia employed 261,900 individuals in 2020. The Center for International Economics created an economic model that determined in the absence of an enlarged mining industry, GDP would be 13 percent lower and real GDP per capita would be $9,700 lower in 2020 (Center for International Economics, 2021). Nearly 60.0 percent of active mining projects in Australia are located near Aboriginal and Torres Strait Islander communities, bringing greater employment prospects and economic activity to remote populations. The sector has also spurred the development of world-leading mining equipment, technology, and related services sectors and is expected to continue to be transformed through digitally-enabled technology, artificial intelligence, and automation, adding nearly $50.0 billion to the Australian economy by 2030 and creating an additional 80,000 jobs in the sector (Estimating the economic benefits of mining expansion, 2021). Similar to Nevada, Australian mining companies directly contribute to the local community through the taxes they pay to local governments as well as infrastructure development, road maintenance, sewage systems, airports, childcares, and other necessary services (Bravus, 2021).

Figure 3.6 – Largest Lithium Producing Countries

Country	2020 Lithium Production* (tonnes)	% of World Total
Australia	40,000	46.3%
Chile	20,600	23.9%
China	14,000	16.2%
Argentina	6,200	7.2%
Brazil	1,900	2.2%
Zimbabwe	1,200	1.4%
U.S.	900	1.0%
Portugal	900	1.0%
Rest of the World	500	0.6%
Total	**86,300**	**100%**

*Production total may not add up to 86,300 due to rounding.

Source: Bhutada, G. (2022, February 9). Charted: Lithium production by country (1995-2020). Visual Capitalist. https://www.visualcapitalist.com/charted-lithium-production-by-country-1995-2020/

Compared to Nevada, where lithium salts are primarily pumped from underground brine, known as “salars”, into surface ponds for solar evaporation and acid plants for processing, most of Australia’s lithium is from spodumene ores (Champion, D., 2018). Ore is mined via drill and blast methods, excavated and trucked to a processing facility, and then crushed in stages to reduce the particle size. Following flotation and magnetic separation, the wet concentrate is filtered and prepared for transportation as a 6.0 percent Lithium Oxide concentrate. To be useful for value-added applications such as the manufacturing of lithium batteries, these concentrates

must be further processed. Most of Australia's bulk concentrate of lithium is exported to China. (Australian Government, 2018). The Australian government and private industry have agreed to fund a $135.0 million modern lithium research center operating out of Curtin University.

In an effort to attract young workers, Australia has launched a new virtual reality program at the University of South Australia (Mine Australia Magazine, 2019). There is also a strong drive to decarbonize mining operations. The Australian government announced the "National Hydrogen Strategy" to accelerate the commercialization of hydrogen energy and build a strong domestic hydrogen sector. The largest mining companies in Australia formed the Green Hydrogen Consortium, pledging to work together to accelerate renewable energy powered hydrogen production and its application to the resources sector and other heavy industries (CSIRO, 2021). The Australian government has given millions of dollars in grants to companies involved in lithium battery value network production with the goal to create vertically integrated production systems in order to provide for the growing green initiatives around the world (Colthorpe, 2021).

3.2.e Applicable "Lessons Learned" from the National and International "Hot Spots"

For Nevada and for the further development of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector's value network and supply chain, there are four specific "lessons learned" from the national and international "hot spots" case studies presented in this section of this University Center for Economic Development technical report, including: (1) the need to improve overall statewide railway connectivity, (2) expanded renewable sources of energy and responsible mining practices, (3) increased use of emerging technology in mining, and (4) reduced ore processing time.

Better Rail Connectivity

Even though Nevada has a rich railroad history, only 23.0 percent of total freight in Nevada is moved using the state's existing railroad network and related infrastructure. The state's rail system has declined to just an estimated 1,193 total miles of railway even as population and industrial activity have grown across the state. A well-connected freight railway network will make it easier for the mining industry to transport heavy equipment and materials and reduce overall costs. According to the 2021 State Rail Plan, authorities are seeking to expand the state's freight railway network (NDOT n.d.).

Renewable Sources of Energy and Responsible Mining

Nevada is rated highest in terms of solar power potential. Nevada also has geothermal energy sources and is home to a first-of-its-kind hybrid geothermal and solar power plant (USEIA, 2022). Similar to Canada and Chile, existing firms operating within Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector should begin the transition away from non-renewable energy usage towards using clean renewable energy for mining operations.

Use of Technology in Mining

Existing firms operating within Australia's mining and natural resource extraction industry sector rely heavily on emerging technologies like automation, artificial intelligence and machine learning to create a platform for the mining equipment services sector. Those existing and future firms operating within Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector can make significant gains in-terms of increased efficiency and increased profitability with collaborative efforts in this area.

Reduced Ore Processing Times

China has significant experience with the processing of rare earth metals and recent industry innovations have reduced ore processing times down to minutes. Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector and the state's existing universities and advanced research facilities stand to benefit from studying such processes and possibly improving upon them and modifying them to fit the needs of mining operations throughout the state.

3.2.f Initial Identification of Gaps in the Value Network and Supply Chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

With the Mining, Quarrying, and Oil and Gas Extraction industry sector playing an important role in Nevada, more than 25,000 people are directly employed by the mining industry throughout the state. Mining requires a wide array of supporting infrastructure and each job in the mining and natural resource extraction industry sector is backed up by approximately four jobs that provide goods and services to firms operating in the mining and natural resource extraction industry sector. By examining both domestic and international mining "hot spots", several initial opportunities to close critical gaps in Nevada's mining industry value network and supply chain are immediately evident.

Underground Drilling Equipment

Over the last five years, underground mining operations have increased by nearly 40.0 percent. Over the next five years, underground mining operations are expected to increase by another 40.0 percent. To support this trend, firms operating throughout Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector need drilling equipment and manufacturers that can deliver the needed equipment and provide the necessary service support quickly and reliably in order to prevent disruption to normal operations.

Industrial Plumbing and Irrigation

Mining needs extensive fluid transmission. Various processes like dewatering, mill processing, and heap leaching need efficient and effective ways to transfer fluids. Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector needs manufacturers of such equipment within the state to quickly address problems as they arise and to provide reliable service.

Integrated Software Solutions

Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector uses various software products developed all over the world. However, due to lack of adequate training and technical support, these software solutions are unable to operate at maximum efficiency. The mining and natural resource extraction industry sector in Nevada needs customized software solutions that can be easily integrated to the processes in place.

Industrial Chemicals

All mining operations use a significant amount and a wide variety of chemicals in the mining and extraction processes. The demand for high quantities and variety of chemicals is no different in Nevada for the firms operating within the state's mining and natural resource extraction industry sector. Local manufacturers, distributors, and providers who can deliver large quantities of necessary chemicals on a short notice are needed to support existing and expanded mining and resource extraction operations.

Custom Fabrication

Mining operations need numerous pieces of equipment, replacement parts and other fixtures. Nevada's mining operations need local manufacturers of custom metal fabrication equipment so that they can reduce their downtime when equipment fails. Growth of Nevada's advanced manufacturing, wholesale trade, and other related sectors is a critical step in closing existing gaps in the state's mining and natural resource extraction industry sector. Additional Career Technical Educational programming, focused on custom fabrication skill development, will also ensure the necessary supply of training and qualified workers to support expanded custom fabrication development across the state.

Elevator and Conveyor Supply

Cortez Mine in Elko County and Lander County is known to operate one of the largest conveyor belts, with an estimated length of nearly 10 miles. Since mining operations move so much material and people, elevators and conveyor belts are key pieces of equipment that mining operators cannot afford to be impacted by a failure. Existing firms in Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector need local support to fix any issues that may arise.

Gaskets, Hoses and Couplers

With so much fluid transmission happening in mining operations and being exposed to the elements of the environment, fluid flow control is an essential part of any mining and natural resource extraction operation. Existing firms in Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector need quick access to these parts since these mines face harsh conditions and mining operations are in constant need of these gaskets, hoses, couplers and other related pieces of equipment (Lander County, n.d.).

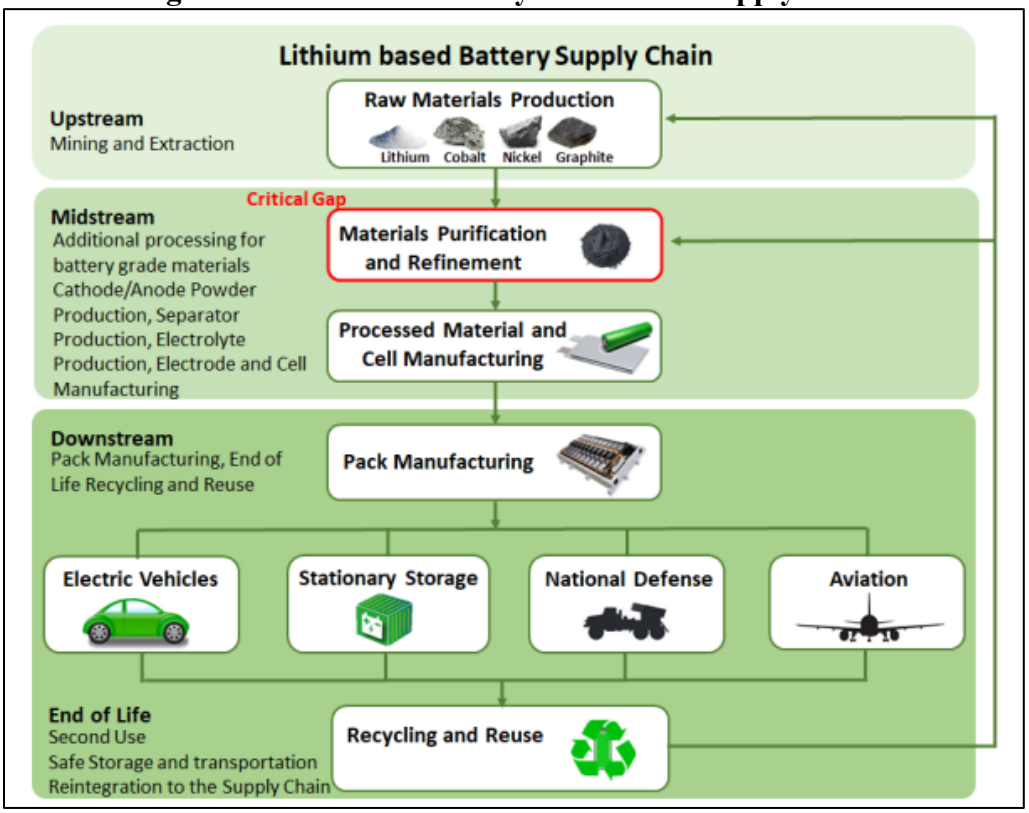
Lack of Employees

Despite the relatively high wages paid to employees within the mining and natural resource extraction industry sector, the mining industry as a whole is struggling to attract younger talent. With younger individuals who are now entering the workforce leaning more towards technology-based sectors, it has become increasingly difficult for the mining industry to tap into this age group. Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector needs to increase its investments in the fields of unnamed autonomous vehicles, automated drilling machines, and robotics in order to gain the attention of this productive workforce (Banning, D., 2019).

Materials Purification and Refinement

In order to support the continued and emerging development of local battery manufacturers, the state of Nevada needs to invest in processing plants that can process raw materials like lithium as shown in Figure 3.7.

Figure 3.7 – Lithium Battery Production Supply Chain



Source: Building Resilient Supply Chains, Revitalizing American Manufacturing, And Fostering Broad-Based Growth. 100-Day Reviews under Executive Order 14017. June 2021. https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf

Currently, the United States relies on other countries for this additional value added production process and the mining industry as well as end consumers would benefit from bridging this gap in the existing value network and supply chain (The White House, 2021).

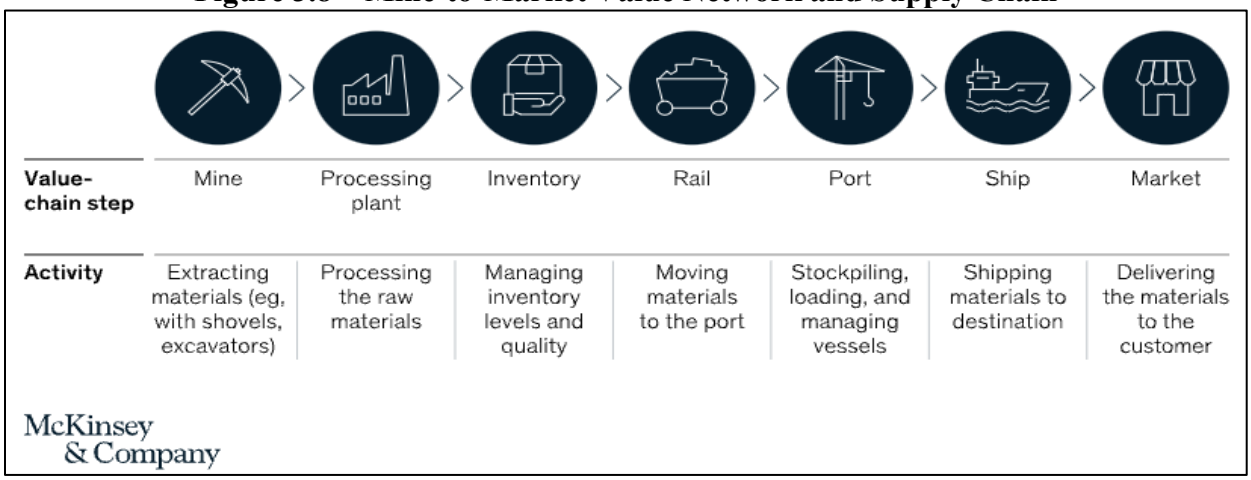
Lithium Recycling

Redwood Materials, founded in 2017, has expanded battery recycling operations and has recently broken ground on the development of a new battery recycling facility on 100 acres of land close to Reno, Nevada. In order to fill this void in the existing value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector, the state of Nevada needs to invest more in this particular recycling process (Associated Press, 2021).

Mine-to-Market Value Network and Supply Chain

There is evidence to support that the mining and natural resource industry sector tends to treat value networks and supply chains the same way since managing value networks has not been the highest priority resulting in organizational silos and poor collaboration as evident in Figure 3.8. Changing this existing mindset and trend can enhance end-to-end performance through improved data collection and analytics (McKinsey & Company, 2021).

Figure 3.8 – Mine-to-Market Value Network and Supply Chain



Source: The mine-to-market value chain: A hidden gem. 2020, October 5. https://www.mckinsey.com/industries/metals-and-mining/our-insights/the-mine-to-market-value-chain-a-hidden-gem

Full integration of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector will require a comprehensive understanding of how mining and natural resource extraction operations support the further development of existing and emerging industry sectors and how the mining and natural resource extraction industry sector is impacted by the growth and development of other directly and indirectly related industry sectors. Developing supportive industry clusters, comprised on directly and indirectly related industry sectors, will both support the continued

growth and expansion of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector while also further diversifying and growing Nevada's existing economic base.

3.3 Nevada's Mined Metals and Analysis of the Economic Impact of Commodity Prices

This sub-section presents a general overview of recent pricing data and trends of industrial and precious metals currently mined and extracted throughout the state of Nevada and a general assessment of commodity price volatility.

3.3.a Summary of Industrial and Precious Metals in Nevada

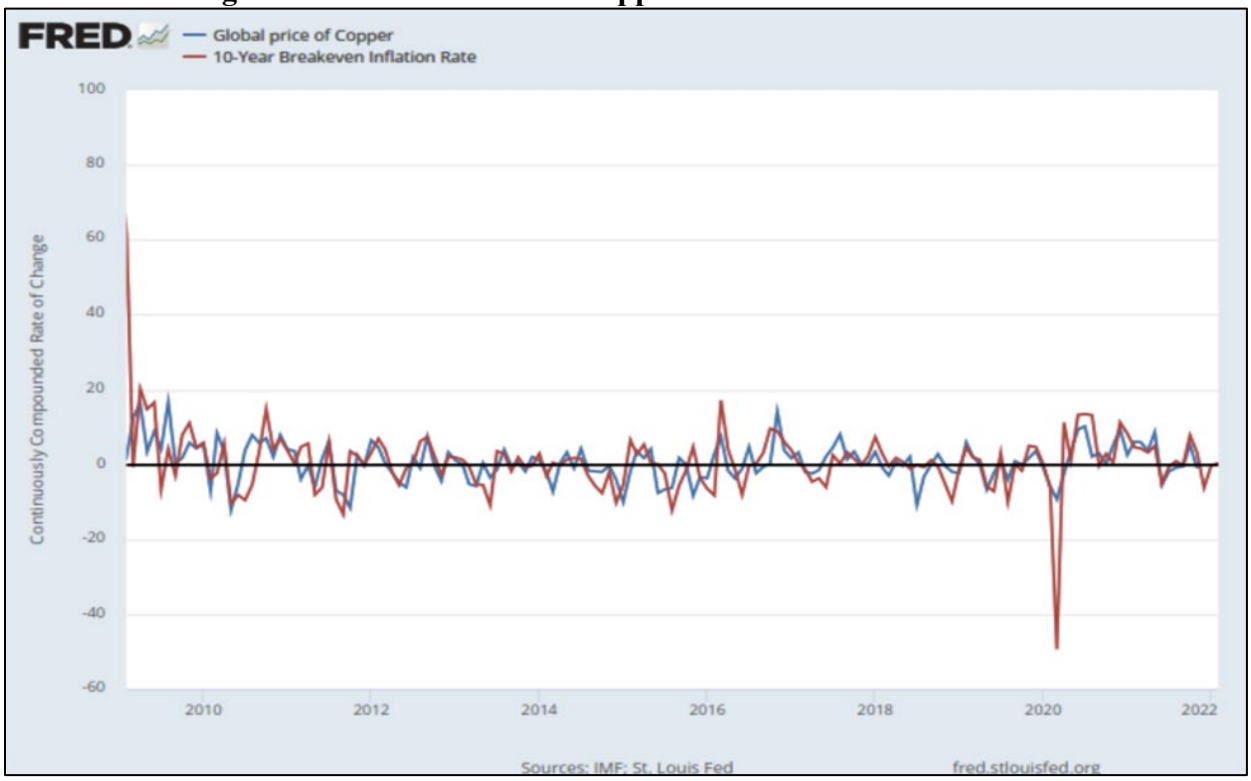
The summary presented here includes an overview of various industrial metals, including copper, lithium, magnesium, and various precious metals. Nevada is host to a variety of mining operations producing a wide range of valuable commodities. In previous parts of this University Center for Economic Development technical report, rare earth elements were explored in detail. Here, industrial metals will be examined further. In particular, this analysis includes copper, lithium, magnesium, and molybdenite. Molybdenite production output in Nevada represents approximately 0.0007 percent of global output and will be excluded given the relatively low importance that the mining and extraction of molybdenite has relative to other commodities mined and extracted throughout Nevada.

Copper

Copper is the largest produced industrial metal extracted from Nevada. When evaluating the percentage change of the global pricing index of copper against the 10-year Breakeven Inflation Rate of the United States, there is a positive and persistent correlation as illustrated in Figure 3.9 (FRED 2021). Over the previous 15 years, copper has a correlation coefficient of 0.8312 to the 10-year Breakeven Inflation Rate and, when further extended to 30 years, retains a coefficient of 0.7513 (FRED 2021). Copper's utilization is predominantly in the sectors of building construction, electronics, and electrical utilization and the global price of copper tends to rise in prior to general consumer prices rise. This generally means that the commodity futures of copper can be speculatively purchased as a proactive inflation hedge.

The reactionary pressure down the supply chain of copper production creates increased inflationary pressures that are eventually passed down to final consumer products. Given the strong correlation to inflation, there is a price pattern for copper that is cyclical with expansions and contractions. Copper reached an all-time price per pound of $4.71 on May 3rd, 2021 and is current trading around $4.60 per pound in March 2022. The Chicago Mercantile Exchange, the United States' largest commodity and derivative exchange, is displaying copper futures contracts into 2023 at a lower price than the current market. Investors are seemingly expecting a possible tightening in fiscal policy by the United States federal government that will eventually slow demand for copper. A reduction in volume in futures contracts trades would bolster this potential trend.

Figure 3.9 – Global Price of Copper and 10-Year Inflation Rate



Source: Federal Reserve Economic Dataset (2021, December 15). Global price of copper. https://fred.stlouisfed.org/series/PCOPPUSDM

Lithium

With the ever-increasing demand for firms and producers to become net zero in-terms of carbon emissions, the demand for battery grade lithium has outpaced supply. Currently, Nevada's output of lithium represents just 1.0 percent of the global production in 2020 where Australia led global lithium production output, accounting for nearly 46.3 percent of global supply. In a BP published Statistical Review of World Energy in 2021, the United States share of global reserve potential for lithium production is approximately 4.0 percent, about one-half that of China and one-tenth of Chile's reserves. However, United States domestic lithium reserves represents a significant resource for potential future expansion (BP 2021).

According to S&P Global's commodities research, the demand forecast for lithium is estimated to reach nearly 2.0 million tons by 2030. This demand forecast would require production to increase by over 2,200.0 percent from 2020 production levels. With demand for lithium outpacing lithium supply, there has been a significant surge in global lithium pricing. By the end of calendar year 2021, the global price of lithium rose by over 430.0 percent from calendar year 2020 to nearly $43,000 per ton. As the gap between global lithium demand and global lithium supply reserves continues to grow and scarcity increases, there is considerable growth potential

for lithium production in Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector.

Magnesium

Most of the magnesium production in the United States is currently happening in Utah at an electrolytic process smelter that recovered magnesium from brines from the Great Salt Lake according to the United States Geological Survey. In the United States Geological Survey year-end report for magnesium, the United States showed a reduction of output in 2021 and the published data was withheld because of proprietary information constraints. The global price for magnesium has shown incredible volatility according to the United States Geological Survey annual reports. *"The price range in Europe for the first 3 months was $2,600 to $2,700 per metric ton. At the end of June, the price range in Europe increased to between $3,500 and $3,700 per metric ton and, by the end of August, the price ranged between $4,100 and $4,500 per metric ton. At the end of September, the price range in Europe increased to between $10,000 and $11,500 per metric ton and, by mid-October, the price ranged from $12,000 to $15,000 per metric ton. In late October, the price range started to decrease and was $7,700 to $9,500 per metric ton by mid-November."* (USGS 2021)

Precious Metals

In 2020, Nevada-based mines produced nearly 4.6 million ounces of gold, with an estimated value output of nearly $8.2 billion. Likewise, Nevada-based mines extracted nearly 6.1 million ounces of silver, with an estimated value output that totaled approximately $12.5 million. The extraction of both gold and silver ore accounted for approximately 92.6 percent of the state of Nevada's estimated value output (Visher, Patterson 2021). Unquestionably, the extraction of gold is the driving force behind these figures but the importance of silver to Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector should not be undervalued. Considering that neither platinum or palladium have been mined in Nevada since 1919 (two of the most common precious metals) and are not expected to be a focus for the foreseeable future, the two most prominent precious metals that the state of Nevada has access to are gold and silver. Both commodities are incredibly intriguing as the value and volatility of them may very well be subject to current market settings, economic impacts, and political skepticism.

3.3.b Commodities Price Volatility

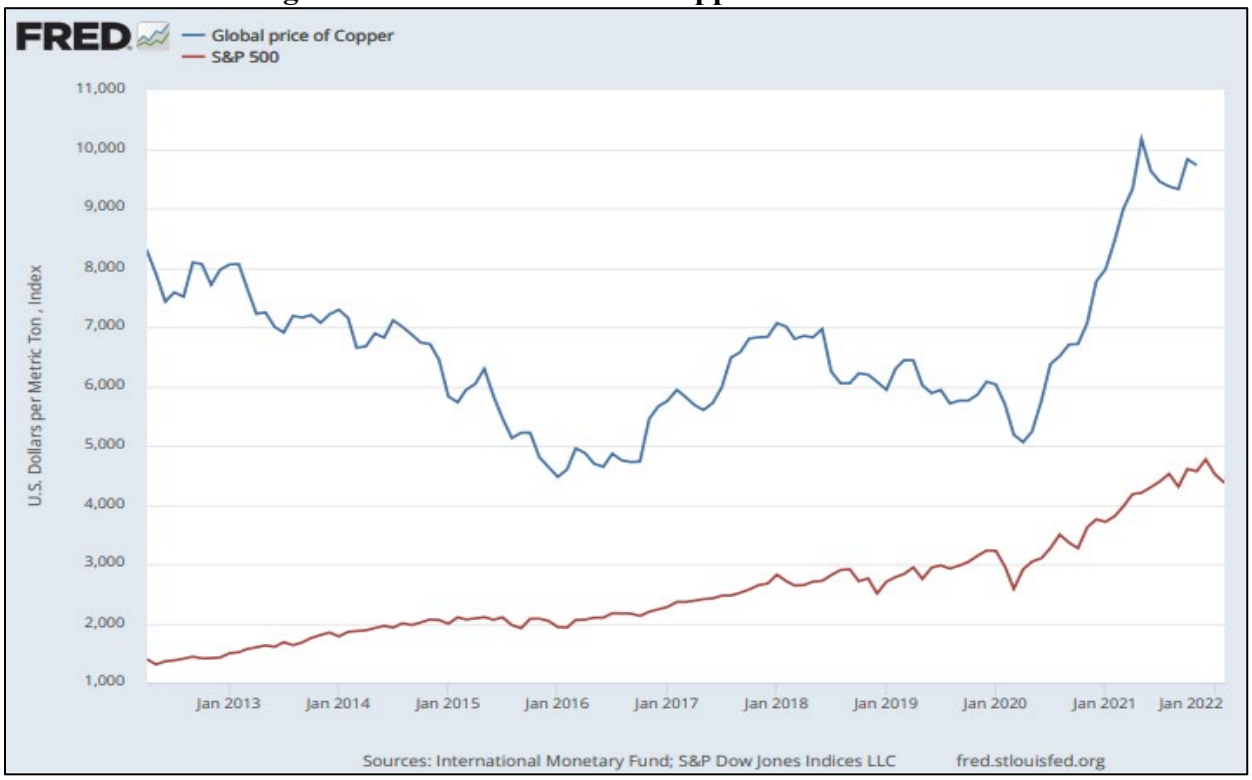
Analyzing annual prices for copper and lithium dating from 2002 to 2020 shows the average global price for copper is $5,771 per metric ton and the standard deviation from this mean is 2,024 (FRED 2021). Lithium has a much higher annual average during the same time period of $11,884 per metric ton and larger standard deviation of 21,460 (Metalary 2018 and Trading Economics 2022). These price trends for both copper and lithium are presented in Table 3.5. Lithium has had a significantly greater increase and price change during these two decades than copper.

Table 3.5 – Global Prices of Copper and Lithium Average Annual Price (Mean) and Reported Standard Deviation 2002 through 2020		
Category	**Global Price of Copper (U.S. Dollars)**	**Global Price of Lithium (U.S. Dollars)**
Average Annual Price (Mean)	$5,770.98	$11,883.84
Standard Deviation	$2,024.34	$21,460.35

Source: FRED. (2021, December 15). *Global price of copper.* Federal Reserve of Economic Data. https://fred.stlouisfed.org/series/PCOPPUSDM; Metalary. (2017, April 5). *Latest and historical metal prices.* https://www.metalary.com/lithium-price/; Trading Economics. (2022). *Lithium 2022 data - 2017-2021 historical - 2023 forecast - price - quote - chart*. https://tradingeconomics.com/commodity/lithium?user=analyst42200

While two standard deviations represent 95.0 percent of the possible variations over this time period, copper has stayed within those parameters. Meanwhile, there were times when the price of lithium moved outside this criteria. This occurred more recently in 2019 and 2020. This aligns with the price change of an increase of 45.0 percent of the price of lithium from 2018 to 2019 and an increase of 74.0 percent from 2018 to 2019.

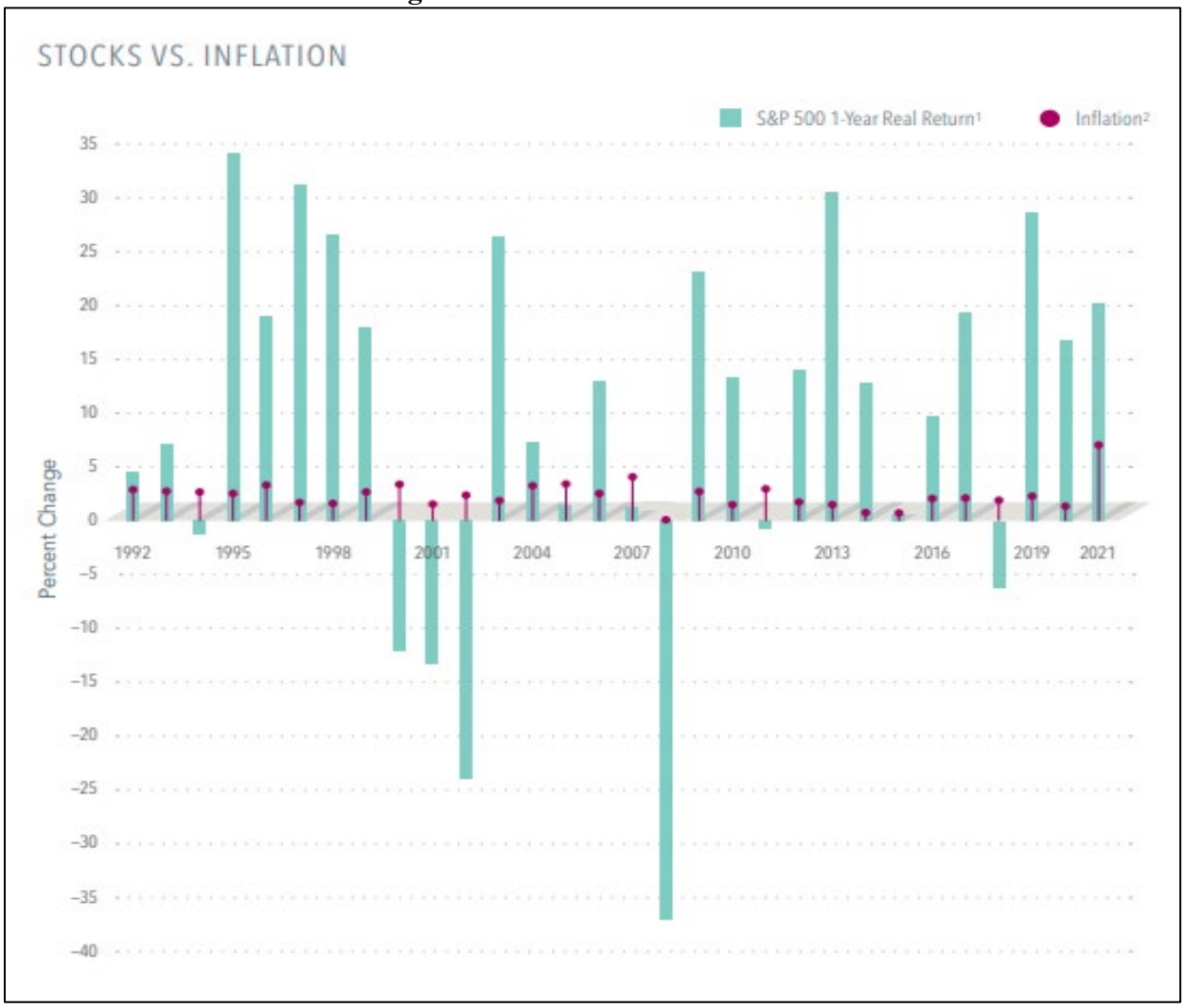
Figure 3.10 – Global Price of Copper and the S&P 500



Source: Federal Reserve Economic Dataset. (2021, December 15). *Global price of copper.* https://fred.stlouisfed.org/series/PCOPPUSDM

Although there was still an increase from 2019 to 2020 and well outside the two standard deviation metric, this was only at 18.0 percent. While longer-term patterns and links to inflation are evident, a slightly different approach was used to compare these commodities to see if copper and lithium are leading indicators that have any correlation to indices such as the S&P 500. While the correlation coefficient between these two data sets is uncorrelated, the chart presented in Figure 3.10 also highlights that there is a lack of synchronization between these two factors. From 2012 to 2022, the S&P has had lower volatility and steady growth while the price of copper has had small growth and significant volatility. There seems to be a stronger correlation between industrial earth metals and inflation compared to industrial earth metals and financial markets.

Figure 3.11 – Stocks vs. Inflation

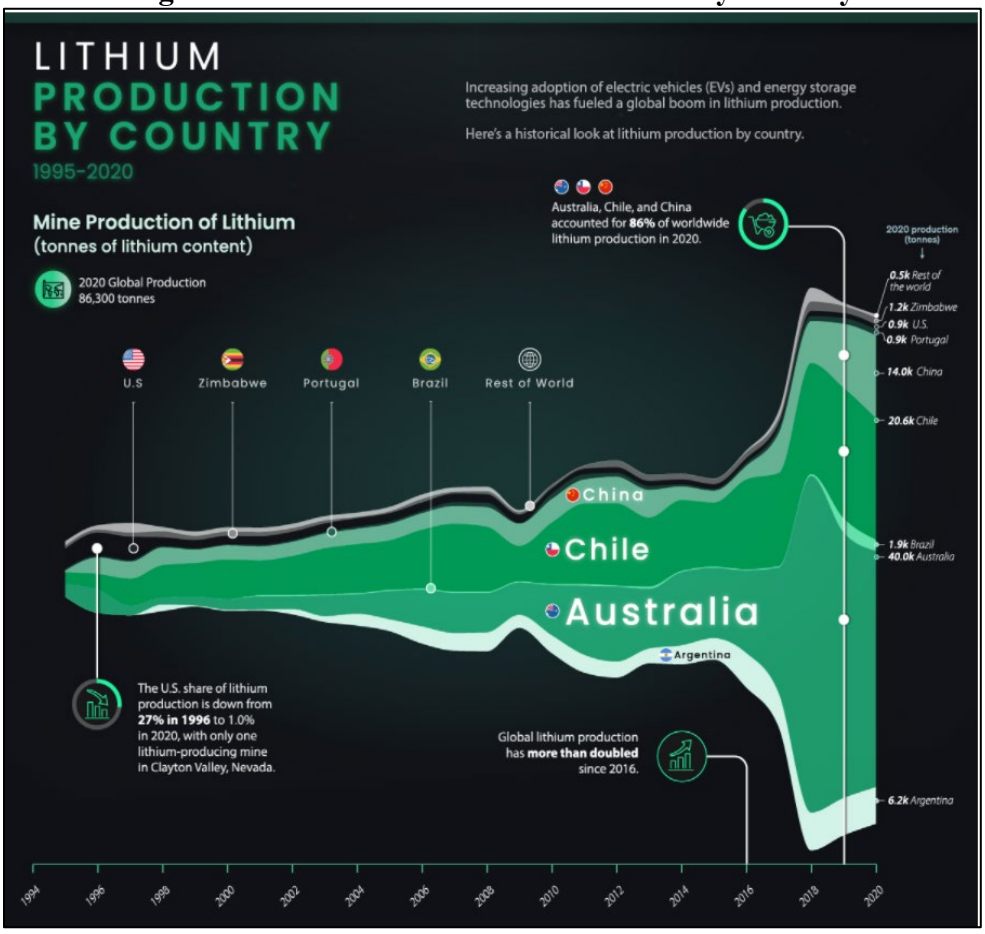


Source: Dimensional. (2021) *Will inflation hurt stock returns? Not necessarily.* https://dimensional.com/fi-en/insights/will-inflation-hurt-stock-returns-not-necessarily

When looking at the historical data between United States domestic stock returns and high inflation, there does not seem to be a strong connection between the two going back to 1992 as illustrated in Figure 3.11. Since 1926 through 2021, inflation has remained relatively constant at 2.9 percent and the S&P 500 has remained steady with an estimated growth rate of approximately 10.5 percent. (Dimensional 2021). Commodities, in general, have historically been a good hedge against inflation (Dimensional 2021). While there is a strong correlation between copper and inflation, the demand for the limited supply of lithium has influenced the price beyond factors like inflation.

Many countries have prioritized the electric vehicle and, in-turn, the demand for lithium. The production of lithium has more than doubled between 2016 to 2020 as illustrated in Figure 3.12. The increase in demand in batteries for electric vehicles has increased from approximately 18.0 percent in 2010 to nearly 71.0 percent in 2020 and is only expected to continue to increase (Scotch Creek, 2022).

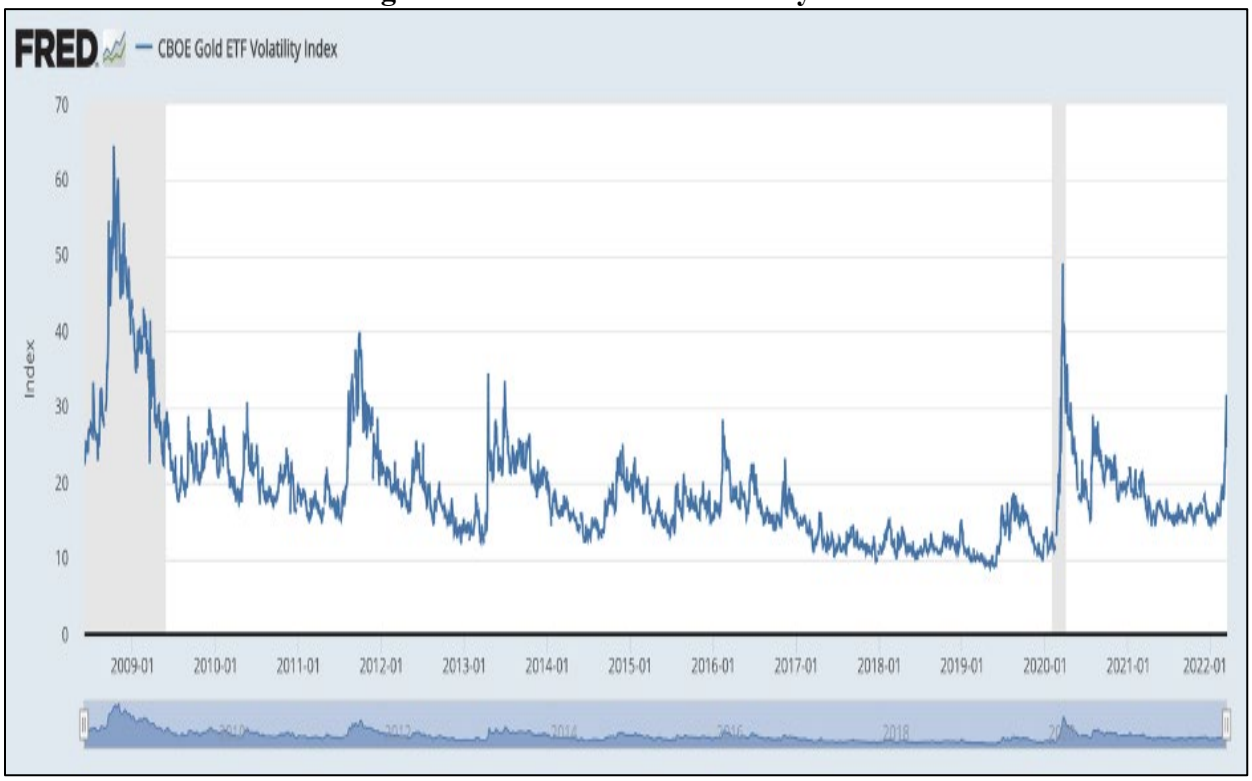
Figure 3.12 – Global Lithium Production by Country



Source: Bhutada, G. (2022, February 9). Charted: Lithium production by country (1995-2020). Visual Capitalist. *https://www.visualcapitalist.com/charted-lithium-production-by-country-1995-2020/*

New studies have brought to light the volatility of gold and numerous reasons as to why the price of gold moves the way it does. As shown in Figure 3.13, the significant increase in the volatility of gold between 2008 and 2009 and in 2020 were a result of general economic uncertainty (FRED, 2022a), the Great Recession, and the global COVID-19 pandemic. Each factor and event caused great doubt as they were unprecedented times. During times of economic uncertainty, as well as political insecurity, more people turn to the investment in gold as it can act as a hedge against inflation. When expected returns of more common investments such as real estate, bonds, and equities fall, the interest in gold tends to increase and drives up the price of gold (Investopedia, 2021). Given that gold can act as an alternative investment strategy, the resulting price is very unstable. At the turn of the 21st Century, the price of gold was priced at approximately $477.94 an ounce. As the tech bubble burst and the Great Recession loomed, the price of an ounce of gold, as shown in Figure 3.14, reached $1,088.44 in 2007 and $2,284.90 an ounce at the height of the Great Recession in 2011, a 127.7 percent increase from 2000 to 2007 and a 109.9 percent increase from 2007 to 2011(Macrotrends, 2022). The fluctuations in the value of gold indicate a need for ambiguity for an uptick in price. In a similar sense, the price, volatility, and cause for variations is similar in silver.

Figure 3.13 – Gold ETF Volatility Index



Source: Federal Reserve Economic Dataset. (2022a). CBOE Gold ETF Volatility Index. Federal Reserve of Economic Data. https://fred.stlouisfed.org/series/GVZCLS

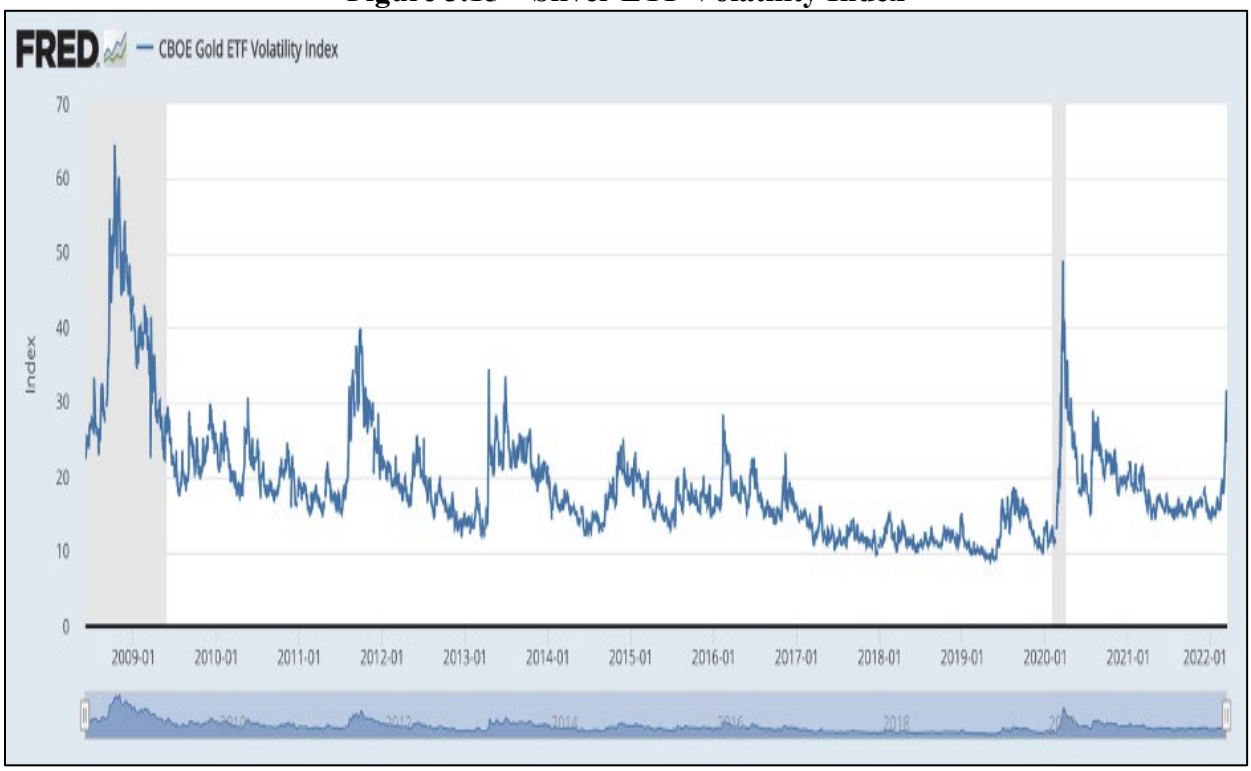
Figure 3.14 – Historical Price Data for Gold

Source: Macrotrends. (2022). Gold Prices – 100 Year Historical Chart. *https://www.macrotrends.net/1333/historical-gold-prices-100-year-chart*

The price of silver in relation to gold is unquestionably inferior due to its higher degree of availability. However, the price action of silver and its reason for change are similar to the price action and reason for change for gold. Like gold, silver prices experienced a significant increase in volatility prior to the global COVID-19 pandemic both price and volatility as illustrated in Figure 3.15. In 2000, the price of silver was $8.94 an ounce and $19.95 an ounce and $48.12 an ounce in 2007 and 2011 respectively as seen in Figure 3.16 (Macrotrends, 2022). These price increases for silver show a 123.5 percent and 141.2 percent price increase, similar to the general price change behavior in gold over the same periods.

The precious metals of gold and silver are both valuable as a hedge against inflation and both commodities are used in wide variety of products. As new and emerging technologies are developed, the demand for both gold and silver will likely increase for the near future as both commodities are heavily used in a number of existing and emerging industry sectors with direct and indirect ties to gold and silver mining and extraction operations (SBC Gold, 2021). The use of gold and silver in electronics, specifically, is a major contributing factor to the growing need for gold and silver. One note that must be made clear, if not already evident, is the positive correlation between gold and silver. Both gold and silver, although far different in their valuations as individual commodities, share a strong relationship in general price sensitivity and volatility.

Figure 3.15 – Silver ETF Volatility Index



Source: Federal Reserve Economic Dataset. (2022a). *CBOE Gold ETF Volatility Index*. Federal Reserve of Economic Data. https://fred.stlouisfed.org/series/GVZCLS

Similar to the volatility index presented for the change in price of gold, general levels of economic uncertainty have directly affected the price behavior of silver in national and international markets. The collapse of tech stocks in the late 1990's, the 9-11 Terrorist Attacks on the World Trade Center in New York and the Pentagon in Washington, D.C. on September 11, 2001, the Great Recession that occurred between 2009 and 2011, and the ongoing global COVID-19 global pandemic that began in the early part of 2020 are events that track with sudden increases in the price of silver. While economic and even political uncertainty has and will likely continue to influence the price and general volatility of silver prices in national and international markets, the increased demand of silver in the manufacturing of goods in existing and emerging industry sectors are likely to have a greater influence on long-term pricing and volatility changes of silver. This trend is similar to how the increased demand of gold in the manufacturing of similar goods in the same existing and emerging industry sectors have affected the price and general volatility of gold prices in national and international markets.

For Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector, and for the specific production of gold and silver ore, continued expansion of gold and silver production and extraction operations will likely continue as prices for both commodities remain relatively high. This continued trend is beneficial for local communities across the state of Nevada that depend on gold and silver production and extraction as a primary driver of local community and economic growth.

Figure 3.16 – Historical Price Data for Silver

Source: Macrotrends. (2022). Silver Prices – 100 Year Historical Chart.
https://www.macrotrends.net/1470/historical-silver-prices-100-year-chart

References for Section 3.0, White Paper for Part 2 *Evaluating National and International Mining, Quarrying, and Oil and Gas Extraction Industry Sector Value Networks and Supply Chains*

Alaska Centers. (n.d.). *Recreational Gold Mining*. Alaska Public Land Information Centers. https://www.alaskacenters.gov/explore/things-to-do/gold-mining

Albemarle Corp. (2018, February). *Silver Peak Lithium Mine*. Albemarle Corporation. https://www.macalester.edu/miningfutures/PDFs/Silver_Peak_Lithium_Mine.pdf

Alves, B. *(2022, March 7). Lithium mine production in Chile 2021.* Statista. *https://www.statista.com/statistics/717594/chile-lithium-production/*

APMEX (n.d.). *How precious metals are vital to space exploration.* APMEX. https://www.apmex.com/education/science/how-precious-metals-are-vital-to-space-exploration

Arangio, S. (2019, September 24). *Official Opening of Canada's first all-electric mine*. CTV News. https://northernontario.ctvnews.ca/official-opening-of-canada-s-first-all-electric-mine-northern-ontario-1.4607600

Associated Press. (2021, June 16). *Battery recycling firm to expand operations in Nevada*. Associated Press News. https://apnews.com/article/nv-state-wire-nevada-recycling-technology-business-dd28158a3032d7008465837676048ff8

Australian Government. (2018, December 11). *Lithium-Ion Battery Value Chain Report*. Australian Trade and Investment Commission. https://www.austrade.gov.au/search.aspx?moduleid=8367&multisite=false&keywords=lithium+ion

AX Legal. (2021, December 14). *Water for Chile's copper mines*. AX Legal. https://ax.legal/2021/12/14/water-for-chiles-copper-mines/

AZGS. (2018, June 6). *King copper*. The University of Arizona - Arizona Geological Survey. https://azgs.arizona.edu/minerals/king-copper

Bahouth, B. (2021, January 15). *BLM approves Thacker Pass Lithium Mine near Winnemucca, Nevada*. Sierra Nevada Ally. https://www.sierranevadaally.org/2021/01/15/blm-approves-thacker-pass-lithium-mine/

Baker McKenzie. (n.d.). *Global Mining Guide: China*. Retrieved March 18, 2022, from https://resourcehub.bakermckenzie.com/en/resources/global-mining-guide/asia-pacific/china/topics/global-mining-guide

Banning, D. (2019, Oct 1). *Nevada mining continued transition into high-tech.* Nevada Business Magazine. https://www.nevadabusiness.com/2019/10/nevada-mining/

Bateman, A.M. (1961) Minerals: Supply and Demand, Bulletin of the Atomic Scientists. https://www.tandfonline.com/doi/abs/10.1080/00963402.1961.11454260?journalCode=rbul20

Basov, V. (2022, February 1). *The world's largest lithium producing countries in 2021 - Report*. Kitco. https://www.kitco.com/news/2022-02-01/Global-lithium-production-up-21-in-2021-as-Australia-solidifies-its-top-lithium-producer-status.html

Bhutada, G. (2022, February 9). *Charted: Lithium production by country (1995-2020).* Visual Capitalist. https://www.visualcapitalist.com/charted-lithium-production-by-country-1995-2020/

Boyle, M. and Reeves, M. (2021). *What Drives the Price of Gold?* Investopedia. https://www.investopedia.com/financial-edge/0311/what-drives-the-price-of-gold.aspx

BP. (2021). Statistical review of world energy 2021: 70th edition https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf

Bravus. (2021, July 15). *The Positive Effects of Mining on the Economy*. Bravus Mining & Resources. https://www.bravus.com.au/the-positive-effects-of-mining-on-the-economy/

Casey, J. P. (2021, March 15). *In numbers: How mining came to be Australia's most profitable sector*. Mining Technology. https://www.mining-technology.com/features/in-numbers-how-mining-came-to-be-australias-most-profitable-sector/

Center for International Economics. (2021, May 21). *Estimating the economic benefits of mining expansion and further productivity reforms*. https://www.minerals.org.au/sites/default/files/_FINAL.PDF/

Champion, D., 2019. Australian Resource Reviews: Lithium 2018. Geoscience Australia, Canberra. https://d28rz98at9flks.cloudfront.net/126759/ARR_Lithium_2018.pdf

China Power Team. (2020, July 17). *Does China pose a threat to global rare earth supply chains?* China Power. https://chinapower.csis.org/china-rare-earths/

CMMP (n.d.). *Mining in Canada*. Government of Canada. The Canadian Minerals and Metals Plan. https://www.minescanada.ca/en/content/mining-canada-0

Cohen, A. (2021, June 2). *China's journey to the center of the Earth - for rare minerals*. Forbes. https://www.forbes.com/sites/arielcohen/2021/06/02/chinas-journey-to-the-center-of-the-earth/?sh=ee25b6f131f7

Colthorpe, A. (2021, July 22). *Australian government issues grants to support vanadium and Lithium Battery Materials Processing*. Energy Storage News. https://www.energy-storage.news/australian-government-issues-grants-to-support-vanadium-and-lithium-battery-materials-processing/

Couturier, G., & Law-west, D. (2020, April 3). *Gold*. The Canadian Encyclopedia. https://www.thecanadianencyclopedia.ca/en/article/gold

CSIRO. (2021, February 19). *Hydrogen's key role in decarbonising the mining industry*. Commonwealth Scientific and Industrial Research Organisation. https://www.csiro.au/en/work-with-us/industries/mining-resources/resourceful-magazine/issue-21/moving-to-hydrogen

Data USA. (n.d.). Retrieved March 15, 2022, from https://datausa.io/

Dentzer, B. (2021, October 2). *Nevada's next boom: Demand poised to spur Silver State's lithium production*. Las Vegas Review-Journal. https://www.reviewjournal.com/local/local-nevada/nevadas-next-boom-demand-poised-to-spur-silver-states-lithium-production-2451259/

Desjardins, J. (2017, June 21). *How copper riches helped shape Chile's economic story*. Visual Capitalist. https://www.visualcapitalist.com/copper-shape-chile-economic-story/

Dimensional. (2021) *Will inflation hurt stock returns? not necessarily.* https://dimensional.com/fi-en/insights/will-inflation-hurt-stock-returns-not-necessarily

EIA (Energy Information Administration). (2007). Annual Energy Review 2006. Report No. DOE/ EIA-0384 (2006). Washington, D.C. http://www.eia.doe.gov/emeu/aer/contents.html

Erickson, C., & Keen, K. (2021, December 21). *Chile's mining industry unfazed by leftist Gabriel Boric's victory*. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/chile-s-mining-industry-unfazed-by-leftist-gabriel-boric-s-victory-68148415

FRED. (2022a). *CBOE Gold ETF Volatility Index*. Federal Reserve of Economic Data. https://fred.stlouisfed.org/series/GVZCLS

FRED. (2022b). CBOE *Silver ETF Volatility Index*. Federal Reserve of Economic Data. https://fred.stlouisfed.org/series/VXSLVCLS

FRED. (2021, December 15). *Global price of copper.* Federal Reserve of Economic Data. https://fred.stlouisfed.org/series/PCOPPUSDM

Garside, M. (2021, September 6). *Silver mine production U.S. by State 2018*. Statista. https://www.statista.com/statistics/253296/us-silver-production-by-state/

Garside, M. (2022a, January 24). *U.S.: Gold mine production by State*. Statista. https://www.statista.com/statistics/238418/us-gold-production-by-state/

Garside, M. (2022b, March 4). *Distribution of rare earths production worldwide as of 2021, by country*. Statista. https://www.statista.com/statistics/270277/mining-of-rare-earths-by-country/

Garside, M. (2021, April 27). *Rare earth oxide demand worldwide 2025.* Statista. https://www.statista.com/statistics/1114638/global-rare-earth-oxide-demand/

GBR. (n.d.). *Water, Energy and Environment: The Journey to Green Mining*. Global Business Reports. https://projects.gbreports.com/chile-mining-2021/water-energy-and-environment/

Global rare-earth metals market 2021-2026: Lanthanum, cerium, neodymium, praseodymium, samarium, europium: Opportunities in recycling and reuse of rare-earth metals. (2021). *Focus on Catalysts, 6*(2): https://doi.org/10.1016/j.focat.2021.05.003

Government of Canada. (2021a, December 13). *Canadian Mineral Production*. https://www.nrcan.gc.ca/science-data/science-research/earth-sciences/earth-sciences-resources/earth-sciences-federal-programs/canadian-mineral-production/17722

Government of Canada. (2021b, April 12). *Canada sets a world standard for Sustainable Mining*. https://www.tradecommissioner.gc.ca/canadexport/0003604.aspx?lang=eng

Government of Canada. (2022a, February 22). *Gold Facts*. https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/gold-facts/20514

Government of Canada. (2022b, February 3). *Minerals and the economy*. https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/minerals-and-the-economy/20529

Grant County, NM. Data USA. (n.d.). https://datausa.io/profile/geo/grant-county-nm

Greenovation Hub (2014). *China's Mining Industry at Home and Overseas: Development, Impacts, and Regulation*. https://www.ghub.org/cfc_en/wp-content/uploads/sites/2/2014/11/China-Mining-at-Home-and-Overseas_Main-report2_EN.pdf

Holman, J and Ribeiro, H. (2021). *Commodities 2022: Global lithium market to remain tight* *https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/energy-transition/121421-commodities-2022-global-lithium-market-to-remain-tight-into-2022*

Home: Tombstone Exploration Corporation. (n.d.). https://www.tombstonemining.com/

Horwath, J. & Feliba, D. (2021, August 30). *Rich in renewable energy, Chile seeks to become global hydrogen powerhouse*. S&P Global. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/rich-in-renewable-energy-chile-seeks-to-become-global-hydrogen-powerhouse-66012212

ICA. (2017). *The Impacts of Copper Mining in Chile Economic and Social Implications for the Country*. International Copper Association. https://sustainablecopper.org/wp-content/uploads/2018/05/ICA-Summary-Document-The-Impacts-of-Copper-Mining-in-Chile-FV-04.04.2018.pdf

IKI. (2021, June 8). *Sustainable mining in Chile*. International Climate Initiative. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. https://www.international-climate-initiative.com/en/news/article/sustainable_mining_in_chile

ILO (2011, April 27). *Chile ratifies ILO Convention 187 on the Promotional Framework for Occupational Safety and Health*. International Labour Organization. https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_154811/lang--en/index.htm

ITA (2021, August 16). *Australia - Country Commercial Guide: Mining*. International Trade Administration. https://www.trade.gov/country-commercial-guides/australia-mining

ITA (2022, January 25). *Chile - Country Commercial Guide: Mining*. International Trade Administration. https://www.trade.gov/country-commercial-guides/chile-mining

Kennedy, J. (2019, March 21). *China Solidifies Dominance in Rare Earth Processing*. National Defense. https://www.nationaldefensemagazine.org/articles/2019/3/21/viewpoint-china-solidifies-dominance-in-rare-earth-processing

Kesler, S. (2019). *Mineral Supply and Demand into the 21st Century.* USGS.gov. https://pubs.usgs.gov/circ/2007/1294/reports/paper9.pdf.

Kurmelovs, R. (2022, January 30). *New Electric Vehicle Sales triple in Australia with Tesla outstripping other makers*. The Guardian. https://www.theguardian.com/environment/2022/jan/31/new-electric-vehicle-sales-triple-in-australia-with-tesla-outstripping-other-makers

LePan, N. (2021, November 23). *Rare earth elements: Where in the world are they?* Visual Capitalist. https://www.visualcapitalist.com/rare-earth-elements-where-in-the-world-are-they/

Lithium Americas. (2021, October 7). *News*. Lithium Americas. https://www.lithiumamericas.com/news/lithium-americas-expands-resource-at-thacker-pass-and-increases-phase-1-capacity-to-target-40000-tpa-lithium-carbonate

Lynch, J. (2021, May 5). *Copper's role in growing electric vehicle production*. Reuters. https://www.reuters.com/article/sponsored/copper-electric-vehicle

Macrotrends. (2022). *Gold Prices – 100 Year Historical Chart*. https://www.macrotrends.net/1333/historical-gold-prices-100-year-chart

Macrotrends. (2022). *Silver Prices – 100 Year Historical Chart*. https://www.macrotrends.net/1470/historical-silver-prices-100-year-chart

Massachusetts Institute of Technology. (2012). *REE supply and demand.* https://web.mit.edu/12.000/www/m2016/finalwebsite/problems/ree.html

McElroy, M. (2019, May 27). *Could gold be the key to making gene therapy for HIV and other blood disorders more accessible?* Fred Hutch. https://www.fredhutch.org/en/news/releases/2019/05/fred-hutch-at-asco-hpv-vaccine-in-us-immunotherapy-and-sarcoma-financial-toxicity-of-cancer-health-care-disparities-and-more/could-gold-be-the-key-to-making-gene-therapy-for-hiv-and-other-blood-disorders-more-accessible.html

McKinsey & Company. (2021, September 27). *The mine-to-market value chain: A hidden gem*. McKinsey & Company. https://www.mckinsey.com/industries/metals-and-mining/our-insights/the-mine-to-market-value-chain-a-hidden-gem

McLemore, V. T. (1996). Copper in New Mexico. *New Mexico Geology*, *18*(2).

Metalary. (2017, April 5). *Latest and historical metal prices.* https://www.metalary.com/lithium-price/

Mine Australia Magazine. (2019, March). *Project live-mm: Attracting talent to Australia's minerals industry*. Mine Australia Magazine. https://mine.nridigital.com/mine_australia_mar19/project_live-mm_attracting_talent_to_australia_s_minerals_industry

MT. (2021, August 25). *Cypress' Clayton Valley Lithium Project, Nevada, USA*. Mining Technology. https://www.mining-technology.com/projects/cypress-clayton-valley-lithium-project-nevada-usa/

National Academies of Sciences, Engineering, and Medicine (NASEM). (2008) Minerals,Critical Minerals, and the U.S. Economy. Washington, DC: The National Academies Press. https://doi.org/10.17226/12034

National Minerals Information Center, & Thompson, D. V., *Crushed Stone And Sand And Gravel In The Fourth Quarter 2020* (2021). U.S. Department of the Interior.

Naylor Association Management Software. (n.d.). *Naylor Association management software*. Facts About Aggregates and Their Role In Texas Construction. https://www.tx-taca.org/aggregate-faqs

NDOT (n.d.). *2021 State Rail Plan*. Nevada Department of Transportation. https://www.dot.nv.gov/home/showpublisheddocument/19780/637635847516530000

Network News Wire. (2021, March 16). *Importance of rare earth elements (REEs) soars as demand increases.* https://www.prnewswire.com/news-releases/importance-of-rare-earth-elements-rees-soars-as-demand-increases-301248259.html

Nevada Copper Corp. (n.d.). *Welcome to Nevada Copper Corp*. Nevada Copper Corp. https://nevadacopper.com/

Nevada GOED (2019). *Mining in Nevada.* Nevada Governor's Office of Economic Development https://www.leg.state.nv.us/App/NELIS/REL/80th2019/ExhibitDocument/OpenExhibitDocument?exhibitId=36158&fileDownloadName=Nevada%20Governors%20Office%20of%20Economic%20Developement%20Mining%20Brochure.pdf

NMCR (n.d.). *Where it is Mined*. New Mexico Copper Rules. http://www.nmcopperrules.com/basics/where-it-is-mined/

NVMA Copper Production (n.d.). *Nevada Mining Production: Copper*. Nevada Mining Association Data Analysis. https://www.nevadamining.org/faqs/analysis/

Nuggets, R. G. (2018, July 1). *Nevada gold mines - the biggest mines and richest gold producers*. RareGoldNuggets.com. https://raregoldnuggets.com/?p=6781

OEC (n.d.). *Chile exports, imports, and trade partners*. Observatory of Economic Complexity. https://oec.world/en/profile/country/chl

Parman, R. (2019, September 26). *An elemental issue*. https://www.army.mil/article/227715/an_elemental_issue

Pelegri, L. (2021, November 30). *Potential modification of Chilean Mining Royalty tax*. International Tax Review. https://www.internationaltaxreview.com/article/b1vp7d93bgy9qc/potential-modification-of-chilean-mining-royalty-tax

Pistilli, M. (2022a, March 8). *Copper mining in the United States*. INN. https://investingnews.com/daily/resource-investing/base-metals-investing/copper-investing/copper-mining-in-the-united-states/

Pistilli, M. (2022b, March 8). *Top rare earth reserves by country*. INN. https://investingnews.com/daily/resource-investing/critical-metals-investing/rare-earth-investing/rare-earth-reserves-country/

Provident Metals. (2019, September 15). *Modern uses of precious metals*. Provident Metals. https://www.providentmetals.com/knowledge-center/precious-metals-resources/modern-metals-uses.html

Raff, J. (2019, November 22). *Sand and gravel in the U.S.* ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/c7738db2f3024b079756c13cef39fa87

Rettner, R. (2018, Dec 4). *Cancer DNA binds to gold. that could lead to new cancer blood test.* Live Science. https://www.livescience.com/64234-cancer-dna-gold-new-test.html

Reuters Staff. (2019, May 30). *China's rare earth supplies could be vital bargaining...* Reuters. https://www.reuters.com/article/us-usa-china-rareearth-explainer/explainer-chinas-rare-earth-supplies-could-be-vital-bargaining-chip-in-u-s-trade-war-idUSKCN1T00EK

Romo, D. (2015). The dynamic evolution of leach pad designs in Chile during the last decade. *Proceedings of Heap Leach Solutions*. https://doi.org/https://ausenco.com/assets/images/The-dynamic-evolution-of-leach-pad-designs-in-Chile-during-the-last-decade_2021-08-13-204331_nkge.pdf

SBC Gold. (2021). *10 Factors that Influence Silver Prices*. https://www.sbcgold.com/investing-101/10-factors-influence-silver-prices/

Sierra College Press (2009). *Mining techniques of the Sierra Nevada and gold country.* https://www.sierracollege.edu/ejournals/jsnhb/v2n1/miningtechniques.html

Skidmore, Z. (2022, January 24). *China merges key rare earth producers*. Mining Technology. https://www.mining-technology.com/news/china-merges-rare-earth/

Supply Chain Minded (2014, September 7). *Heading north: Navigating Alaska's Supply Chain*. Supply Chain Minded. https://supplychainminded.com/heading-north-navigating-alaskas-supply-chain/

The Global Economy (2020). *Political stability in South America*. The Global Economy. https://www.theglobaleconomy.com/rankings/wb_political_stability/South-America/

The White House. (2021, June). *Building Resilient Supply Chains, Revitalizing American Manufacturing, And Fostering Broad-Based Growth. 100-Day Reviews under Executive Order 14017.* The Whilte House. https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf

Tingley, J. V., Castor, S. B., Hess, R. H., & Davis, D. A., The Nevada Mineral Industry 2002 (2003). Reno, NV; Mackay School of Mines.

Trading Economics. (2022). *Lithium 2022 data - 2017-2021 historical - 2023 forecast - price - quote - chart*. https://tradingeconomics.com/commodity/lithium?user=analyst42200

United States Department of Labor Mine Safety and Health Administration (2022). *State of Nevada Program Summary.* https://www.msha.gov/nevada

University of Alaska Southeast. (n.d.). *Alaska Mines.* https://uas.alaska.edu/career_ed/mining/alaska-mine.html

USEIA (2022, March 17.) - *Nevada State Energy Profile and Energy Estimates.* U.S. Energy Information Administration. https://www.eia.gov/state/analysis.php?sid=NV

U.S. Geological Survey. (2022). *Mineral Commodities Summary 2022*. https://pubs.usgs.gov/periodicals/mcs2022/mcs2022.pdf

USGI. (2018, June 12). *Top 10 gold producing countries*. US Global Investors. https://www.usfunds.com/resource/top-10-gold-producing-countries/

USGS National Minerals Information Center. (n.d.) *Rare earths statistics and information.* https://www.usgs.gov/centers/national-minerals-information-center/rare-earths-statistics-and-information

USGS. (2022). Mineral Commodity Summaries 2021 - Magnesium Metal. https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-magnesium-metal.pdf

Visher, M., and Patterson, L. (2021). *Major mines of Nevada 2020—Mineral Industries in Nevada's Economy*: Nevada Bureau of Mines and Geology Special Publication P-32. https://minerals.nv.gov/uploadedFiles/mineralsnvgov/content/Programs/Mining/MiningForms/MM2020_p032_text.pdf

Visual Capitalist. (2022). *Scotch Creek Company spotlight*. https://www.visualcapitalist.com/company_spotlight/scotch-creek/

Watari, T., Nansai, K., & Nakajima, K. (2021). Major metals demand, supply, and environmental impacts to 2100: A critical review. *Resources. Conservation and Recycling, 164*(105107). https://doi.org/10.1016/j.resconrec.2020.105107

World Gold Council. (2021, June 16). *Gold production by country: Gold production: Goldhub*. World Gold Council. https://www.gold.org/goldhub/data/historical-mine-production

World Mining Data. (n.d.). *Copper Production by Country 2022*. World Population Review. https://worldpopulationreview.com/country-rankings/copper-production-by-country

Wu, G., Li, Y., Tongda, J., & Neal. (2021, March 1). *Mining in China: Overview*. Thomas Reuters Practical Law. https://uk.practicallaw.thomsonreuters.com/w-011-1348?contextData=(sc.Default)

Yao, S., & Holden, J. (2021, March 12). *Chinese foreign mining investment - China's private sector eyes low-cost regions*. S&P Global. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/chinese-foreign-mining-investment-8212-china-s-private-sector-eyes-low-cost-regions-63066809

4.0 A Comprehensive Value Network and Supply Chain Map of the Mining, Quarrying, and Oil and Gas Extraction Industry Sector in Nevada

This section of this University Center for Economic Development technical report presents an edited version of the initial white paper developed for Part 3, *A Comprehensive Value Network and Supply Chain Map of the Mining, Quarrying, and Oil and Gas Extraction Industry Sector in Nevada*. Part 3 of this analysis of the value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector included the following elements:

- An analysis by regional economic development authority of key measures of economic performance of Nevada's *Mining, Quarrying, and Oil and Gas Extraction* industry sector including, but not limited to, employment compensation, total employment, and propriety income.

- Identification and discussion regarding existing and possible leakages amongst the value network and supply chain in Nevada's *Mining, Quarrying, and Oil and Gas Extraction* industry sector and directly and indirectly related industry and occupation sectors.

- Final development of comprehensive Input-Output model for Nevada's *Mining, Quarrying, and Oil and Gas Extraction* industry sector and an examination of how the results of this model apply to critical value network and supply chain management functions including, but not limited to, the building of a true value network and supply chain for Nevada's mining and natural resource industry sector, the importance and types of relationships and partnerships that may exist within this industry sector, and the role that strategic planning plays in the growth and development of this industry sector.

This report presents a comprehensive map of the value network and supply chain of Nevada's Mining Quarrying, and Oil and Gas Extraction industry sector. The analysis was performed using IMPLAN, a platform that combines different databases, economic factors, demographic statistics, and well-defined econometric models. IMPLAN insight into an industry's economic impact within a defined geographic region. Data used for this analysis was based on the year 2020 since that was the most recent dataset available. For Nevada's mining and natural resource extraction industry sector, for each of the eight regional economic development authorities, and for the entire state of Nevada, key measures of economic performance including, but not limited to, total output, total employment, gross inputs, and regional inputs were collected and analyzed.

Analysis of Nevada's mining and natural resource extraction industry sector incorporated specific criteria including use of the Regional Purchase Coefficient (RPC) which measures the

proportion of local demand for a commodity that is currently met by local production, and Regional Supply Coefficient (RSC) which measures the proportion of local supply of a commodity that goes to meet local demand. In general, gaps in a local or regional value network or supply chain exists when higher average RPC values and lower average RSC values are present, resulting in a scenario where local demand is well below the large quantities of the commodity produced.

Significant gaps were identified in the value network and supply chain of Nevada's mining and natural resource extraction industry sector across several different regions throughout the state. For the entire state of Nevada, the production and use of tires emerged at the top of the list of existing value network and supply chain gaps with an estimated annual gap of approximately $183.0 million. This was followed by basic organic chemicals with an estimated gap of approximately $111.0 million, explosives with an estimated gap of approximately $55.0 million, petrochemicals with an estimated gap of $53.0 million, conveyor equipment with an estimated gap of approximately $17.0 million, and mining machinery with an estimated gap of approximately $10.0 million. Adding various sectors that are directly and indirectly related to the state's mining and natural resource extraction industry sector, total annual economic leakage is an estimated $532.0 million. By investing in some of these areas, Nevada will benefit from a diversified workforce, increased economic activity, and improved economic diversification.

4.1 Economic Development Authority of Western Nevada

Appendix C of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top 20 industry sectors in-terms of total economic output, total employment and total output by commodity produced by industry sector, backward linkages for the Truck Transportation industry sector, the Architectural, Engineering, and Related Services industry sector, and the Maintenance and Repair, Construction industry sector, and for identified for forward linkages for the Economic Development Authority of Western Nevada. The Economic Development Authority of Western Nevada includes Washoe County. The total population of the Economic Development Authority of Western Nevada in 2020 was an estimated 479,927 total individuals and the total economic output of the entire region was an estimated $51.0 billion. Of the 292,541 total individuals employed throughout the region in 2020, combined personal income was nearly $32.0 billion with an average per capita personal income of approximately $109,000 per employed individual. There were an estimated 356 total individual industry sectors operating within the region in 2020.

4.1.a Economic Performance of the Economic Development Authority of Western Nevada, Top Performing Industry Sectors

For the top 20 industries, operating within the Economic Development Authority of Western Nevada, Mining, Quarrying, and Oil and Gas Extraction was not a top industry sector in terms of total economic output. As a result, rather than explaining direct linkages between mining-related companies, the big picture of the value network and the industry sectors for the Economic

Development Authority of Western Nevada can be analyzed and evaluated in ways that focus on which value network and supply chain operations can better facilitate mining and natural resource extraction activities in other counties and in other regions within the state. Insurance Carriers, Truck Transportation, and Architectural, Engineering, and Related Services are each present in the Economic Development Authority of Western Nevada's top 20 industries in terms of total economic output. The mining and natural resource extraction industry sector, for example, relies heavily on transportation for logistics and distribution. As a result, by thoroughly examining these sectors, firms may be able to identify and begin to close some of the existing gaps and leaks and, by addressing them, the entire value network of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector may operate more efficiently and effectively. The insurance industry sector also plays an important part in the mining and natural resource extraction industry sector and, by uncovering leakages in this sector that may be addressed locally, the entire statewide value network and supply chain will benefit. Mining insurance is a type of business insurance that provides the necessary coverage types required to protect a mining and natural resource extraction firm from market risks. It contains liability, property, and income coverage, as do most company insurance policies. Mining insurance offers a variety of coverage choices that are specific to the mining and natural resource extraction industry sector.

4.1.b Mining-Related Commodity Industry Sector Analysis

Among the 19 commodities analyzed as part of larger statewide Mining, Quarrying, and Oil and Gas Extraction industry sector value network and supply chain mapping effort, firms operating within the Economic Development Authority of Western Nevada's geographic boundaries are currently active in producing 16 separate natural resource commodities. These 16 commodities include natural gas and crude petroleum, gold ore, metal mining services, sand and gravel, other nonmetallic minerals services, support activities for oil and gas operations, other nonmetallic minerals, oil and gas wells, copper, nickel, lead, and zinc ore, silver ore, other chemical and fertilizer mineral, and stone. Each of these individual commodities produces more than $1.0 million individuals in valued output, resulting in approximately $369.0 million in total value output. Natural gas and crude petroleum and gold ore are the most significant sectors with a production amount of more than twice metal mining services, the third most valued commodity in-terms of total valued output.

4.1.c Backward and Forward Linkages

Looking at the mining and natural resource extraction industry sector's value network and supply chain gaps for just the Economic Development Authority of Western Nevada, determining the difference between what commodities each industry sector requires and whether or not those needs can satisfied throughout local production is used to estimate the size of the gap in related value networks and supply chains. If demand is not met locally, money will flow out of the region in order to purchase the needed goods and services in order to fulfill them. There are opportunities to localize some additional local production in order to reduce or close existing regional value network and supply chain gaps.

Beginning with Truck Transportation, of the top 20 sectors with higher (Gross Absorption, Regional Inputs) amounts, Tires and Motor Vehicle Parts has an estimated 0 RPC for the Economic Development Authority of Western Nevada, indicating that local suppliers within the region were able to meet 0.0 percent of the need in these areas, resulting in a net leakage of $8.0 million. Looking at the sectors with the highest leakage rate in Insurance Carriers, virtually 0.0 percent of Petroleum Lubricating Oil and Grease and All Other Petroleum and Coal Products required by this industry are fulfilled through local production. An estimated $7,898 per year could be captured by localizing production in each of these sectors. However, as compared to the potential benefits of localizing other production processes in other industries, this amount is insignificant. There is also an opportunity to expand local or regional production in Other Basic Organic Chemicals, Fabricated Structural Metal Products, and Iron and Steel and Ferroalloy Products and capture nearly $10.0 million in annual economic leakage by targeting the Architectural, Engineering, Related Services industry sector. Additional, only about 2.0 percent of local needs for Refined Petroleum Products, Stone, and Motor Vehicle Steering, Suspension Components (Except Spring), and Brake Systems are met locally in the Maintenance and Repair Construction industry sector. Improved local and regional production in this value network has the potential of capturing nearly $15.0 million per year in total economic output.

Looking at downstream mining and natural resource extraction value network and supply chain opportunities for the Economic Development Authority of Western Nevada, it can be observed that local sources in some areas meet only small amounts of local demand while very significant quantities of certain commodities are exported outside the region and outside the state of Nevada in order to support additional value added production. As a result of integrating supply and demand locally, there will be new opportunities for employment creation, industrial development, and general economic growth. For example, within the Economic Development Authority of Western Nevada, only about 2.0 percent of the Other Chemical and Fertilizer industry sector is being used to meet only about 6.0 percent of the local demand. Similarly, just 2.0 percent of Other Clay, Ceramic, Refractory Minerals production is being used to satisfy just 0.7 percent of existing local demand, indicating that there is significant room for growth in each of these sectors. Despite the fact that there is a significant economic leakage in the Maintenance and Repair Construction industry sector, where only about 2.9 percent of the stone needed for this industry is fulfilled locally, almost all of the region's total production capacity of stone is being used to meet local demand, as 94.6 percent of the produced stone is used locally.

4.2 Churchill Economic Development Authority

Appendix D of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top 20 industry sectors in-terms of total economic output, total employment and total output by commodity produced by industry sector, backward linkages for the Metal Mining Services industry sector, for the Oil and Gas Extraction industry sector, and for the Other Chemical and Fertilizer Mineral Mining industry, and for identified for forward linkages for the Churchill Economic Development Authority. The Churchill Economic Development Authority consists only of Churchill County. The total population of the Churchill Economic Development Authority region in 2020 was an

estimated 24,259 total individuals and had a reported median annual income by housing of $57,824 (Churchill, n.d.). Between 2018 and 2019, Churchill County and the Churchill Economic Development Authority's region has experienced a growth in population of approximately 1.0 percent and a growth in median income of approximately 12.2 percent.

4.2.a Economic Performance of the Churchill Economic Development Authority, Top Performing Industry Sectors

Throughout the entire Churchill Economic Development Authority region, the only industry sector which ranks among the top 20 and is directly related to mining and natural resource extraction activities is the Secondary Processing of Nonferrous Metals. This industry sector generated over $130.0 million in total economic output and nearly $2.0 million in proprietor income in 2020. The Secondary Processing of Nonferrous Metals industry sector employed an estimated 155 total individuals is one of the largest industry sectors in Churchill County. Other top sectors included Owner-Occupied Dwellings and Dry, Condensed, and Evaporated Dairy Product Manufacturing. Top industry sectors in positions adjacent to mining and natural resource extraction activities include Search, Detection and Navigation Instruments Manufacturing, Scientific Research and Development Services, and Geothermal Electric Power Generation. The yearly total economic output of all industry sectors combined within the Churchill Economic Development Authority region exceeded $4.0 billion in 2020. In 2020, total employment within Churchill County and throughout the Churchill Economic Development Authority region was an estimated 24,551 total individuals.

4.2.b Mining-Related Commodity Industry Sector Analysis

Of the 19 commodity industry sectors analyzed over the course of this research, Churchill County and the Churchill Economic Development Authority only produces a recorded output of six industry sectors with a direct tie to the mining and natural resource extraction industry sector. These industry sectors, listed in descending order of total economic output include, Metal Mining Services, Oil and Gas Extraction, Other Chemical and Fertilizer Mineral Mining, Other Nonmetallic Minerals Services, Support Activities for Oil and Gas Operations, and Drilling Oil and Gas Wells. In 2020, the Metal Mining Services sector employed just 27 total individuals and generated a total economic output of nearly $10.0 million. The Metal Mining Services sector is nearly twice as large as the next highest-ranking sector. Oil and Gas Extraction accounted for approximately $6.0 million in total economic output employed only 17 total individuals. Other Chemical and Fertilizer Mineral Mining is the only other commodity industry sector in the mining and natural resource extraction industry sector within the Churchill Economic Development Authority region to exceed more than $1.0 million in total annual economic output.

4.2.c Backward and Forward Linkages

Looking at the top three commodities identified as part of the Churchill Economic Development Authority's mining and natural resource extraction industry sector, the identification of economic leakage is determined when local demand for certain goods and services is satisfied by suppliers located outside the region. This is known as a backward linkage. In the Metal Mining Services

industry sector, only approximately 0.1 percent of regional demand for storage batteries is being met by local sources. Nearly $2.0 million is spent on storage batteries every year and virtually none of this demand is supplied by local producers and manufacturers. Additionally, hundreds of thousands of dollars are spent in the Metal Mining Services industry sector meeting demand for Scales, Balances, and Other General Purpose Machinery, Lighting Fixtures, and Spring and Wire Products, with a fraction of total local demand being met by local sources. The money spent on these three areas alone totals just over $1.0 million each year, at $592,000, $423,000, and $283,000 respectively.

In the Oil and Gas Extraction industry sector, more than $1.0 million is spent on Custom Computer Programming Services each year. Only about 7.0 percent of this local demand is met by local suppliers. Other areas of large local demand that is satisfied primarily by outside suppliers include Pipeline Transportation Services, Other Chemical Products, and Steel Wire. Nearly $350,000 is spent on Pipeline Transportation Services annually, nearly $123,000 is spent on Other Chemical Products, and nearly $87,000 is spent on Steel Wire. Virtually none of this annual local demand is met by local sources. For Other Chemical and Fertilizer Mineral Mining, $135,000 is spent on Basic Organic Chemicals annual and nearly $171,000 is spent on Iron, Steel, and Ferroalloy Products. Almost none of this local demand is met by local sources. Each of these commodities serve as a potential source of job creation and increased economic production and activity for the Churchill Economic Development Authority region.

There are multiple opportunities to expand current production levels for several commodities within Churchill County and within the Churchill Economic Development Authority region. Where small amounts of local demand are met by local sources and large proportions of a commodity go to meet this local demand, the industry experiences what is known as a forward linkage. In this case, opportunities for increased employment and industry development arise. For Support Activities for Oil and Gas Operations, approximately 72.0 percent of local supply goes to meet only 4.9 percent of local demand. In Oil and Gas Wells, nearly 73.4 percent of local supply goes to meet approximately 8.1 percent of local demand. For Other Nonmetallic Minerals Services, approximately 68.3 percent of local supply goes to meet approximately 17.4 percent of local demand. Each of these commodity sectors rank among the highest in total output for the mining and natural resource extraction industry sector, making them attractive targets for expansion and targeted growth.

4.3 Lincoln County Regional Economic Development Authority

Appendix E of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top 10 industry sectors in-terms of total economic output, total employment and total output by commodity produced by industry sector, backward linkages for the Other Nonmetallic Minerals industry sector, the Other Nonmetallic Minerals and Services industry sector, and for the Oil and Gas Extraction industry sector, and for identified for forward linkages for the Lincoln County Regional Economic Development Authority. The Lincoln County Regional Economic Development Authority

region consists solely of Lincoln County. As of 2020, the total population of Lincoln County was an estimated 4,499 total individuals (Census Bureau, 2022).

4.3.a Economic Performance of the Lincoln County Regional Economic Development Authority, Top Performing Industry Sectors

Lincoln County and the Lincoln County Regional Economic Development Authority, located in the southeastern part of the state of Nevada, is currently the sole extractor and provider of perlite in Nevada. In relation to the top 20 industry sectors in Lincoln County, Other Nonmetallic Minerals generated more than $12.0 million in total economic output in 2020, ranking sixth within the region in-terms of total economic output by industry sector. Additionally, the Other Nonmetallic Minerals industry sector employed an estimated 34 total individuals in 2020, ranking eight in-terms of total employment within the Lincoln County Regional Economic Development Authority region. The top five industry sectors in 2020 in the Lincoln County Regional Economic Development Authority region, in regard to total economic output included Owner-Occupied Dwellings, Employment and Payroll of Local Government, Wholesale – Petroleum and Petroleum Products (relating directly to the region's mining and natural resource extraction industry sector, Wired Telecommunication Carriers, and All Other Crop Farming. In 2020, the total economic output of all industry sectors with operations within the Lincoln County Regional Economic Development Authority region totaled nearly $194 million in total economic output and employed an estimated 1,100 total individuals.

4.3.b Mining-Related Commodity Industry Sector Analysis

Data in 2020 for only three mining and natural resource extraction related industry sectors, Other Nonmetallic Minerals, Other Nonmetallic Minerals and Services, and Oil and Gas Extraction, was available for this analysis. Total economic output for the Other Nonmetallic Minerals industry sector for the Lincoln County Regional Economic Development in 2020 was an estimated $12.0 million, was an estimated $3.0 million for the Other Nonmetallic Minerals and Services industry sector, and was an estimated $950,000 for the Oil and Gas Extraction industry sector in 2020. Combined, these three commodity industry sectors employed an estimated 45 total individuals in 2020 and had a combined total economic output of approximately $15.0 million. Because of this relatively small level of total economic output, it is noted that Lincoln County and the Lincoln County Regional Economic Development Authority region is not a county or region that drivers statewide mining and natural resource extraction economic activity. Moreover, the combined $15.0 million total economic output of these mining-related commodity industry sectors accounted for just 7.9 percent of Lincoln County's and the Lincoln County Regional Economic Development Authority's total economic output in 2020.

4.3.c Backward and Forward Linkages

In order to get a better understanding of Lincoln County's and the Lincoln County Regional Economic Development Authority's mining and natural resource extraction industry sector and the industry sector's value network and supply chain, the region's RPC was analyzed. For just the Other Nonmetallic Minerals industry sector, an estimated 0.0 percent of regional demand for

Explosives, Iron and Steel Products, and Construction (mining-related) Machinery was met by local suppliers. In 2020, firms within Lincoln County's and the Lincoln County Regional Economic Development Authority's mining and natural resource extraction industry sector spent nearly $150,000 on Explosives, $60,000 on Iron and Steel Products, and $50,000 on Construction (mining-related) machinery. Over $100,000 of other mining related material and jobs related to the county's and region's mining and natural resource extraction industry sector were sourced from communities and regions located outside Lincoln County. In the other Nonmetallic Mineral Services industry sector, total economic leakage in 2020 was an estimated $216,000. Further development of local production in Petrochemicals and Other Fabricated Metals have the most potential for additional development and growth given the economic ties of both commodity industry sectors to the mining and natural resource extraction industry sector and to other industry sectors that drive a significant part of Lincoln County's and the Lincoln County Regional Economic Development Authority's existing economic base.

While mining and natural resource extraction activities are not a primary driver of economic activity in Lincoln County, there are opportunities for growth in this industry sector and in directly and indirectly related sectors. While local supply in the Nonmetallic Minerals sector and the Nonmetallic Minerals Services sector generally meets local demand, there are emerging new economic development opportunities for both sectors in Lincoln County and for the Lincoln County Regional Economic Development Authority.

4.4 Las Vegas Global Economic Alliance

Appendix F of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top industry sectors in-terms of total economic output, total employment and total output and for the region's commodity industry demand for the Las Vegas Global Economic Alliance region. The Lincoln County Regional Economic Development Authority region consists solely of Lincoln County. The Las Vegas Global Economic Alliance consists solely of Clark County located in southern Nevada. In 2020, the total population of Clark County and the Las Vegas Global Economic Alliance region was approximately 2.3 million total individuals and the total countywide or regional per capita gross domestic product was an estimated $42,913 per individual. The civilian workforce of Clark County in 2020 was an estimated 915,555 total individuals and the county's estimated average annual household income was an estimated $61,048 (US Census, 2020).

4.4.a Economic Performance of the Las Vegas Global Economic Alliance, Top Performing Industry Sectors

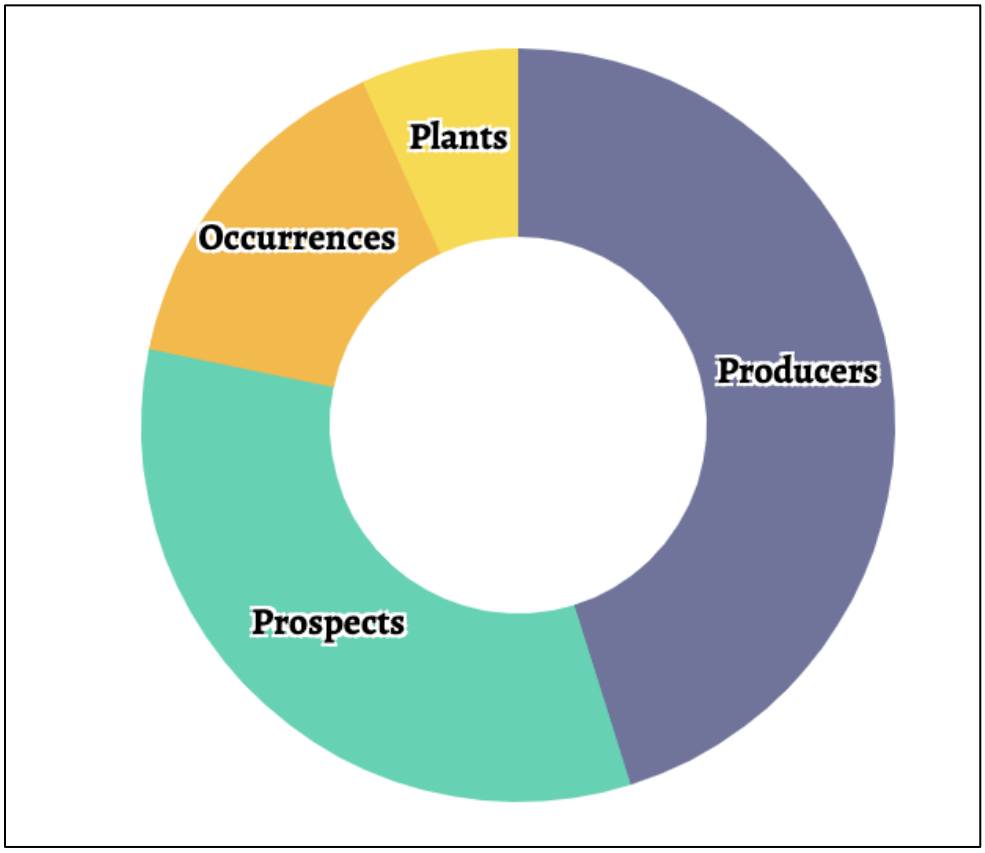
For 2020, Owner-Occupied Dwellings contributed the most to total economic output in Clark County, with a total economic output of $194.0 billion. This industry sector employed approximately 1.2 million people. The second largest industry was Other Real Estate industry sector that contributed nearly $11.0 billion to total economic output but total employment was recorded as an estimated 0 total individuals. Total employment in 2020 for the Other Real Estate industry sector was 0 total individuals because this industry sector is primarily a second source

of income and not a main source of employment. The third largest contributor to total economic output in Clark County and within the Las Vegas Global Economic Alliance region was Hotels, Motels, and Casino Hotels, with a total economic output of approximately $10.9 billion and employing an estimated 56,995 total individuals.

4.4.b Mining-Related Commodity Industry Sector Analysis

There are 487 identified mines located throughout Clark County with 73 classified as occurrence mines, 161 mines classified as prospects, and 220 mines are classified as active as illustrated in Figure 4.1.

Figure 4.1 – Classification of Mining Activities in Clark County 2022



For all of Clark County and the Las Vegas Global Economic Alliance region, Mining and Mineral Manufacturing does not rank among the region's top 250 industries. Chemical and Mineral Mining is the one industry sector that that contributes to Clark County's and the Las Vegas Global Economic Alliance's economic base, with an estimated $6.1 million in total economic output and employing just 17 total individuals in 2020. Specific commodities generated from mining and natural resource extraction activities such as coal, copper, nickel, lead, zinc, iron, gold, and silver contribute so little to Clark County's and the region's economic base no data was collected on either total economic output or total employment were available

for any of these commodities. Looking beyond the top 20, there are three sectors with a non-zero level of economic output, including Sand and Gravel Mining, Metal Mining Services, and Other Chemical and Fertilizer Mineral Mining. In other regions throughout the state of Nevada, the use of power distribution, machinery, oil and gas, and wholesale petroleum can support either the mining and natural resource extraction industry sector directly or other industry sectors directly or indirectly related to mining and natural resource extraction activities. However, in Clark County, most of these energy production areas support the energy needs of the county's and region's tourism and hospitality industry sector. Clark County and much of the Las Vegas Global Economic Alliance's region is so far developed in other industry sectors that the mining and natural resource extraction industry sector is simply outperformed. The three main commodity resources mined in Clark County are gold, silver, and copper.

4.4.c Backward and Forward Linkages

For Clark County and the Las Vegas Global Economic Alliance region, three industry sectors were focused on in regard to mapping the backward linkages of the mining and natural resource extraction industry sector. These three industry sectors include Sand and Gravel Mining, Metal Mining Services, and Other Chemical and Fertilizer Mineral Mining. For the Sand and Gravel industry sector, the gross absorption rate is an estimated 33.0 percent and total economic value is an estimated $74.0 million. The regional absorption rate is an estimated 16.7 percent with an estimated total economic value of approximately $38.0 million. Based on this analysis, the total regional economic leakage in the Sand and Gravel industry sector is an estimated $37.0 million. In comparison, the estimated regional economic leakage in the Metal Mining Services industry is much smaller with an estimated $105,800, which is just 46.0 percent of the total gross absorption rate. Lastly, for the Other Chemical and Fertilizer industry sector, the estimated total regional economic leakage for the entire Las Vegas Global Economic Alliance region in 2020 was an estimated $941,417, with an estimated 3.4 percent total gross absorption rate. The top two commodities sectors driving this regional economic leakage included lime and gypsum products. For the county's and region's forward linkages, the RSC was analyzed. For Metal Mining, the RSC was an estimated 99.6 percent. This means that all of the ore and commodities mined in Clark County, primarily lime and gypsum, that is produced in Clark County is used locally in the area and is not exported to areas outside the Las Vegas Global Economic Alliance region for additional downstream or forward valued added production. Most of the metal ore and other commodities produced is generally used in Construction and Building industry sector activities in Clark County.

4.5 Nevada 95-80 Regional Development Authority

Appendix G of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top industry sectors in-terms of total economic output, total employment and total output and for the region's commodity industry demand, backward linkages for gold and silver ore mining, and for forward linkages of various commodities produced through mining and natural resource extraction activities in the Nevada 95-80 Regional Development Authority region. The Nevada 95-80 Regional

Development Authority region includes both Humboldt County and Pershing County. Total population in Humboldt County in 2020 was an estimated 17,600 total individuals and total population in Pershing County was an estimated 6,700 total individuals in 2020 (Census Bureau, 2022). In 2020, the single largest industry sector in Nevada 95-80 Regional Development Authority region was the Gold Ore Mining industry sector. During the most recent Nevada US-95 I-80 Futures event held in Winnemucca, Nevada, mining and natural resource industry sector representatives and local community stakeholders concluded that future growth of the region's mining and natural resource extraction industry sector may likely be curtailed by a lack of additional housing and the growing demand for increasingly scarce workers (Northern Nevada Business Weekly, 2021).

4.5.a Economic Performance of the Nevada 95-80 Regional Development Authority, Top Performing Industry Sectors

Humboldt County and Pershing County are located in the northcentral part of Nevada and has historically been a fruitful region for mining and natural resource extraction activities including the production of gold ore. Although mining materials may not be the top industry sector in-terms of total economic output for the Nevada 95-80 Regional Development Authority region, there are a lot of services that provide key outputs that are both important for this region and for the entire state of Nevada as a whole. The top economic output industry sectors for this region are Gold Ore Mining with a total economic output of about $1.0 billion in 2020, Metal Mining Services with a total economic output of about $136.0 million, Owner-Occupied Dwellings with a total economic output of nearly $116.0 million, Electric Power Transmission and Distribution with a total economic output of nearly $90.0 million, and Crop Farming with a total economic output of approximately $89.0 million. Based on these estimates, it can be identified that Gold Ore Mining is one of the top economic output sectors for the region with other industry sectors being either directly or indirectly related to services or ranching.

4.5.b Mining-Related Commodity Industry Sector Analysis

Analyzing commodity industry sectors for the Nevada 95-80 Regional Development Authority region, the region's top ten commodity sectors were analyzed. These commodity sectors include Gold Ore Mining, Metal Mining Services, Silver Ore Mining, Other Nonmetallic Minerals, Stone Mining and Quarrying, Oil and Gas Extraction, Other Chemical and Fertilizer Mineral Mining, Other Non-Metallic Minerals Services, Drilling Oil and Gas Wells, and Support Activities for Oil and Gas Operations. For this commodity sectors, it is evident that this region is not the sole provider of the minerals and other materials mined in the state but is rather a backbone of support for statewide mining and natural resource extraction activities. These are parts of mining and natural resource extraction industry sector that facilitate the flow of economic activity in the statewide mining and natural resource extraction industry sector.

4.5.c Backward and Forward Linkages

In order to get a better understanding of the Nevada 95-80 Regional Development Authority region's mining and natural resource industry's gaps, it is important to first examine the RPCs

for this industry. A as previously mentioned, an RPC is a measure of current demand for a specific commodity by local production within a defined geographic area. In the evaluation of both Humboldt County and Pershing County combined, RPCs are important in evaluating the region's backward and forward linkages in the mining and natural resource extraction industry sector because it can indicate whether an existing local demand can be met locally or if the demand needs to be satisfied with the supply of specific goods and services imported from areas located outside the region.

The first group of RPCs in this evaluation of the backward and forward value network and supply chain linkages for the mining and natural resource extraction industry sector for the Nevada 95-80 Regional Development Authority region are the backwards linkages between Gold Ore Mining. For the Gold Ore Mining industry sector for this region, there are 18 commodities that had an RPC of 0.0 percent in 2020, meaning that specific good or service is not currently being provided by local suppliers. These goods, services, and other commodities include coal, iron ore, other metal ore, preserved wood products, paperboard, paperboard containers, basic organic chemicals, explosives, and tires, among others. While Gold Ore Mining industry sector activities drive a considerable amount of the region's economic activity, a significant portion of the economic value associated with these activities is exported and lost to geographic areas located outside the Nevada 95-80 Regional Development Authority.

4.6 Northern Nevada Development Authority

Appendix H of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top industry sectors in-terms of total economic output, total employment and total output and for the region's commodity industry demand, backward linkages for gold and silver ore mining, and for forward linkages of various commodities produced through mining and natural resource extraction activities in the Northern Nevada Development Authority region. The Northern Nevada Development Authority consists of four counties, Douglas County, Lyon County, Mineral County, and Storey County, and the independent municipality of Carson City. While mining commodities produced throughout the Northern Nevada Development Authority in 2020 only accounts for approximately 0.5 percent of the region's total economic output, there are still a wide and diverse set of mining and natural resource extraction industry sector directly and indirectly related industries present throughout the region.

4.6.a Economic Performance of the Northern Nevada Development Authority, Top Performing Industry Sectors

Within the Northern Nevada Development Authority, there are no mining and natural resource extraction industry sector related industries in the top 20 industry sectors for this region. Any mining related commodities are first identified in the Metal Mining and Services industry sector that is ranked 48 among the region's existing set of industry sectors. The Metal Mining and Services industry sector generated an estimated $100.0 billion of total economic output in 2020 and employed an estimated 247 total individuals. While significant by itself, this level of total

economic output accounts for just 0.5 percent of the entire region's total economic output in 2020 and for just 0.3 percent of total employment throughout the entire Northern Nevada Development Authority region. The region's single largest industry sector is the Storage Battery Manufacturing industry sector that generated an estimated $1.0 billion in total economic output in 2020. The next four largest industry sectors in 2020 for the Northern Nevada Development Authority region included Owner-Occupied Dwellings, Other Real Estate, Employment and Payroll of State Government and Other Services, and Warehousing and Storage. Including the Storage Battery industry sector, these top five industry sectors accounted for almost a quarter of the region's total economic output and for about 20.0 percent of the region's total employment.

4.6.b Mining-Related Commodity Industry Sector Analysis

There are 13 individual commodity production sectors that provide supportive output and employment for the Northern Nevada Development Authority's mining and natural resource extraction industry sector. However, these supportive output and employment commodity sectors represents about 2.4 percent of the region's total economic output. Each of these commodity production sectors provide account for a little over 1.0 percent of total employment throughout this region. The Metal Mining Services sector accounts for the highest total economic output and employment with an estimated total economic output in 2020 of approximately $105.0 billion and 247 total individuals employed. The next largest commodity sector included Drilling Oil and Gas Wells, with an estimated total economic output and value of approximately $4.0 million and an estimated total employed of 17 total individuals in 2020.

4.6.c Backward and Forward Linkages

When looking at backward linkages for the Metal Mining Services industry sector for the Northern Nevada Development Authority in 2020, there are six individual commodities that are used in production that are completely provided by suppliers located outside the Northern Nevada Development Authority region and must imported. In 2020, these commodity items included Coal, Paperboard from Pulp, Explosives, Cutlery, Utensils, Pots, and Pans, Broadcast and Wireless Communications Equipment, and Noncomparable Imports. The largest gross output of these six commodity sectors is Noncomparable Imports, with annual regional demand totaling $1.1 million dollars followed by Explosives with a gross input of over approximately $500,000. There are another of other commodities that are imported into the region that have gross input values of over $5.0 million, including Scales, Balances, and Miscellaneous General Purpose Machinery. Other heavy import and supportive sectors include Lighting Fixtures with just under $4.0 million in 2020 in local demand, and nearly 100.0 percent of local and regional demand being supplied by suppliers located outside the region.

Backward linkages for the Gold Ore Mining sector include only 1.1 percent of local demand for Lime being supplied by local suppliers, with an expected annual economic value of approximately $5 million in gross inputs for this region. This is followed by Tires, where local and regional suppliers supply just 0.04 percent of local and regional demand and local annual demand totaling just under $3.0 million. For Oil and Gas Extractions, 0.01 percent of locally and regionally consumed Steel Wire comes from local suppliers, with an estimated gross input of

approximately $1.0 million. For the commodities of Copper, Nickel, Lead, and Zinc that are also produced within the Northern Nevada Development Authority region, just 0.04 percent of local and regional demand for Tires, with an estimated annual economic value of more than $1.0 million, is supplied by local and regional suppliers.

For existing forward linkages in the Northern Nevada Development Authority region and in the region's Support Activities for Oil and Gas Operations sector, approximately 99.7 percent of local supply is used to meet about 10.0 percent of the local and regional demand. This estimate is similar for the estimates for Potash, Soda, and Borate Mineral, with nearly 99.3 percent of total production of each commodity satisfying only 10.5 percent of local demand.

4.7 Northeastern Nevada Regional Development Authority

Appendix I of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top industry sectors in-terms of total economic output, total employment and total output and for the region's commodity industry demand, backward linkages for several commodity sectors, and for forward linkages for all Mining and Natural Resource Extraction sectors in the Northeastern Nevada Regional Development Authority region. The Northeastern Nevada Regional Development Authority consists of Elko County, Eureka County, Lander County, and White Pine County. In 2020, the region's combined total population was just over 70,000 total individuals and the total economic output of the entire region was an estimated $11.0 billion. With an estimated total civilian workforce of 42,311 total individuals and the combined total personal income close to nearly $4.0 billion, the average income per employed individual was just over $90,000. There were 231 total industry sectors represented in the Northeastern Nevada Regional Development Authority region in 2020 and the region continues to focusing on improving regional broadband Internet and telecommunication access and the region's overall housing stock over the coming years (Steinmann, F., 2021a) (Steinmann, F., 2021b) (Steinmann, F., 2021c).

4.7.a Economic Performance of the Northeastern Nevada Regional Development Authority, Top Performing Industry Sectors

In 2020, the Gold Ore Mining industry sector was the largest contributor to the region's economic base. This sector generated over $4.0 billion in total economic output and accounted for nearly 39.0 percent of the region's total economic output. In 2020, the Gold Ore Mining industry sector employed 7,716 total individuals, accounting for nearly 18.0 of total employment throughout the entire Northeastern Nevada Regional Development Authority region. The second largest industry sector was Metal Mining Services, with a total economic output of nearly $557.0 million and employed an estimated 1,324 total individuals. Wholesale Petroleum and Petroleum Products was the third largest industry sector throughout the entire region in 2020, generating an estimated $449.0 million in total economic output and employing an estimated 241 total individuals.

Copper, Lead, Nickel, and Zinc Mining was the next largest industry sector in the Northeastern Nevada Regional Development Authority region. In 2020, this sector generated an estimated $353.0 million in total economic output and employed an estimated 617 total individuals. This was followed by the Electric Power Transmission and Distribution an estimated $257.0 million in total economic output and employed 189 total individuals. The Construction of New Power and Communication Structures and the Wholesale Machinery, Equipment and Supplies industry sector were the next largest individual industry sectors in the region in 2020, generating an estimated $227.0 million and $192.0 million in total economic output respectively with the combined total employment of both industry sectors totaling an estimated of 1,316 individuals. Other notable mining-related sectors, such as Chemical and Fertilizer Mineral Mining, Stone Mining and Quarrying, Non-Metallic Minerals, Sand and Gravel Mining and Other Metal Ore Mining added nearly a combined $205.0 million in total economic output and employed just over a combined 900 total individuals.

4.7.b Backward and Forward Linkages

In the Gold Ore Mining industry sector in 2020, nearly $2.0 billion was spent on gross inputs from other industry sectors. Out of those gross inputs, approximately $800.0 million was provided by regional suppliers but over $1.0 billion dollars was lost to economic leakage. Twenty industry sectors accounted for about 80.0 percent of this net economic leakage. The top five industry sectors, in terms of overall economic leakage throughout the entire Northeastern Nevada Regional Development Authority region, included Lime, Industrial Gasses, Tires, Refined Petroleum Products, and Other Basic Organic Chemicals. In the Metal Mining Services industry sector in 2020, about $400.0 million was spent on gross inputs from other industry sectors. Out of these gross inputs, about $59.0 million was provided by regional suppliers but nearly $354.0 million was lost to economic leakage. Twenty industry sectors accounted for approximately 85.5 percent of this net economic leakage leakage. The top five industry sectors, in terms of overall economic leakage, included Storage Batteries, Scales, Balances, and Miscellaneous General Purpose Machinery, Lighting Fixtures; all other Miscellaneous Wood Products, and Travel Arrangement and Reservation Services.

In the Wholesale Petroleum and Petroleum Products industry sector, in 2020, approximately $43.0 million was spent on gross inputs from other industry sectors. Of these gross regional inputs, approximately $18.0 million was provided by regional suppliers but nearly $25.0 million was lost to economic leakage. Twenty industry sectors accounted for about 67.0 percent of the gross regional leakage for the Northeastern Nevada Regional Development Authority in the Wholesale Petroleum and Petroleum Products industry sector in 2020. The top five industry sectors, in terms of regional economic leakage, included Other Insurance, Business Support Services, Other Real Estate Services, Management of Companies and Enterprises, and Warehousing and Storage Services. In the Copper, Nickel, Lead, Zinc Mining industry sector in 2020, approximately $153.0 million was spent on gross inputs from other industry sectors. Of this, approximately $58.0 million was provided by regional suppliers but nearly $95.0 million was lost to economic leakage. Twenty industry sectors accounted for about 85.0 percent of this regional economic leakage with the top five industry sectors, in terms of overall regional

economic leakage, including Custom Computer Programming Services, Refined Petroleum Products, Tires, Maintained and Repaired Nonresidential Structures, and Explosives.

In the Electric Power Transmission and Distribution industry sector in 2020, approximately $134.0 million was spent on gross regional inputs from other industry sectors. Approximately $80.0 million of the $134.0 million in gross regional inputs was provided by regional suppliers and nearly $54.0 million was lost to economic leakage. The Electricity Industry sector accounted for nearly 100.0 percent of the $54.0 million lost to economic leakage in 2020 in the Electric Power Transmission and Distribution industry sector for the Northeastern Nevada Regional Development Authority region. In the Construction of New Power and Communications Structures industry sector in 2020, about $43.0 million was spent on gross regional inputs from other industry sectors. Of these $43.0 million in gross regional inputs, approximately $14.0 million was provided by regional suppliers and nearly $29.0 million was lost to economic leakage. Twenty industry sectors accounted for approximately 57.0 percent of this regional economic leakage with the top five contributing industry sectors including Architectural, Engineering, and Related Services, Prefabricated Metal Buildings and Components, Refined Petroleum Products, Turned Products and Screws, Nuts, and Bolts, and Fabricated Structural Metal Products.

In the Wholesale Machinery, Equipment, and Supplies Structures industry sector in 2020, approximately $69.0 million was spent on gross regional inputs from other industry sectors. Of these $69.0 million in gross regional inputs, nearly $27.0 million was provided by regional suppliers but nearly $42.0 million was lost to economic leakage. Twenty industry sectors accounted for only approximately 1.5 percent of this existing economic leakage in 2020 as this regional economic leakage was spread throughout various individual industry sectors. The top five industry sectors, in terms of regional economic leakage in the Wholesale Machinery, Equipment, and Supplies Structures industry sector for the Northeastern Nevada Regional Development Authority region in 2020, included Advertising, Public relations, and Related Services, Other Real Estate Services, Warehousing and Storage Services, Management Consulting Services, and Management of Companies and Enterprises.

By analyzing the average RPC and RSC values of various industry sectors for the entire Northeastern Nevada Regional Development Authority region, several opportunities for future investment and targeted economic development efforts were identified. The first sector where there is considerable opportunity to close existing gaps in industry sector value networks and supply chains is in the Gold Ore Mining industry sector. The Northeastern Nevada Regional Development Authority region, with a total economic output of just over $4.0 billion in Gold Ore Mining industry sector alone, has an RPC value of 99.3 percent and an RSC value of 8.9 percent. This means that almost all of the gold ore produced throughout the region is exported out of the region for additional value-added production. Similarly, the Metal Mining Services industry sector, the second largest industry sector in terms of total economic output in the region, has an RPC of 99.2 percent and an RSC value of 29.8 percent, leading to the same conclusion that the majority of economic outputs in this sector are exported outside the region for additional value-added production. The Copper, Nickel, Lead and Zinc ore industry sector follows a similar pattern. With an RPC value of 99.3 percent and RSC value of 2.4 percent, the majority of the

ore among these various commodities that is produced throughout the region is shipped out of the region to other geographic areas for further downstream usage and value-added production. By closing these gaps, the Northeastern Nevada Regional Development Authority region will significantly benefit by keeping more dollars of broad economic activity within the region.

4.8 Southwest Central Regional Economic Development Authority

Appendix J of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for the region's top industry sectors in-terms of total economic output, total employment and total output and for the region's commodity industry demand, backward linkages for several individual sectors, and for forward linkages of various commodities produced through mining and natural resource extraction activities in the Southwest Central Regional Economic Development Authority region. The Southwest Central Regional Economic Development Authority consists of two counties, including Esmeralda County and Nye County. As of July 2021, the total population of Esmeralda County was an estimated 743 total individuals and the total population of Nye County was an estimated 53,450 total individuals (Census Bureau, 2022). Esmeralda County is the least populated county in the state of Nevada.

4.8.a Economic Performance of the Southwest Central Regional Economic Development Authority, Top Performing Industry Sectors

In Esmeralda County and Nye County combined, the industry sectors that are directly related to the mining and natural resource extraction industry sector in the region's top 20 industry sectors in terms of total economic output are Gold Ore Mining, Other Clay, Ceramic, Refractory Minerals Mining, and Metal Mining Services. Gold Ore Mining was the largest mining and natural resource extraction industry sector throughout the entire Southwest Central Regional Economic Development Authority region in 2020, with an estimated $600.0 million in total economic output and an estimated total employment of 1,150 total individuals. Other Clay, Ceramic, Refractory Minerals Mining had an estimated total economic output of nearly $66.0 million in 2020 and employed an estimated 159 total individuals. Total economic output throughout this region in 2020 for Metal Mining Services was an estimated $44.0 million and employed an estimated 118 total individuals.

Sectors not directly related to mining and natural resource extraction activities within the Southwest Central Regional Economic Development Authority but indirectly related in 2020 included Scientific Research and Development Services and Petroleum Refineries. Scientific Research and Development Services is the largest industry sector in terms of total employment throughout the region, employing an estimated 1,269 total individuals in 2020. Other top sectors operating throughout the Southwest Central Regional Economic Development Authority region in 2020 included Owner-Occupied Dwellings, Electric Power Transmission and Distribution, Other Real Estate, and Facilities Support Services.

4.8.b Mining-Related Commodity Industry Sector Analysis

Of the 19 individual commodity sectors with active production within the Southwest Central Regional Economic Development Authority in 2020, ten of them have an estimated total economic output and total employment that is greater than zero. These positive economic output and total employment commodity sectors include Gold Ore Mining, Other Clay, Ceramic and Refractory Minerals Mining, Metal Mining Services, Stone Mining and Quarrying, Oil and Gas Extraction, Other Chemical and Fertilizer Mineral Mining, Other Nonmetallic Minerals, Other Nonmetallic Minerals Services, Drilling Oil and Gas Wells, and Support Activities for Oil and Gas Operations. In 2020, the total economic output for Gold Ore Mining throughout the entire region was an estimated $594.0 million and total employment was an estimated 1,150 total individuals. The estimated 1,150 total individuals employed by the Gold Ore Mining commodity sector was nearly ten times the estimated total employment in the Other Clay, Ceramic and Refractory Minerals Mining commodity sector. The Other Clay, Ceramic and Refractory Minerals Mining commodity sector employed 159 total individuals in 2020 and generated nearly $66.0 million in total economic output. The commodity sectors following Gold Ore Mining have notably smaller output quantities as well as notably smaller total employment estimates.

4.8.c Backward and Forward Linkages

In the Gold Ore Mining industry sector, 0.0 percent of regional demand for Tires is being met by local suppliers. The total economic value of the economic leakage in the Gold Ore Mining industry sector was over $18.0 million in 2020 for Tires. Another source of economic leakage in the Gold Ore Mining industry sector in the Northeastern Nevada Regional Development region comes from Wholesale Services of Machinery, Equipment, and Supplies. While just 8.6 percent of regional demand is being met by local suppliers, there is still a total economic leakage of nearly $12.0 million after subtracting regional input from gross input. Individual firms operating throughout the Southwest Central Regional Economic Development Authority in the Gold ore Mining industry sector also spent almost $6.0 million on explosives in 2020, with nearly 100.0 percent of this total economic value being spent on suppliers located outside the region. Two other wholesale industries with significant economic leakages in 2020 were Petroleum and Petroleum Products and Motor Vehicle and Motor Vehicle Parts and Supplies. The estimated economic value of the total leakage for both industry sectors were an estimated $4.0 million and $8.0 million respectively in 2020.

In the Other Clay, Ceramic and Refractory Minerals Mining industry sector, Management of Companies and Enterprises was a source of a significant economic leakage for the Southwest Central Regional Economic Development Authority region in 2020. Only about 19.0 percent of regional demand for goods and services in the Management of Companies and Enterprises sector is being fulfilled by regional suppliers, resulting in an estimated total economic leakage of just under $2.0 million. Demand for Iron and Steel and Ferroalloy Products has largely been fulfilled by suppliers located outside the region. The estimated economic value of the economic leakage for Construction Machinery was an estimated $220,000 in 2020 and the estimated economic value of the economic leakage for Other Motor Vehicle Parts was an estimated $190,000 in 2020. Almost all of the demand for goods and services from both of these sectors by firms

operating within the region and within the Other Clay, Ceramic and Refractory Minerals Mining industry sector was fulfilled by suppliers located outside the region.

In the Metal Mining Services industry sector, many of the individual sources of regional economic leakage stem from services directly related to the extraction of ore from the Earth. For example, Scales, Balances, and Miscellaneous General Purpose Machinery and Lighting Fixtures are two of the top commodity sectors based on their respective gross inputs. For both, effectively 0.0 percent of regional demand is being met by regional suppliers and the estimated total economic value for both sectors is an estimated $1.8 million and an estimated $2.6 million respectively. Only 0.6 percent of regional demand in the Scales, Balances, and Miscellaneous General Purpose Machinery and Lighting Fixtures commodity sectors is met by regional suppliers. This has resulted in a combined leakage of just over $7.7 million.

Forward linkages occur when local demand is met by the region's suppliers and large amounts of a commodity produced within that region go to meet said demand. A forward linkage provides opportunities for employment and diversification of a region's economic base. For the Gold Ore Mining industry, only 9.1 percent of total production is used within the Southwest Central Regional Economic Development Authority region for additional value added production while 99.7 percent is exported outside region. The 9.1 percent represents the total amount of output in the Gold Ore Mining sector that that can be used for further value-added production. For Other Clay, Ceramic and Refractory Minerals, approximately 92.5 percent of local supply goes to meet approximately 6.7 percent of local demand. For Metal Mining Services, approximately 84.2 percent of local supply goes to meet approximately 49.1 percent of local demand. These three commodity sectors rank among the highest for the Southwest Central Regional Economic Development Authority region. This not only provides ample opportunities for linkage analysis but also for potential areas for further economic expansion and growth.

4.9 State of Nevada

Appendix K of this University Center for Economic Development technical contains the resulting IMPLAN analysis results including tables for entire state of Nevada's top industry sectors in-terms of total economic output, total employment and total output and for the state's commodity industry demand, backward linkages for several individual sectors, and for forward linkages of various commodities produced through statewide mining and natural resource extraction activities. In 2020, the state of Nevada's total population was in excess of 3.1 million total individuals and the state's total civilian workforce was an estimated 1.7 million total individuals. Total economic output for all of Nevada's 455 total industry sectors was an estimated $284.0 billion in 2020.

4.9.a Economic Performance of the State of Nevada, Top Performing Industry Sectors

Much of Nevada's existing economic base is directly tied to the state's tourism and hospitality industry sector. After removing Owner-Occupied Dwellings and Other Real Estate Operations from the state's total economic output, Hotels and Motels (including casino hotels) was the top

industry sector statewide in 2020, generating an estimated $9.0 billion in statewide total economic output and employing an estimated 83,000 total individuals. The sixth largest industry sector in terms of total statewide economic output Gold Ore Mining, indicating that the Gold Ore Mining industry sector is a significant contribute to statewide total economic output and the state's existing economic base.

4.9.b Mining-Related Commodity Industry Sector Analysis

Of the 19 mining-related commodity sectors in Nevada, Gold Ore Mining stands alone in terms of total statewide economic impact. When viewing the industry sectors that are directly related to the mining and natural resources extraction industry sector, in the top ten sectors as ranked by total economic output statewide, only Gold Ore Mining is present. Gold Ore Mining is the sixth highest ranked industry sector by total economic output with an estimated total economic output of approximately $6.2 billion in 2020. The Gold Ore Mining industry sector also employed 11,579 total individuals statewide. As evident from analysis presented in this section of this University Center for Economic Development technical report for each of the eight existing regional economic development authorities, each of the 19 mining commodity sectors have an impact on statewide total output. However, with the exception of gold ore, none of the other commodity sectors ranked in the top 20 sectors for the state in 2020.

4.9.c Backward and Forward Linkages

Narrowing in on the gold ore commodity sector there are several high value sectors of economic leakage in the production process. The largest of these is the regional and statewide demand for Tires. With a gross statewide total input of approximately $183.9 million, effectively 0.0 percent of statewide demand for Tires is being met by suppliers operating within the state. Another source of economic leakage in the Gold Ore Mining industry sector comes from the commodity class for Other Basic Organic Chemicals with a gross statewide total economic input of approximately $111.2 million and effectively 0.0 percent of statewide demand for Other Basic Organic Chemicals is met by suppliers operating within the state. The Petrochemicals commodity sector and the Explosives commodity sector both have gross economic inputs in excess of nearly $50.0 million with zero percent of internal statewide demand being met by in-state suppliers.

By analyzing the value-added changes on the price for gold ore production in the state of Nevada via the regional supply coefficient as a percentage of the regional price coefficient, a similar pattern in the forward linkage exists between the gold producing counties and the state as a whole. The statewide total output of the Gold Ore Mining industry sector was just over $6.2 billion and has an RPC value of 99.7 percent and an RSC value of 10.0 percent. This means that almost all of the gold ore produced throughout the state of Nevada is exported out of state for additional value-added production. In contrast, looking at the Oil and Gas Wells industry sector, with an average RPC of 6.4 percent and an average RSC of 99.6 percent, very little of the total supply produced from this sector was exported out of the state. Reducing the gap and increasing overall utilization would benefit the economic base of the entire state of Nevada.

References for Section 4.0, White Paper for Part 3 *A Comprehensive Value Network and Supply Chain Map of the Mining, Quarrying, and Oil and Gas Extraction Industry Sector in Nevada*

Census Bureau (2020, Apr 1). *QuickFacts Nevada: United States.* https://www.census.gov/quickfacts/fact/map/NV,US/PST045221

Churchill County, NV. Data USA. (n.d.). Retrieved April 17, 2022, from https://datausa.io/profile/geo/churchill-county-nv

"Mining in Clark County, Nevada." *The Diggings™*, https://thediggings.com/usa/nevada/clark-nv003#:~:text=The%20most%20commonly%20listed%20primary,Clark%20has%20161%20prospect%20mines.

Northern Nevada Business Weekly (2021, Nov 11). *Business leaders highlight economic growth in rural Northern Nevada.* https://www.nnbw.com/news/2021/nov/11/conference-highlights-economic-growth-rural-northe/

Steinmann, F. (December 2021a). *THE 2021 ANNUAL UPDATE TO THE COMPREHENSIVE ECONOMIC DEVELOPMENT STRATEGY FOR ELKO COUNTY, NEVADA AND FOR THE INDIVIDUAL COMMUNITIES OF THE CITY OF ELKO, JACKPOT, AND SPRING CREEK, 2020 THROUGH 2025.* Northeastern Nevada Regional Development Authority (NNRDA). *https://nnrda.com/wp-content/uploads/2021/12/The-2021-Annual-Update-to-the-CEDS-for-the-City-of-Carlin-UCED-Technic....pdf*

Steinmann, F. (November 2021b). *THE 2021 ANNUAL UPDATE TO THE COMPREHENSIVE ECONOMIC DEVELOPMENT STRATEGY FOR LANDER COUNTY, NEVADA, 2020 THROUGH 2025.* Northeastern Nevada Regional Development Authority (NNRDA). *https://nnrda.com/wp-content/uploads/2021/12/The-2021-Annual-Update-to-the-CEDS-for-the-City-of-Carlin-UCED-Technic....pdf*

Steinmann, F. (November 2021c). *THE 2021 ANNUAL UPDATE TO THE COMPREHENSIVE ECONOMIC DEVELOPMENT STRATEGY FOR WHITE PINE COUNTY, NEVADA, 2020 THROUGH 2025.* Northeastern Nevada Regional Development Authority (NNRDA). *https://nnrda.com/wp-content/uploads/2021/12/The-2021-Annual-Update-to-the-CEDS-for-the-City-of-Carlin-UCED-Technic....pdf*

"U.S. Census Bureau Quickfacts: Clark County, Nevada." *US Census Gov*, https://www.census.gov/quickfacts/clarkcountynevada.

5.0 Identifying Value Network and Supply Chain Gaps and Developing Community and Economic Development Recommendations

This section of this University Center for Economic Development technical report presents an edited version of the initial white paper developed for Part 4, *Identifying Value Network and Supply Chain Gaps and Developing Community and Economic Development Recommendations*. The fourth and final part of this analysis of the value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector included the following elements:

- Development of a set of criteria in order to determine the level of balance, strengths, and resiliency present in Nevada's *Mining, Quarrying, and Oil and Gas Extraction* industry sector.

- An evaluation of balanced, strong, and resilient Nevada's *Mining, Quarrying, and Oil and Gas Extraction* industry sector is. This evaluation also includes an assessment of how the mining and natural resource extraction industry sector in Nevada has been either positively or negatively affected by the ongoing COVID-19 global pandemic.

- A series of regional and statewide community and economic development actions that the state of Nevada, each of the eight regional economic development authorities, and local government and industry and occupation sector representatives could potentially develop and implement in order to capitalize on identified 'gaps' in the value network and supply chain of Nevada's *Mining, Quarrying, and Oil and Gas Extraction* industry sector.

This section also provides a detailed discussion regarding three critical terms with respect to value network and supply chain management, including balance, strength, and resiliency. These three terms are often used as a measure of how an individual firm and an entire industry sector deals with uncertainties. Additional analysis on how balanced, strong, and resilient the value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector is, taking into account the ongoing COVID-19 pandemic and related global supply chain disruptions, is also presented. In general, the higher level of safety-and-health-awareness culture and disaster preparedness already in place throughout Nevada's mining and natural resource industry sector facilitated the approach that individual firms and the industry as a whole took in addressing the COVID-19 crises and mitigating many of the affects that the pandemic has had on other firms in other industries.

Specific community and economic development recommendations that state, regional, and local government and industry and occupation sector representatives could further develop and implement in order to capitalize on identified 'gaps' in the value network and supply chain of Nevada's Mining, Quarrying, Oil and Gas Extraction industry sector are presented at the end of

this section. Three main downstream segments that these recommendations are focused on are tires, electrical power and distribution and transmission, and storage batteries. A discussion regarding specific tax incentives and abatements that can be offered to companies that are willing to move operations to Nevada is included as part of the specific community and economic development recommendations. This section concludes with a long-term vision for the state of Nevada that is focused on investing in sectors like clean energy, electronic manufacturing, and sustainable mining.

5.1 Defining Balance, Strength, and Resiliency in Relation to Value Networks and Supply Chains

Balance, strength and resiliency are terms used in supply chain management to describe how an industry can be sustainable and how individual companies can stay competitive and excel in a defined marketplace. According to Lora Cecere, the founder of Supply Chain Insights, obtaining balance, strength, and resiliency requires companies within an industry to mature in their ability to define, align, manage, and fine-tune cross-functional metrics (Cecere, 2015, p. 65). For Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector, several metrics matter, from maintaining a skilled workforce to bolstering other inputs such as advanced technology, raw materials and tax incentives. Definitions of balance, strength, and resiliency are provided in order to outline how the value network and supply chain of Nevada's mining and natural resource extraction industry sector may improve upon this foundation in the future.

5.1.a Defining Balance

In study and practice of supply chain management, balance refers to how a firm performs within a complex system. With shifts in the market and rising competition, there is often a need to change capabilities or to enhance the capacity and expertise an organization has at its disposal. As internal organizational and external environment complexities increase, the value network should and must be well managed. To do this, employees should use measurements that have meaningful results and analyze business operations often for process management. When an organization aims to improve balance within their organization's portfolio, the firm begins by evaluating their own internal processes and technologies, analyzing how to increase overall flexibility and agility (Cecere, 2015, p. 73). This analysis should not result in just one area of focus but must include a holistic perspective across the firm's entire value network and supply chain that emphasizes effectiveness over efficiency. Efficiency must eventually be achieved but this can only occur when processes are deemed effective.

Individual firms are increasingly using a balanced scorecard to measure metrics internally and externally. Balanced scorecards define and measure the knowledge, skills, and systems employees will use to innovate and perform the firm's strategic capabilities (Kaplan and Norton, 2000). By maintaining this balanced scorecard, the firm can improve efficiency in business processes that ultimately can lead to higher customer satisfaction and expanded shareholder value. Overall, balance is achieved through the recognition of these key capabilities and ongoing maintenance of processes used to obtain high performance standards.

5.1.b Balance in Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

Throughout Nevada's mining history there has been an evolutionary process in the extraction methods, government regulations, and employee safety processes that individual mining and natural resource operations employ. These operational and capability changes over time have represented a willingness by individual firms and the industry as a whole to change and adapt in order to maintain and improve overall operational effectiveness. These changes due to adaptability demonstrate how the industry's strategic capabilities change to meet demand from employees as well as consumers. One example in which Nevada's mining and natural resource extraction industry sector has not improved overall levels of balance relative to other international mining industries is in environmental concerns and relationships.

There have been regulations set by the Initiative for Responsible Mining Assurance regarding these topics. These include guidelines regarding business integrity, social responsibility, and environmental responsibility. There has been a historical lack of balance in the ways these guidelines have affected social responsibility and environmental responsibility activities pursued across the entire industry sector. For example, this can be seen in the relationship that the mining and natural resource extraction industry sector has had with indigenous peoples and Native American populations historically and the negative public image surrounding proposed mine sites to be located on land belonging to Native American tribes (Flin, 2021). While this image is not necessarily unique to Nevada's mining and natural resource extraction industry sector, it is an image that is part of the larger national industry sector and the sector's historical legacy.

5.1.c Defining Strength

Strength in supply chain management begins with an organization's mission statement. If employees continue to adhere to the vision as they implement actionable strategy that is tied to specific goals and objectives, an individual firm can excel in the market. Individual firms should be eager to be proactive, not reactive, to changes in market competition. To do this, an individual firm must be closely aligned with their partners, wary of their competitors, and open to shifting internal processes toward their customers' wants and needs. Ultimately, an individual firm is as strong as their people are and corporate executives and managers should be focused on securing and developing a steady workforce.

Partnerships also boost the strength of an organization, for they have been proven to drive procurement, supplier relations, sales, marketing, and customer relations in the supply chain (Rudzki, 2004). Partners, or other agencies, firms, organizations, and even individuals and individual customers who are external to the individual firm, can help the firm read the market more clearly, increasing visibility across the supply chain. Executives and managers should be sure about what type of relationship a partnership is, knowing which ones are more basic and transactional, and those that are more advanced and require considerably more attention and effort. Performance improves through the strength of a value network as individual firms align cross-functionally with one another, generally adhering to the same business strategy (Cecere,

2015, p.62). Working together covers more 'nodes' across a larger value network in order to more fully align processes horizontally instead of vertically.

5.1.d Strength in Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

Despite ranking 32nd out of 50 for the states across the Untied States with the most COVID-19 cases since the beginning of the global pandemic in early 2020, the state of Nevada was still heavily impacted by the resulting shutdowns that the pandemic necessitated (Statista, 2022). Nevada's two largest counties, in-terms of total population and in-terms of total economic output, Clark County and Washoe County, generate significant economic activity and output each county's tourism and hospitality sectors compared to any other counties in Nevada. With mandated business closures and restrictions on foreign and domestic travel, cities like Reno and Las Vegas were significantly and negatively affected by the impacts of the COVID-19 global pandemic. Aside from the mining and natural resource industry sector, businesses and entire industry and occupation sectors in Clark County attempted to minimize these impacts and, as a result of proactive efforts, only reported about an approximately 18.0 percent loss in total employment as a result of the pandemic (Ritter, 2022). Comparatively, Washoe County, a county that began its economic diversification efforts decades before the pandemic, has actually seen the countywide unemployment rate improve, reporting only 4.5 percent civilian unemployment rate in early 2022 (NNBW, 2022).

Although Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector has enjoyed a relatively strong supply chain and operation for quite some time, the impacts of the COVID-19 global pandemic on the industry and on individual mining and natural resource extraction operations were inevitable. Safety and health awareness, as well as crisis planning, are highly valued in the mining and natural resource extraction industry sector. However, due to the ongoing and longer than anticipated effects of the COVID-19 pandemic, there was still a significant decline in overall economic output and activity in general macroeconomic conditions and across the state's mining and natural resource extraction industry sector. During the global pandemic, market capitalization declined by more than a third of its value in a matter of weeks and the specter of a severe economic depression loomed. Effective communication and a strong health-and-safety-oriented culture, both of which are inherent in the mining and natural resource extraction industry sector, have aided Nevada's mining operations in overcoming the effects of the pandemic with comparatively little production disruption and job loss. Meanwhile, the bulk of Nevada's gold-mining enterprises ended fiscal year 2020 with higher-than-expected cash flows (Stattarvand, 2021).

5.1.e Defining Resiliency

A resilient value network and supply chain accepts change while staying demand driven. When an individual firm can handle a disruption, the firm becomes less likely to fail. Disruption is bound to happen because uncertainty is always present in and a generally defining characteristic of any industry. According to Willy Shih, an economist and professor at Harvard Business School, resilience "reduces the risk from future disruptions that are certain to occur" (Shih, 2020). Disruptions like natural disasters or a worldwide pandemic can cause market shifts,

which are inherently detrimental to a firm's value network and supply chain. The value network and supply chain, however, can remain resilient by already having practices in place to handle disruption and continued levels of uncertainty.

Resiliency within and across a value network and supply chain is also a reflection of an organization's ability to increase their potential and reach new goals in a system. Often, goals include improving customer-service, lowering inventory, and reducing costs across the entire operation (Cecere, 2015, p. 75). This requires intensive demand sensing capabilities in order to balance inventory while making it appealing to the customer as it is distributed in a way that brings financial value back to the firm. Appropriate technology for data analysis and forecasting can aid an individual firm and an entire value network and supply chain in the attempt to sustain processes that manage demand shifts and keep the value network and supply chain functioning effectively.

5.1.f Resiliency in Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector has seen many changes in the operations, safety measures, and regulation adherence protocols that individual firms within the industry sector undertake. Throughout the COVID-19 global pandemic, Nevada's mining and natural resource extraction industry sector sector saw already strict operating guidelines increase as a result of federally and state mandated COVID-19 safety protocols. Not only were these strict guidelines fairly easy to implement and follow by employees and by individual firms because of the industry sector's historical approach to workplace and workforce safety, but there was also less of a culture change needed within the industry in order to adhere to new pandemic-related health and safety guidelines. The disruption that new federally and state government imposed mandates was, however, felt much more dramatically across other industry sectors, notably the state's tourism and hospitality industry sector.

Sean Harapko's 2021 article regarding the COVID-19 global pandemic's impact on global supply chains, *How COVID-19 Impacted Supply Chains and What Comes Next*, discusses how problems that had existed in a small way prior to the pandemic could be "accelerated and magnified" as a result of the pandemic. One of these problems that has been exacerbated is the lack of workers that Nevada's Mining, Quarrying, and Oil and Gas Extraction industry faced even prior to the global pandemic and currently faces. Individual firms operating within Nevada's mining and natural resource extraction industry sector have worked with organizations like the University of Nevada, Reno to recruit additional workers into the industry through the efforts of the Mackay School of Mines and with other Nevada System of Higher Education institutions including Career Technical Educational and degree programs offered through Great Basin College. This had been a great source of employment before the pandemic but there are remaining gaps between employment demand and workforce supply that the ongoing COVID-19 global pandemic has enlarged.

Changes are happening quickly with respect to consumer electronics. As discussed throughout this University Center for Economic Development technical report, rare earth elements and metals are necessary for manufacturing and product development in electronics, aerospace,

automotive, and defense. The permanent magnets found in products like computers, cell phones, and automobiles are the single largest end-uses for these rare earth metals (Government of Canada, n.d.). Nevada is the only state in the United States that produces lithium. This provides Nevada and Nevada's mining and natural resource extraction industry sector with an opportunity to adapt to changing consumer needs while being aware of demand. As new and emerging technologies being developed as part of the nation's defense industry that utilize rare earth metals, Nevada's role in these changes could be monumental if taken advantage of at the right time and in the right way. Throughout the COVID-19 global pandemic, the political and economic relationship between the United States and China, and between much of the developed world and China, has changed significantly. While the Biden Administration is trying to increase the usage of these rare earth metals found in the United States, it is too soon to determine whether or not this can be connected to the resiliency of Nevada's mining and natural resource extraction industry because of China's existing dominance in the production of rare earth metals, the processing of rare earth metals, and the use of rare earth metals in additional value-added production.

5.2 Community and Economic Development Recommendation No. 1, Tire Production

A significant and persistent gap in Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector exists in the production and distribution of off-the-road tires used in mining and natural resource extraction operations throughout the entire state. The state of Nevada in conjunction with strategic regional development agencies should develop and implement the necessary strategic economic development steps needed to bolster in-state off-the-road tires that are used in mining and natural resource extraction operations.

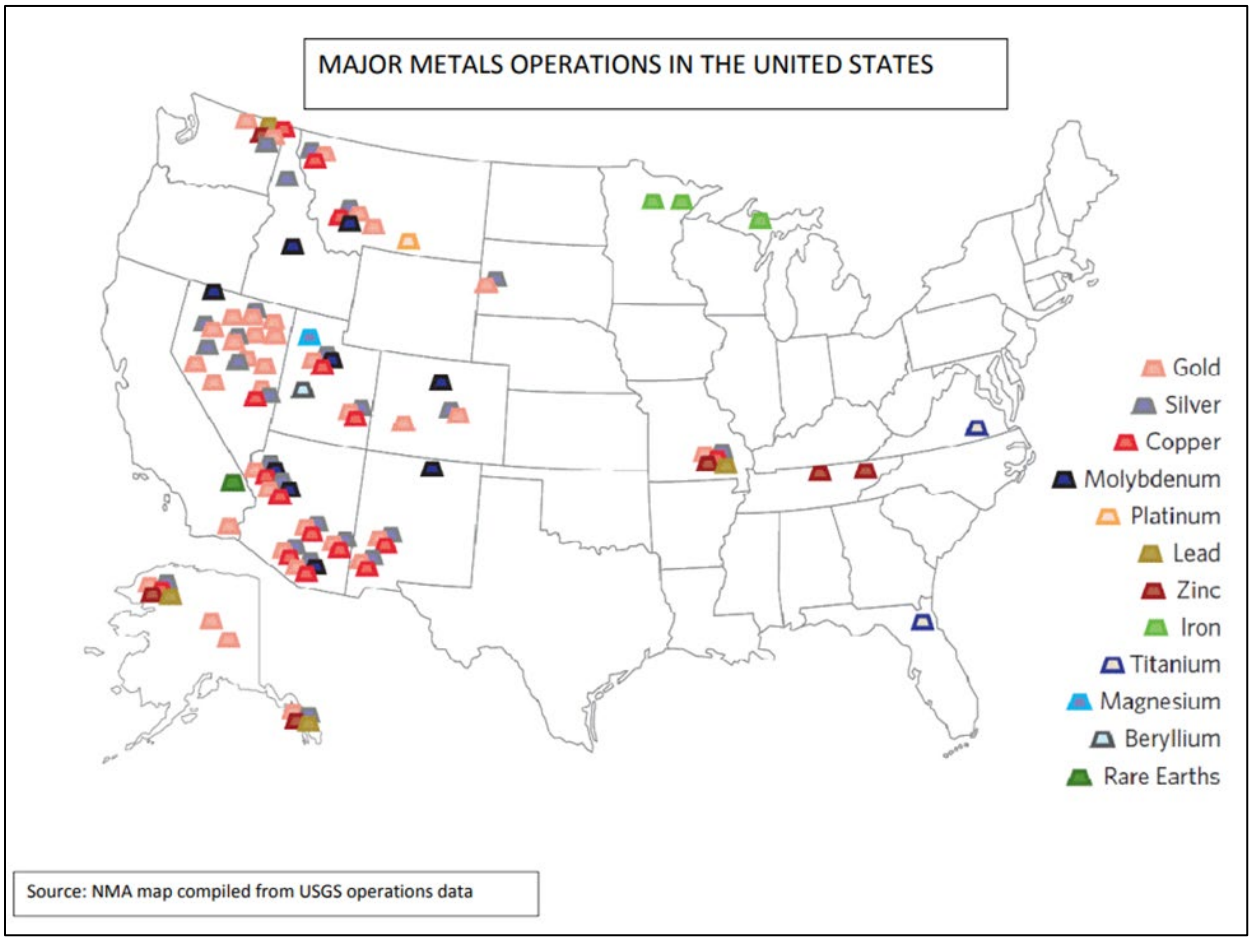
5.2.a Current Industry Leakage, Tire Production

While formulating the recommendations for value network and supply improvements in Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector, an analysis was completed using local-level and regional input-output models utilizing economic impact analysis data provided by IMPLAN for the calendar year 2020. This analysis, presented in Section 4.0 of this University Center for Economic Development technical report revealed that there is significant uncaptured economic activity in the production of off-the-road tires. For calendar year 2020, total economic activity in the consumption of off-the-road tires by firms operating within Nevada's mining and natural resource extraction industry sector was $193,517,592. Of this total economic output, ***less than one-half of one percent*** was captured by local suppliers located and operating within the state of Nevada. This uncaptured economic output is generally lost to suppliers with operations located outside the state of Nevada is a major development opportunity for the state of Nevada and for Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector in strengthening the value network and supply chain of this industry sector.

5.2.b Multi-State Alliance for Metal Mining

The majority of off-the-road tire production is based outside of the United States. One key exception to this is the manufacturing of Bridgestone off-the-road tires at the Aiken County Off Road Tire Plant in Trenton, South Carolina. This 1.5 million square foot facility was constructed in 2014 and employs 450 full time staff. Production of the tires utilized in surface, quarrying, mining, and underground applications are highly specialized and extremely large. Mining off-the-road tires can exceed 12,000 lbs. in total weight or the equivalent of between two and three full-sized pick-up trucks (Burris, 2014). According to data provided by the United States Geological Survey, the majority of active major metal mining operations reside in the western region of the United States extending from the Canadian border in Washington State and down to the Mexican border in Arizona and New Mexico as illustrated in Figure 5.1.

Figure 5.1 – Location of Major Metal Operations in the United States 2020



Nevada in centrally located in this western and intermountain western "mining belt" region. As previously discussed, mining oriented off-the-road tires are extremely large and extremely heavy, creating logistical challenges and increased costs as a result of transporting them internationally or from the Bridgestone Aiken County Off Road Tire Plant in Trenton, South

Carolina plant to the mines and mining operations located in the western and intermountain western United States. By successfully attracting production of off-the-road tires to Nevada, there is an opportunity to create a competitive advantage for tire producers in order to close the gap between production and distribution. This successful effort would, in-tern, reduce lead times, transportation costs, and related overhead costs (Major Metals Operations, 2020).

5.2.c Input Variables for Production

Successfully establishing a mining oriented off-the-road tire production operation in Nevada will require a facility of significant size, a workforce capable of operating that facility, and efficient and effective transportation infrastructure assets. Across many existing and even emerging industry sectors, but especially for the mining and natural resource extraction industry sector, the availability of a skilled labor workforce has become a significant limiting factor. With these requirements and keeping labor utilization in mind, there are several regions throughout the state of Nevada that have sufficient access to labor. The first region includes the Las Vegas Global Economic Alliance with the ability to draw a workforce from Clark County. The second region includes the Northern Nevada Development Authority, which includes Carson City, Douglas County, Lyon County, and Storey and the cities of Fernley and Yerington. The third region includes the Economic Development Authority of Western Nevada that includes Washoe County and the cities of Reno and Sparks. The fourth region includes the Churchill Economic Development Authority that includes Churchill County and the city of Fallon. Factoring in specific logistical transportation needs, land availability, and workforce needs, the Tahoe Reno Industrial Center, located in Storey County and part of the Northern Nevada Development Authority, could serve as a viable location for new mining oriented off-the-road tire production.

5.3 Community and Economic Development Recommendation No. 2, Electricity Distribution and Transmission

Regarding electricity distribution and transmission, it is peculiar in that electricity distribution and transmission is not solely related to Nevada's mining and natural resource extraction industry sector but has major impacts on other existing and emerging industry sectors throughout the state. Furthermore, the control of electricity distribution and transmission is not mandated by any one company and is currently not structured in the state of Nevada. Although control with this issue as it relates to the mining and natural resource extraction industry sector in Nevada is not currently actionable, current national and international events are impacting national and international energy production efforts must be considered now in order to reap the full benefits once put in effect. The opportunity and potential growth in electricity distribution and transmission that is feasible is simply too great to ignore.

5.3.a Current Industry Leakage, Electricity Distribution and Transmission

As already mentioned, electricity distribution and transmission is a matter that is not isolated to mining and natural resource extraction operations within the state but does have a major impact on the operations of individual firms across a wide variety of industry sectors. As illustrated in

table 5.1, two notable regional development authorities are the Economic Development Authority of Western Nevada and the Las Vegas Global Economic Alliance, producing total gross commodity demands of $549,477,932 and $2,324,179,427 respectively.

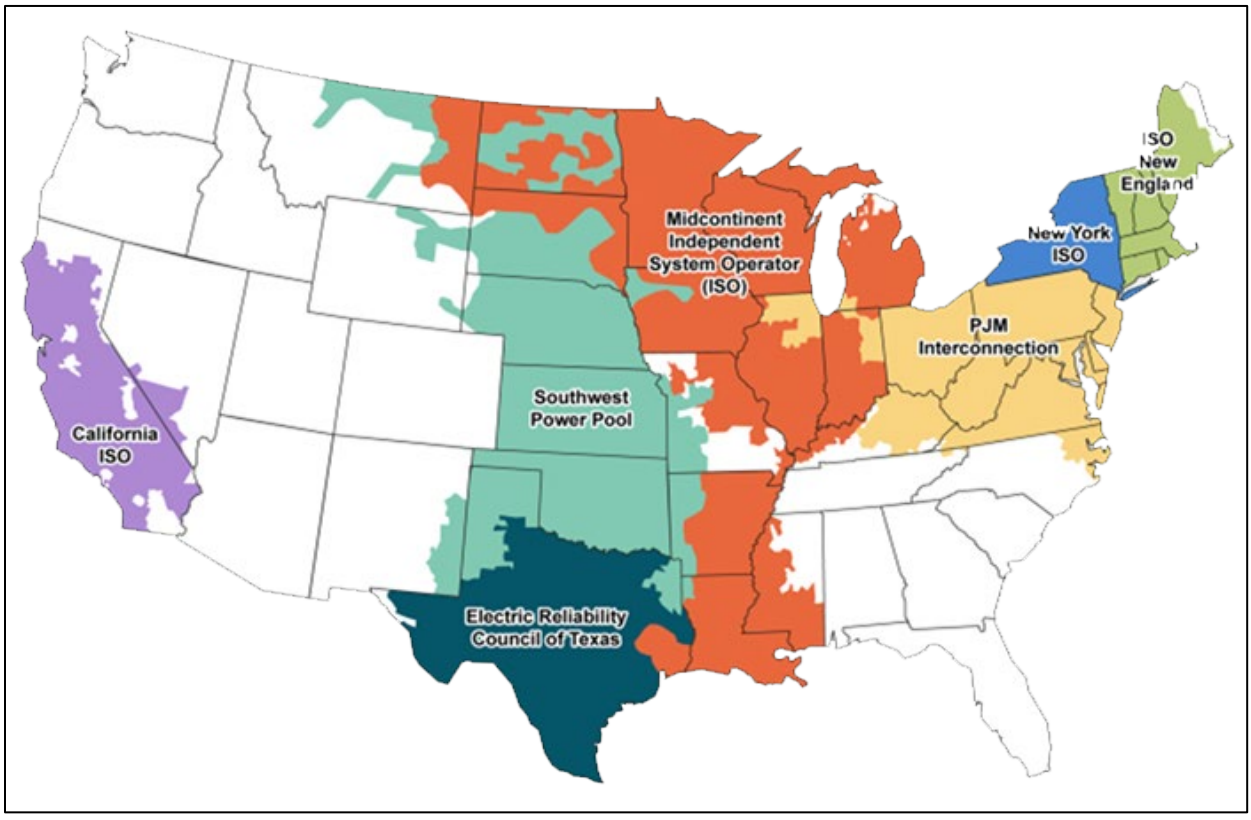
Table 5.1 – Electricity Transmission and Distribution Analysis Nevada Regional Development Authorities			
Regional Development Authority	**Local Use of Local Supply**	**Total Gross Commodity Demand**	**Domestic S/D Ratio**
Economic Development Authority of Western Nevada	$362,757,863	$549,477,932	66.0%
Churchill Economic Development Authority	$23,448,380	$28,021,101	83.7%
Lincoln County Regional Development Authority	$3,188,202	$3,538,014	90.1%
Las Vegas Global Economic Alliance	$1,678,387,378	$2,324,179,427	72.2%
Nevada 95-80 Regional Development Authority	$41,153,700	$42,342,694	97.2%
Northern Nevada Development Authority	$69,130,274	$269,598,399	25.6%
Northeastern Nevada Regional Development Authority	$131,404,165	$131,941,368	99.6%
Southwest Central Regional Economic Development Authority	$45,610,198	$45,746,106	99.7%
State of Nevada	**$2,454,342,594**	**$3,394,845,041**	**72.3%**

Although total gross commodity demands in both regional development authorities is significant, mining and natural resource extraction operations contribute little to overall regional economic activity as tourism and hospitality drive a significant amount of economic activity in both regions. As it relates to the mining and natural resource extraction industry sector, the Nevada 95-80 Regional Development Authority, the Northern Nevada Development Authority, and the Northeastern Nevada Regional Development Authority produced total gross commodity demands of $42,342,694, $269,958,399, and $131,941,368, totaling a gross commodity demand of $444,242,461 and a local fulfillment of only $241,688,139. The resulting domestic supply to demand ratio is an estimated 54.4 percent for all three regional development authorities combined.

5.3.b Regional Strategies Used to Address Electricity Distribution and Transmission

While Nevada's electricity grid remains fragmented, seven regions in the United States have been able to increase overall electricity distribution and transmission efficiency and decrease overall costs because of creating individual Regional Transmission Organizations and Independent System Operators. As shown in Figure 5.2, the southeast region (Alabama, Florida, Georgia, North Carolina, South Carolina, and Tennessee) and much of the west (essentially every state except California) has failed to create a Regional Transmission Organization or an Independent System Operator. The benefits of these structures include, but are not limited to, a more efficient distribution of energy, improved access to low-cost power, and benefits transferred to state-level operations which can directly impact the mining and natural resource extraction industry sector (The Nevada Independent).

Figure 5.2 – Regional Transmission Organizations and Independent System Operators United States



Both Nevada and Colorado, two states in the western and intermountain United States that are currently part of a Regional Transmission Organization or an Independent System Operator, have recently passed legislation directing utility companies to join a regional market by 2030. What may seem like a distant forebode is, in reality, a fast go to market plan. Regulators are currently analyzing the feasibility of a regional electricity market that would include the state of Nevada. The current legislation and discussions regarding this topic has the potential to have a significant impact on Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector.

While significant restructuring of electricity distribution and transmission in Nevada will be required to realize this opportunity, localizing increased electricity distribution and transmission at the regional level throughout the state can significantly reduce the amount of economic leakage experienced in the mining and natural resource extraction industry sector and result in the development of a new industry sector that could significantly diversify the state's existing economic base.

5.4 Community and Economic Development Recommendation No. 3, Storage Batteries

The recommendation to expand storage production in Nevada as part of the larger effort to close critical gaps in Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector will largely focus on the existing Tesla Gigafactory located in the Tahoe Reno Industrial Center in Storey County and the opportunity that exists to replicate this approach throughout the state. As storage battery production directly relates to Nevada's mining and natural resource extraction industry sector and future opportunities for rare earth element production across the state, ongoing storage battery economic leakage will only intensify as more quantities of rare earth elements are produced across the state and if additional strategy battery production capacity is not increased.

5.4.a Current Industry Leakage, Storage Batteries

Whereas nearly $1.0 billion of economic leakage is related to the electricity distribution and transmission recommendation, storage battery local use of supply, as illustrated in Table 5.2, is estimated to be $70,071,323 yet total gross commodity demand is an estimated $266,433,518, resulting in a net economic leakage of $196,362,195 that could be capture if storage battery production capacity is increased within the state.

Table 5.2 – Electricity Distribution and Transmission vs. Storage Batteries State of Nevada

Commodity	Local Use of Local Supply	Total Gross Commodity Demand
Electricity Distribution and Transmission	$2,454,342,594	$3,394,845,041
Storage Batteries	$70,071,323	$266,433,518

Although the estimates of statewide local use of supply and total gross commodity demand for storage batteries is significantly less than the estimates of statewide local use of supply and total gross commodity demand for electricity distribution and transmission, the gap between local use

of supply and total gross commodity demand for storage batteries is significantly greater than the gap for electricity distribution and transmission. The emerging nature of storage battery production also indicates that these estimates of local use of supply and total gross commodity demand for storage batteries will likely increase over the near term as rare earth element production and national and international demand for storage batteries increases.

5.4.b The Impacts of the Tesla Gigafactory and its Replicable Model for Storage Battery Production

When Tesla was considering several states for their eventual Gigafactory, the final three states being considered were California, Texas, and of course, Nevada. While the incentives that Tesla was demanding were known, the benefits and impact that it would have on the state is what drove the final selection decision. As it was announced that Tesla's Gigafactory would be built in Storey County, Nevada, the potential economic opportunity was significant. For Nevada, the Gigafactory would create nearly $100 billion in total economic activity over 20 years and add an estimated 4.0 percent to Nevada's statewide gross domestic product. Although the impact on the entire state's economy is significant, the Gigafactory has created an opportunity for Nevada's mining and natural resource extraction industry sector as Tesla's product line utilizes mined resources such as gold, silver, lithium, and cobalt, all of which are mined here in the state of Nevada. This represents a major opportunity for mining companies as there is an opportunity for increased economic activity and a growing need to decrease individual transportation costs. An increase in storage battery manufacturers throughout the state and in selected regional development authority would reduce existing economic leakage in Nevada's mining and natural resource extraction industry sector and reduce the further gap that existing in the industry sector's value network and supply chain.

5.5 Examining and Reevaluating Nevada's Economic Development Incentives and Incentive Structure

This sub-section presents an overview of how existing economic development incentives used by the state of Nevada and by each of the eight existing regional development authorities could be rethought, restructured, and repurposed in targeted and strategic ways. By rethinking, restructuring, and repurposing this incentives, the state of Nevada and each of the eight regional economic development authorities can begin to close targeted gaps in the value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector.

5.5.a Past Incentive Programs

In recent years, Nevada has made use of a set of substantial incentive programs to attract sizable capital investments from growing companies. The Tesla Gigafactory was awarded an incentive package that include 20 years without sales tax payments, ten years without property tax payments, and millions of dollars in tax credits (Lecher, 2016). This occurred after a bidding war between various states ensued in an attempt to capture the production capacity of the firm. The Gigafactory is expected to generate nearly $100.0 billion in total economic activity over the

next 20 years and has placed Nevada in a strong position to lead the nation in the growing advancement and development of clean energy (Lecher, 2016).

Data centers belonging to Apple and Google now located and operating in Nevada have also received tax incentives in order to encourage further investment. Apple's data center has created over 100 jobs with their nearly $1.0 billion investment (Damon, 2017). Google requested a sales tax abatement of 2.0 percent and an abatement of 75.0 percent for the next 20 years (Hidalgo, 2020). While these abatements total nearly $25.0 million, Google's $1.2 billion investment is expected to generate approximately $427.0 million in economic activity over the next 20 years. It is clear that the use of tax and other incentives to encourage individual firms to make sizable and significant investments in the state has been successful in creating jobs and diversifying Nevada's economy.

5.5.b Existing Nevada Tax Incentives

Generally speaking, Nevada has demonstrated its willingness to offer and provide sales tax abatements on equipment purchases with rates as little as 2.0 percent (NDCTA, 2022). The state of Nevada also offer business tax abatements of 50.0 percent on the current 1.378 percent tax range on wages above $50,000 (NDCTA, 2022). The Nevada Governor's Office of Economic Development also provides an abatement on personal property tax as long as the abatement does not exceed 50.0 percent over a period of ten years. The Nevada Governor's Office of Economic Development also offers a maximum of a 50.0 percent abatement on real and personal property taxes for qualifying recycling businesses. Other incentives pertaining to employee training and assistance with intellectual property development are also available through the Governor's Office of Economic Development and other state agencies and departments (NDCTA, 2022).

5.5.c Tire Manufacturing Incentives

In order to encourage new tire manufacturers to enter the state and partner with individual firms in Nevada's mining and natural resource extraction industry sector, there are a number of existing incentives that could be utilized. The first is suspension of elements of Nevada Revised Statute Chapter 444A as it applies to the sale of tires to individual Nevada-based mining and natural resource extraction firms (FGI, 2022). This step would remove the $1.00 tax that currently exists and is levied on each tire sold within the state regardless of type, size, and use. A second recommendation and incentive package that would incentive new tire manufacturing in the state would suspend the levying of applicable sales tax rates on the sale of any raw material and input into production used in the manufacturing of off-the-road tires that are sold to mining and natural resource extraction firms within the state of Nevada. It is important to note that the raw inputs and materials used in the production of off-the-road tires are currently subject to the sales tax exemption for unfinished materials (Hinton, 2019).

A sales and property tax exemption of up to ten years for any new off-the-road tire manufacturer should also be explored. These exemptions should come with the conditions that at least 50 to 100 full-time jobs are created, these employees are paid above the average wage of the state, and that substantial capital investment is made by the firm. Tire manufacturers should be encouraged

to provide discounts to Nevada mining operations. The state and private mining and natural resource extraction firms should also explore additional investment in transportation infrastructure alongside interested tire manufacturers in order to ensure ease of transportation between the tire manufacturer and the end user. Finally, tax incentives should be explored for retreading and recycling infrastructure and the siting of this infrastructure alongside off-the-road tire production facilities to reduce total costs for all parties.

5.5.d Electronics Manufacturing Incentives

For electronics manufacturing, individual states that have excelled in electronic manufacturing and have successfully utilized exemptions and incentives to encourage business development have been examined as part of this analysis in order to develop a possible set of incentives designed to encourage additional electronics manufacturing across the state of Nevada. The state of California and the state of Texas are two of the largest electronics manufacturers in the United States. California policymakers have focused on exemptions for equipment, research and development, and limitations set by the state (IPC, 2020). The state of California has put in requirements that equipment or machinery purchased through the use of these incentives must be used 50.0 percent or more during the manufacturing processes, and as part of this specific requirement, research and development equipment does qualify (Miles, 2022). This promotes additional development of electronics manufacturing and establishes a set of standards for an individual firm to keep utilizing their resources and to improve overall efficiency in their manufacturing processes. Other considerations that California has made when offering these incentives are the amount of jobs the individual firm will create and retain within the state, the amount of private investment ultimately expended, the extent of poverty or unemployment in the area that the individual firm will eventually locate within, the overall economic impact that the individual firm will have on levels of general economic activity, and the incentives available to the individual firm that is being offered by other states (Miles, 2022).

The state of Texas has a similar approach to the state of California in the incentivization of new and expanded electronics manufacturers. The state of Texas's incentive program was designed to benefit the individual company receiving the incentive and also the people working for that individual firm. The state of Texas has a vision to keep the state economy growing while supporting new business creation and attraction and existing business retention and expansion. Texas has created the "Texas Enterprise Fund" which awards "deal-closing" grants to companies that are considering a new project that may be competing with other out-of-state businesses (TEF, 2022). This incentive was created to incentivize existing businesses already operating within the state of Texas whose projects would significantly contribute to capital investment as well as new employment opportunities within the state (TEF, 2022). Requirements associated with grants awarded by the Texas Enterprise Fund include ensuring overall economic growth, creating new employment opportunities, encouraging additional private sector capital investment, and a good overall community liking.

For a business to be considered for funding through the Texas Enterprise Fund, some of the eligibility requirements are that the individual firm must be in active competition with at least one out-of-state business and that the company must not have made a location decision,

projected new job creation must exceed 75 full-time jobs (urban areas) or 25 full-time jobs (rural areas), the average wage for new jobs created must meet or exceed the average county wage, the company must demonstrate significant capital investment, the project must be supported by the city or county, the company must be well established, and the company must operate in an advanced industry (TEF, 2022). These requirements ensure that the benefiting individual company positively contributes to local, regional, and statewide economic growth. In addition to the Texas Enterprise Fund, Texas property tax code permits a 100.0 percent exemption on the appraised value of solar, wind, or biomass energy devices installed or constructed for the production and use of energy on-site (TPTC, 2020). For Nevada, a similar property tax incentive could support additional electronics manufacturing in the area of renewable energy, especially if the state of Nevada added geothermal energy production in addition to solar, wind, and biomass energy devices.

5.6 A Long-Term Vision for the Value Network and Supply Chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction Industry Sector

Closing the existing gaps in the value network and supply chain of Nevada's Mining, Quarrying, and Oil and Gas Extraction industry sector, through the growth of tire production, storage batteries, electricity distribution and transmission, and electronics manufacturing is to develop stronger and deeper relationships between individual mining and natural resource extraction firms operating throughout the state and other firms in existing and emerging industry sectors. Increased electronics manufacturing and increased renewable and green energy production will both support Nevada's mining and natural resource extraction industry sector and further diversify Nevada's economic base. Nevada's geography presents opportunities for the overall expansion in solar, geothermal, and even nuclear power. The state has ready access to gold for use in battery and circuit board manufacturing as well as the potential for rare earth element mining, an uncommon and crucial part of battery production.

Coupling this natural complementary relationship with the national push towards renewable and green energy resources creates unique possibilities with respect to green mining initiatives. Electric mines and the use of green hydrogen are becoming increasingly popular throughout the global mining and natural resource extraction industry sector. These eco-friendly efforts will ensure Nevada's continued leadership in global mining and natural resource extraction operations and serve as new drivers of economic activity across the state. Encouraging friendly business practices toward electronics manufacturers and cooperative efforts between existing firms will provide a solid foundation for new partnerships to grow. These resulting relationships will create jobs and galvanize Nevada's economy by introducing several new sources of economic activity within the state alongside the existing mining and natural resource extraction industry sector and the tourism and hospitality industry sector.

References for Section 5.0, White Paper for Part 4 *Identifying Value Network and Supply Chain Gaps and Developing Community and Economic Development Recommendations*

Bridgestone Opens first US Mining Tire Manufacturing Facility. E & MJ Engineering and Mining Journal. (2014, November 20). Retrieved from https://www.e-mj.com/news/leading-developments/bridgestone-opens-first-us-mining-tire-manufacturing-facility/

Burris, R. (2014, November 18). *Bridgestone opens off-road giant tire plant in Aiken County*. The State.

Cecere, L. M. (2015). *Supply chain metrics that matter*. Wiley.

Damon, A. (2017, May 11). *Apple announces $1 billion data center expansion east of Reno*. Reno Gazette Journal. Retrieved May 8, 2022, from https://www.rgj.com/story/news/2017/05/10/breaking-apple-announces-1-billion-data-center-expansion-east-reno/316884001/

Elflein, J. (2022). Total Number of Coronavirus Cases in the United States as of May 2, 2022, by state. *Statista*. https://www.statista.com/statistics/1102807/coronavirus-covid19-cases-number-us-americans-by-state/

Flin, B. (2021, December 2). '*Like putting a lithium mine on Arlington cemetery': the fight to save sacred land in Nevada*. The Guardian. https://www.theguardian.com/us-news/2021/dec/02/thacker-pass-lithium-mine-fight-save-sacred-land-nevada

Funding, Grants & Incentives | california office of the small business ... (2022). Retrieved May 9, 2022, from https://calosba.ca.gov/funding-grants-incentives/

Geppert, K. (1997, August 6). *Bridgestone is likely to build new tire plant in Aiken, S.C.* The Wall Street Journal. Retrieved from https://www.wsj.com/articles/SB870801956420958500

Government of Canada (n.d.). *Rare Earth Elements*. Government of Canada. 22, from https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/rare-earth-elements-facts/20522

Hidalgo, J. (2020, September 19). *Google gets $25 million tax break for data center near Reno, expanding Henderson Project*. Reno Gazette Journal. Retrieved May 8, 2022, from https://www.rgj.com/story/news/money/business/2020/09/16/google-invest-additional-600-million-new-nevada-data-center/5823165002/

Hinton, B. C., Robison, B. B., Markel, B. A., Garbe, B. E., Winer, B. M., & Staff, B. T. R. (2019, October 10). *OTR tire manufacturers share plans for 2019, trends in OTR Market*. Tire Review Magazine. Retrieved May 8, 2022, from https://www.tirereview.com/otr-tire-manufacturers-share-plans-for-2019-trends-in-otr-market/

IPC -- Association Connecting Electronics Industries. (2020, May 13). *Electronics manufacturing supports more than 5.3 million U.S. jobs and almost 4% of U.S. GDP, says IPC*. GlobeNewswire NewsRoom. Retrieved May 4, 2022, from https://www.globenewswire.com/news-release/2020/05/13/2032951/0/en/Electronics-Manufacturing-Supports-More-Than-5-3-Million-U-S-Jobs-and-Almost-4-of-U-S-GDP-Says-IPC.html

Kaplan, R.S. & Norton, D.P. (2000). Having trouble with your strategy? Then map it. *Balanced Scorecard.*

Lecher, C. (2016, February 8). *Inside Nevada's $1.3 billion gamble on Tesla*. The Verge. Retrieved May 8, 2022, from https://www.theverge.com/2016/2/8/10937076/tesla-gigafactory-battery-factory-nevada-tax-deal-elon-musk

Major Metals Operations in the United States - National Mining Association. (2020, October 22). Retrieved from https://nma.org/wp-content/uploads/2018/02/m_map_mines.pdf

Miles Consulting Group. (2022). *Multi-state Tax Links & Resources*. milesconsultinggroup.com. Retrieved May 4, 2022, from https://www.milesconsultinggroup.com/services-ca-tax-incentives.html

Nevada Data Center Tax Abatements (NDCTA). (2022). Retrieved May 9, 2022, from https://goed.nv.gov/wp-content/uploads/2020/02/Data-Center-2019.pdf

NNBW Staff Report. (2022). Ongoing Recovery, Washoe County Jobless Rate Improves. *Northern Nevada Business Weekly.*

Ritter, K. (2022). Nevada Casinos Data: Jobs lost, revenue down amid pandemic. *Las Vegas Sun.*

Rothberg, D. 2022. *Nevada is taking steps toward a Western electric grid. What will it look like?* The Nevada Independent. January 20.

Rudzki, R.A. (2004). The advantages of partnering. *Supply Chain Management Review, 8*(1), 44-51.

Shih, W.C. (2020). Global supply chains in a post-pandemic world. *Harvard Business Review.*

Stattarvand, J. (2021). Knock on effects of COVID-19 on the mining industry. *Mining Engineering Magazine: February issue.*

Texas Enterprise Fund. Fort Bend Economic Development Council. (2022). Retrieved May 8, 2022, from https://fortbendcounty.com/why-ft-bend/incentives-and-financing/texas-enterprise-fund

Texas Property Tax Code (TPTC). DSIRE. (2020, July 8). Retrieved May 8, 2022, from https://programs.dsireusa.org/system/program/detail/173

Appendix A: Allowable Deductions to Calculate Net Proceeds, per Nevada Revised Statute Chapter 362 Section 120

Nevada Revised Statute Chapter 362 Section 120

(a) The actual cost of extracting the mineral, which is limited to direct costs for activities performed in the State of Nevada.

(b) The actual cost of transporting the mineral to the place or places of reduction, refining and sale.

(c) The actual cost of reduction, refining and sale.

(d) The actual cost of delivering the mineral.

(e) The actual cost of maintenance and repairs of:

(1) All machinery, equipment, apparatus and facilities used in the mine.

(2) All milling, refining, smelting and reduction works, plants and facilities.

(3) All facilities and equipment for transportation except those that are under the jurisdiction of the Public Utilities Commission of Nevada or the Nevada Transportation Authority.

(f) Depreciation of the original capitalized cost of the machinery, equipment, apparatus, works, plants and facilities mentioned in paragraph (e). The annual depreciation charge consists of amortization of the original cost in a manner prescribed by regulation of the Nevada Tax Commission. The probable life of the property represented by the original cost must be considered in computing the depreciation charge.

(g) All money expended for premiums for industrial insurance, and the actual cost of hospital and medical attention and accident benefits and group insurance for employees actually engaged in mining operations within the State of Nevada.

(h) All money paid as contributions or payments under the unemployment compensation law of the State of Nevada, as contained in chapter 612 of NRS, all money paid as contributions under the Social Security Act of the Federal Government, and all money paid to either the State of Nevada or the Federal Government under any amendment to either or both of the statutes mentioned in this paragraph.

(i) The costs of employee travel which occurs within the State of Nevada and which is directly related to mining operations within the State of Nevada.

(j) The costs of Nevada-based corporate services relating to paragraphs (e) to (i), inclusive.

(k) The actual cost of developmental work in or about the mine or upon a group of mines when operated as a unit, which is limited to work that is necessary to the operation of the mine or group of mines.

(l) The costs of reclamation work in the years the reclamation work occurred, including, without limitation, costs associated with the remediation of a site.

(m) All money paid as royalties by a lessee or sublessee of a mine or well, or by both, in determining the net proceeds of the lessee or sublessee, or both.

Appendix B: Rate of Tax Upon Net Proceeds, per Nevada Revised Statute Chapter 362 Section 140

Nevada Revised Statute Chapter 362 Section 140

1. Except as otherwise provided in this section, the rate of tax upon the net proceeds of each geographically separate extractive operation depends upon the ratio of the net proceeds to the gross proceeds of that operation as a whole, according to the following table:

Net Proceeds as Percentage of Gross Proceeds	Rate of Tax as Percentage of Net Proceeds
Less than 10	2.00
10 or more but less than 18	2.50
18 or more but less than 26	3.00
26 or more but less than 34	3.50
34 or more but less than 42	4.00
42 or more but less than 50	4.50
50 or more	5.00

Appendix C: IMPLAN Results for the Economic Development Authority of Western Nevada

Table AC-1 – Top 20 Industry Sectors Economic Development Authority of Western Nevada 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Income**
Other real estate	$2,758,891,018	2,718	16,491	$13,772	-$6,816,679
Owner-occupied dwellings	$2,570,225,659	0	0	$0	$0
Insurance carriers, except direct life	$1,694,030,951	1,210	2,129	$919	$6,220,336
Hospitals	$1,359,932,231	7,317	7,329	$12	$2,369,208
Management of companies and enterprises	$1,102,207,913	3,032	3,999	$967	$15,899,922
Offices of physicians	$850,285,070	3,898	5,107	$1,209	$87,792,667
Tenant-occupied housing	$831,884,103	679	3,349	$2,669	-$1,313,896
Construction of other new residential structures	$782,951,801	1,827	2,112	$285	$61,402,603
Limited-service restaurants	$758,958,803	7,307	7,778	$470	$10,068,479
Architectural, engineering, and related services	$755,743,310	3,090	5,268	$2,178	$127,689,110
*Employment and payroll of local govt, education	$744,247,880	8,316	8,317	$0	$0
Monetary authorities and depository credit intermediation	$733,413,784	1,322	1,543	$220	$21,638,738
Employment services	$723,267,488	7,031	8,377	$1,346	$38,624,548
All other miscellaneous manufacturing	$721,530,219	1,494	1,665	$171	$1,563,625

Table AC-1 Cont'd – Top 20 Industry Sectors Economic Development Authority of Western Nevada 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Income**
Warehousing and storage	$714,326,662	6,941	6,989	$47	$1,809,184
Hotels and motels, including casino hotels	$686,970,105	6,992	7,177	$185	$52,950,822
Retail - Nonstore retailers	$683,191,493	1,237	3,436	$2,198	$8,917,023
Truck transportation	$680,364,849	3,259	3,708	$448	$66,745,875
*Employment and payroll of local govt, other services	$680,070,338	5,319	5,320	$0	$0
Construction of new single-family residential structures	$657,940,008	3,922	4,613	$690	$133,949,720
TOTAL	**$20,490,433,684**	**$76,911**	**$104,707**	**$27,786**	**$629,511,285**

Table AC-2 – Total Employment and Total Output by Commodity Produced by Industry Sector Economic Development Authority of Western Nevada 2020		
Commodity Industry Sector	**Total Output**	**Total Employment**
Insurance carriers, except direct life	$1,694,030,951	2,129
Architectural, engineering, and related services	$755,743,309	5,268
Truck transportation	$680,364,848	3,708

Table AC-3 – Backward Linkages, Truck Transportation Economic Development Authority of Western Nevada 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Refined petroleum products	1.94%	6.39%	$43,445,709	0.12%	$842,757	$42,602,952
Other insurance	78.18%	2.53%	$17,202,232	1.98%	$13,449,053	$3,753,179
Other motor vehicle parts	0.42%	0.53%	$3,620,392	0.00%	$15,274	$3,605,118
Wholesale services - Petroleum and petroleum products	87.89%	3.82%	$25,979,218	3.36%	$22,832,379	$3,146,840
Retail services - Gasoline stores	82.30%	2.32%	$15,780,883	1.91%	$12,987,471	$2,793,413
Noncomparable imports	0.00%	0.35%	$2,396,548	0.00%	$0	$2,396,548
Motor vehicle steering, suspension components (except spring), and brake systems	0.28%	0.31%	$2,074,285	0.00%	$5,731	$2,068,554
Motor vehicle gasoline engines and engine parts	0.02%	0.30%	$2,039,936	0.00%	$439	$2,039,496
Monetary authorities and depository credit intermediation	42.40%	0.52%	$3,523,254	0.22%	$1,493,975	$2,029,279
Facilities support services	12.68%	0.22%	$1,508,898	0.03%	$191,306	$1,317,592
Scenic and sightseeing transportation services and support activities for transportation	95.55%	4.00%	$27,218,783	3.82%	$26,008,063	$1,210,720
Office administrative services	17.10%	0.18%	$1,203,956	0.03%	$205,863	$998,093
Air transportation services	27.79%	0.19%	$1,317,695	0.05%	$366,196	$951,499
Wireless telecommunications (except satellite)	25.85%	0.18%	$1,242,830	0.05%	$321,287	$921,543

Table AC-3 Cont'd – Backward Linkages, Truck Transportation Economic Development Authority of Western Nevada 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Pipeline transportation services	37.74%	0.19%	$1,295,693	0.07%	$489,015	$806,677
Other plastics products	2.26%	0.11%	$753,572	0.00%	$17,005	$736,566
Advertising, public relations, and related services	60.20%	0.24%	$1,611,444	0.14%	$970,113	$641,332
Tires	0.00%	0.09%	$621,814	0.00%	$23	$621,791
Machined products	2.77%	0.09%	$616,897	0.00%	$17,101	$599,796
Electricity transmission and distribution	66.02%	0.24%	$1,628,110	0.16%	$1,074,856	$553,254

Table AC-4 – Backward Linkages, Architectural, Engineering, Related Services Economic Development Authority of Western Nevada 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Management consulting services	52.48%	3.17%	$26,769,568	1.66%	$14,049,349	$12,720,219
Other basic organic chemicals	0.00%	0.89%	$7,543,746	0.00%	$87	$7,543,660
Office administrative services	15.65%	0.78%	$6,568,919	0.12%	$1,027,942	$5,540,977
Hotels and motel services, including casino hotels	1.03%	0.50%	$4,193,625	0.01%	$43,037	$4,150,588
Monetary authorities and depository credit intermediation	46.50%	0.91%	$7,693,003	0.42%	$3,577,002	$4,116,001
Noncomparable imports	0.00%	0.39%	$3,285,752	0.00%	$0	$3,285,752
Other computer related services, including facilities management services	57.38%	0.77%	$6,518,688	0.44%	$3,740,140	$2,778,548
Software publishers	51.73%	0.66%	$5,530,182	0.34%	$2,860,913	$2,669,269
Other plastics products	2.09%	0.31%	$2,641,162	0.01%	$55,242	$2,585,919
Wireless telecommunications (except satellite)	28.02%	0.40%	$3,383,960	0.11%	$948,057	$2,435,902
Architectural, engineering, and related services	91.47%	3.34%	$28,169,359	3.05%	$25,765,344	$2,404,015
Air transportation services	38.57%	0.42%	$3,568,817	0.16%	$1,376,374	$2,192,443
Facilities support services	12.84%	0.30%	$2,509,704	0.04%	$322,205	$2,187,500
Other insurance	68.52%	0.77%	$6,458,951	0.52%	$4,425,788	$2,033,163
Computer systems design services	34.96%	0.33%	$2,817,140	0.12%	$984,940	$1,832,200

Table AC-4 Cont'd – Backward Linkages, Architectural, Engineering, Related Services Economic Development Authority of Western Nevada 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Advertising, public relations, and related services	58.04%	0.51%	$4,261,364	0.29%	$2,473,299	$1,788,066
Fabricated structural metal products	5.30%	0.20%	$1,660,988	0.01%	$88,060	$1,572,928
Marketing research and all other miscellaneous professional, scientific, and technical services	86.02%	1.33%	$11,205,697	1.14%	$9,639,503	$1,566,193
Iron and steel and ferroalloy products	0.01%	0.18%	$1,520,004	0.00%	$144	$1,519,860
Fiber optic cables	0.00%	0.18%	$1,495,615	0.00%	$72	$1,495,543

Table AC-5 – Backward Linkages, Maintenance and Repair Construction Economic Development Authority of Western Nevada 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Refined petroleum products	1.92%	1.94%	$7,560,021	0.04%	$144,911	$7,415,110
Stone	2.93%	1.55%	$6,036,582	0.05%	$176,967	$5,859,615
Other plastics products	2.09%	1.47%	$5,711,973	0.03%	$119,472	$5,592,502
Ready-mix concrete	36.23%	1.97%	$7,666,963	0.71%	$2,778,106	$4,888,857
Asphalt shingles and coating materials	0.08%	1.01%	$3,935,763	0.00%	$3,235	$3,932,527
Lighting fixtures	0.03%	0.89%	$3,448,289	0.00%	$1,067	$3,447,222
Dimension lumber	0.74%	0.70%	$2,733,168	0.01%	$20,158	$2,713,010
Asphalt paving mixtures and blocks	20.82%	0.86%	$3,332,276	0.18%	$693,681	$2,638,595
Fabricated structural metal products	5.30%	0.69%	$2,697,358	0.04%	$143,004	$2,554,353
Air conditioning, refrigeration, and warm air heating equipment	1.11%	0.65%	$2,527,632	0.01%	$28,163	$2,499,469
Metal windows and doors	4.20%	0.63%	$2,440,019	0.03%	$102,586	$2,337,433
Plumbing fixture fittings and trims	3.91%	0.56%	$2,182,248	0.02%	$85,270	$2,096,978
Motor vehicle steering, suspension components (except spring), and brake systems	1.01%	0.51%	$1,987,916	0.01%	$20,068	$1,967,847
Ornamental and architectural metal products	2.76%	0.51%	$1,974,380	0.01%	$54,578	$1,919,802

Table AC-5 Cont'd – Backward Linkages, Maintenance and Repair Construction Economic Development Authority of Western Nevada 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Plastics pipes and pipe fittings	9.07%	0.50%	$1,961,976	0.05%	$177,989	$1,783,987
Sheet metal work (except stampings)	8.69%	0.48%	$1,866,548	0.04%	$162,193	$1,704,355
Paints and coatings	0.41%	0.43%	$1,662,512	0.00%	$6,888	$1,655,624
Fiber optic cables	0.00%	0.41%	$1,602,854	0.00%	$78	$1,602,776
Other millwork, including flooring	4.90%	0.41%	$1,607,513	0.02%	$78,751	$1,528,762
Other concrete products	2.68%	0.40%	$1,560,458	0.01%	$41,744	$1,518,713

Table AC-6 – Forward Linkages Economic Development Authority of Western Nevada 2020			
Commodity Code	**Description**	**Average RPC**	**Average RSC**
3020	Natural gas and crude petroleum	54.96%	13.70%
3021	Coal	0.00%	0.00%
3022	Copper, nickel, lead, and zinc ore	38.81%	32.05%
3023	Iron ore	0.00%	0.00%
3024	Gold ore	64.57%	9.57%
3025	Silver ore	61.72%	34.10%
3026	Uranium-radium-vanadium ore	60.80%	62.91%
3027	Other metal ore	0.00%	0.00%
3028	Stone	2.93%	94.56%
3029	Sand and gravel	27.16%	26.44%
3030	Other clay, ceramic, refractory minerals	0.73%	2.04%
3031	Potash, soda, and borate mineral	9.09%	70.78%
3032	Phosphate rock	16.82%	61.08%
3033	Other chemical and fertilizer mineral	5.91%	2.14%
3034	Other nonmetallic minerals	50.82%	14.73%
3035	Oil and gas wells	7.12%	94.70%
3036	Support activities for oil and gas operations	4.09%	93.61%
3037	Metal mining services	66.53%	89.34%
3038	Other nonmetallic minerals services	25.70%	95.87%

Appendix D: IMPLAN Results for the Churchill Economic Development Authority

Table AD-1 – Top 20 Industry Sectors Churchill Economic Development Authority 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Income**
Secondary processing of other nonferrous metals	$130,862,367.59	147	8	155	$1,922,028.78
Owner-occupied dwellings	$122,940,611.29	0	0	0	$0.00
Dry, condensed, and evaporated dairy product manufacturing	$111,047,587.57	85	15	100	-$28,314.23
Employment and payroll of federal govt, military	$106,381,557.14	586	0	586	$0.00
Scenic and sightseeing transportation and support activities for transportation	$79,026,796.62	628	4	632	$443,802.60
Hospitals	$71,299,499.10	375	0	375	$0.00
Facilities support services	$58,788,298.08	252	99	351	$1,622,229.31
Employment and payroll of local govt, education	$55,532,932.53	654	0	654	$0.00
Dairy cattle and milk production	$52,716,853.73	41	18	59	$3,941,499.94
Employment and payroll of federal govt, non-military	$52,572,679.84	477	0	477	$0.00
Search, detection, and navigation instruments manufacturing	$43,303,965.92	98	6	104	-$185,298.67
Limited-service restaurants	$40,134,064.33	416	16	432	$519,849.10

Table AD-1 Cont'd – Top 20 Industry Sectors Churchill Economic Development Authority 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Income**
Employment and payroll of local govt, other services	$38,968,903.31	436	0	436	$0.00
Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	$38,137,156.20	10	116	126	$10,914,147.76
Other real estate	$37,812,572.70	31	218	249	$3,022,961.53
Scientific research and development services	$32,778,607.75	106	53	159	$1,061,550.59
Tenant-occupied housing	$32,451,021.49	41	172	213	$2,463,507.72
Construction of other new residential structures	$31,961,446.42	82	16	98	$915,392.67
Electric power generation - Geothermal	$28,657,963.64	38	0	38	$0.00
Electric power transmission and distribution	$27,379,539.18	21	0	21	$0.00
TOTAL	**$4,283,893,790.36**	**18,772.00**	**5,779.00**	**24,551.00**	**$192,989,966.16**

Table AD-2 – Total Employment and Total Output by Commodity Produced by Industry Sector Churchill Economic Development Authority 2020		
Commodity Industry Sector	**Total Output**	**Total Employment**
Metal mining services	$9,880,605.50	27
Oil and gas extraction	$5,608,785.71	17
Other chemical and fertilizer mineral mining	$4,516,752.82	17
Other nonmetallic minerals services	$543,433.43	2
Support activities for oil and gas operations	$435,664.80	3
Drilling oil and gas wells	$311,258.92	2

Table AD-3 – Backward Linkage Recommendations for Top 3 Commodity Industry Sectors Churchill Economic Development Authority 2020						
Code	**Description**	**Gross Absorption**	**RPC**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Metal Mining Services						
3297	Scales, balances, and miscellaneous general purpose machinery	6.00%	0.00%	$592,678.33	0.00%	$0.11
3333	Storage batteries	17.72%	0.05%	$1,750,611.07	0.01%	$922.62
3323	Lighting fixtures	4.28%	0.00%	$422,976.92	0.00%	$0.12
3246	Spring and wire products	2.86%	0.07%	$283,016.93	0.00%	$208.51
Oil and Gas Extraction						
3459	Custom computer programming services	25.03%	7.60%	$1,403,727.19	1.90%	$106,617.54
3419	Pipeline transportation services	6.19%	3.31%	$347,048.53	0.21%	$11,500.56
3185	Other miscellaneous chemical products	2.21%	0.00%	$123,647.55	0.00%	$0.22
3218	Steel wire	1.55%	0.02%	$86,902.36	0.00%	$15.81
3252	Valve and fittings, other than plumbing	1.48%	0.05%	$82,734.36	0.00%	$37.65
Other Chemical and Fertilizer Mineral Mining						
3163	Other basic organic chemicals	2.99%	0.00%	$135,156.24	0.00%	$0.02
3215	Iron and steel and ferroalloy products	3.80%	0.02%	$171,586.76	0.00%	$38.01
3154	Refined petroleum products	1.85%	3.42%	$83,453.83	0.06%	$2,854.45
3034	Other nonmetallic minerals	1.75%	1.35%	$78,832.10	0.02%	$1,061.66

Table AD-4 – Backward Linkages, Metal Mining Services, Smallest RPC's Churchill Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Coal	0.00%	0.01%	$1,006.11	0.00%	$0.00
Dimension lumber	0.00%	0.31%	$30,574.51	0.00%	$0.00
Preserved wood products	0.00%	2.99%	$295,080.15	0.00%	$0.00
Paperboard from pulp	0.00%	0.00%	$431.45	0.00%	$0.00
Paperboard containers	0.00%	0.00%	$223.71	0.00%	$0.00
Petrochemicals	0.00%	2.75%	$271,436.82	0.00%	$0.00
Other basic organic chemicals	0.00%	1.46%	$144,213.27	0.00%	$0.02
Nitrogenous fertilizer	0.00%	0.00%	$141.49	0.00%	$0.00
Explosives	0.00%	0.58%	$57,563.05	0.00%	$0.00
Other miscellaneous chemical products	0.00%	0.01%	$1,256.56	0.00%	$0.00
Other plastics products	0.00%	0.00%	$219.33	0.00%	$0.00
Tires	0.00%	0.12%	$12,183.32	0.00%	$0.00
Cutlery, utensils, pots, and pans	0.00%	0.17%	$17,190.63	0.00%	$0.39
Handtools	0.00%	0.22%	$21,819.73	0.00%	$1.04
Heat treated products	0.00%	0.01%	$933.71	0.00%	$0.03
Coated and engraved products	0.00%	0.03%	$3,160.60	0.00%	$0.10
Electroplated, anodized, and colored metal	0.00%	0.02%	$2,203.70	0.00%	$0.08
Construction machinery	0.00%	0.03%	$3,239.04	0.00%	$0.05
Mining machinery	0.00%	0.08%	$8,116.21	0.00%	$0.00
Cutting tool and machine tool accessory	0.00%	1.25%	$123,773.00	0.00%	$0.00

Table AD-4 Cont'd – Backward Linkages, Metal Mining Services, Smallest RPC's Churchill Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Pump and pumping equipment	0.00%	0.05%	$4,895.64	0.00%	$0.00
Conveyor and conveying equipment	0.00%	0.04%	$4,278.14	0.00%	$0.00
Overhead cranes, hoists, and monorail systems	0.00%	0.01%	$689.09	0.00%	$0.03
Scales, balances, and miscellaneous general purpose machinery	0.00%	6.00%	$592,678.33	0.00%	$0.11

Table AD-5 – Backward Linkages, Oil and Gas, Smallest RPC's Churchill Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Coal	0.00%	0.05%	$2,690.65	0.00%	$0.00
Paperboard from pulp	0.00%	0.01%	$522.34	0.00%	$0.00
Paperboard containers	0.00%	0.02%	$1,071.21	0.00%	$0.01
Paper bags and coated and treated paper	0.00%	0.02%	$979.51	0.00%	$0.00
Petrochemicals	0.00%	1.11%	$62,155.72	0.00%	$0.00
Other basic organic chemicals	0.00%	0.46%	$25,558.12	0.00%	$0.00
Nitrogenous fertilizer	0.00%	0.00%	$0.00	0.00%	$0.00
Compounded resins	0.00%	0.10%	$5,440.91	0.00%	$0.00
Photographic films and chemicals	0.00%	0.00%	$7.68	0.00%	$0.00
Other miscellaneous chemical products	0.00%	2.21%	$123,647.55	0.00%	$0.22
Other plastics products	0.00%	0.05%	$2,750.69	0.00%	$0.06
Tires	0.00%	0.01%	$544.79	0.00%	$0.00
Abrasive products	0.00%	0.02%	$845.28	0.00%	$0.00
Handtools	0.00%	0.15%	$8,164.14	0.00%	$0.39
Heat treated products	0.00%	0.01%	$506.11	0.00%	$0.01
Coated and engraved products	0.00%	0.03%	$1,713.17	0.00%	$0.05
Electroplated, anodized, and colored metal	0.00%	0.02%	$1,194.49	0.00%	$0.05
Balls and roller bearings	0.00%	0.12%	$6,455.28	0.00%	$0.00
Construction machinery	0.00%	0.15%	$8,132.69	0.00%	$0.11
Mining machinery	0.00%	0.07%	$3,995.03	0.00%	$0.00

Table AD-5 Cont'd – Backward Linkages, Oil and Gas, Smallest RPC's Churchill Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Other commercial service industry machinery	0.00%	0.07%	$4,134.82	0.00%	$0.14
Cutting tool and machine tool accessory	0.00%	0.24%	$13,578.66	0.00%	$0.00
Other engine equipment	0.00%	0.16%	$9,216.08	0.00%	$0.00
Pump and pumping equipment	0.00%	0.11%	$6,353.06	0.00%	$0.00

Table AD-6 – Backward Linkages, Other Chemical and Fertilizer Mineral Mining, Smallest RPC's Churchill Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Coal	0.00%	0.54%	$24,564.44	0.00%	$0.00
Paperboard from pulp	0.00%	0.08%	$3,616.10	0.00%	$0.00
Paper bags and coated and treated paper	0.00%	0.09%	$4,003.93	0.00%	$0.02
Other basic organic chemicals	0.00%	2.99%	$135,156.24	0.00%	$0.02
Explosives	0.00%	0.98%	$44,154.01	0.00%	$0.00
Other miscellaneous chemical products	0.00%	0.26%	$11,502.97	0.00%	$0.02
Tires	0.00%	0.01%	$608.98	0.00%	$0.00
Rubber and plastics hoses and belts	0.00%	0.04%	$1,676.89	0.00%	$0.00
Heat treated products	0.00%	0.06%	$2,659.88	0.00%	$0.08
Coated and engraved products	0.00%	0.20%	$9,003.72	0.00%	$0.28
Electroplated, anodized, and colored metal	0.00%	0.14%	$6,277.77	0.00%	$0.24
Construction machinery	0.00%	0.50%	$22,665.37	0.00%	$0.32
Mining machinery	0.00%	0.07%	$2,919.40	0.00%	$0.00
Cutting tool and machine tool accessory	0.00%	0.03%	$1,485.54	0.00%	$0.00
Conveyor and conveying equipment	0.00%	0.11%	$5,019.77	0.00%	$0.00
Overhead cranes, hoists, and monorail systems	0.00%	0.02%	$871.51	0.00%	$0.04
Industrial trucks, trailers, and stackers	0.00%	0.02%	$1,094.58	0.00%	$0.00

Table AD-6 Cont'd – Backward Linkages, Other Chemical and Fertilizer Mineral Mining, Smallest RPC's Churchill Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Motor vehicle gasoline engines and engine parts	0.00%	0.11%	$5,097.40	0.00%	$0.02
Motor vehicle electrical and electronic equipment	0.00%	0.04%	$1,921.83	0.00%	$0.02
Motor vehicle transmission and power train parts	0.00%	0.28%	$12,460.09	0.00%	$0.00
Other motor vehicle parts	0.00%	0.52%	$23,370.24	0.00%	$0.05
Wholesale services - Motor vehicle and motor vehicle parts and supplies	0.00%	0.20%	$9,108.37	0.00%	$0.00
Travel arrangement and reservation services	0.00%	0.07%	$3,037.47	0.00%	$0.00
Noncomparable imports	0.00%	0.01%	$548.20	0.00%	$0.00

Table AD-7 – Forward Linkages Churchill Economic Development Authority 2020			
Description	**Average RPC**	**Average RSC**	**(RPC-RSC)/RSC**
Coal	0.00%	0.00%	0%
Copper, nickel, lead, and zinc ore	0.00%	0.00%	0%
Iron ore	0.00%	0.00%	0%
Gold ore	0.00%	0.00%	0%
Silver ore	0.00%	0.00%	0%
Uranium-radium-vanadium ore	0.00%	0.00%	0%
Other metal ore	0.00%	0.00%	0%
Other clay, ceramic, refractory minerals	0.40%	28.56%	-99%
Stone	1.25%	79.06%	-98%
Other nonmetallic minerals	1.35%	22.36%	-94%
Sand and gravel	3.21%	19.33%	-83%
Other chemical and fertilizer mineral	4.83%	2.05%	136%
Support activities for oil and gas operations	4.93%	72.13%	-93%
Potash, soda, and borate mineral	6.40%	89.78%	-93%
Oil and gas wells	8.05%	73.35%	-89%
Phosphate rock	8.21%	80.17%	-90%
Other nonmetallic minerals services	17.27%	68.32%	-75%
Natural gas and crude petroleum	47.00%	10.59%	344%
Metal mining services	60.40%	12.37%	388%

Appendix E: IMPLAN Results for the Lincoln County Regional Economic Development Authority

Table AE-1 – Top 10 Industry Sectors Lincoln County Regional Economic Development Authority 2020		
Description	**Total Employment**	**Total Output**
Owner-occupied dwellings	0	$23,459,918.48
*Employment, payroll of local gov., other services	179	$15,556,252.58
Wholesale - Petroleum and petroleum products	9	$14,841,847.47
Wired telecommunication carriers	31	$13,499,284.30
All other crop farming	230	$12,936,006.02
Other nonmetallic minerals	34	$11,686,266.47
Beef cattle ranching and farming, etc.	21	$10,285,972.39
Monetary authorities and depository credit int.	7	$9,840,543.11
Rail transportation	6	$8,192,290.55
Independent artists, writers, and performers	3	$7,807,710.61

Table AE-2 – Total Employment and Total Output by Commodity Produced by Industry Sector Lincoln County Regional Economic Development Authority 2020		
Description	**Total Employment**	**Total Output**
Other nonmetallic minerals	34	$11,686,266.46
Other nonmetallic minerals and services	8	$2,720,563.69
Oil and gas extraction	3	$942,952.55

Table AE-3 – Backward Linkages, Other Nonmetallic Minerals, Smallest RPC's Lincoln County Regional Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Coal	0.00%	0.342%	$39,994.43	0.00%	$0.00
Paperboard from pulp	0.00%	0.073%	$8,504.21	0.00%	$0.00
Explosives	0.00%	1.33%	$155,759.63	0.00%	$0.00
Tires	0.00%	0.036%	$4,251.23	0.00%	$0.00
Construction Machinery	0.00%	0.450%	$52,542.09	0.00%	$0.00

Table AE-4 – Backward Linkages, Other Nonmetallic Minerals and Services, Smallest RPC's Lincoln County Regional Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Coal	0.00%	0.246%	$6.692.10	0.00%	$0.00
Paperboard from pulp	0.00%	0.026%	$717.44	0.00%	$0.00
Petrochemicals	0.00%	2.425%	$65,968.30	0.00%	$0.00
Explosives	0.00%	0.370%	$10,075.73	0.00%	$0.00
Tires	0.00%	0.045%	$1,227.04	0.00%	$0.00

Table AE-5 – Backward Linkages, Oil and Gas Extraction, Smallest RPC's Lincoln County Regional Economic Development Authority 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Coal	0.00%	0.048%	$453.89	0.00%	$0.00
Paperboard from pulp	0.00%	0.009%	$88.12	0.00%	$0.00
Petrochemicals	0.00%	1.112%	$10,485.23	0.00%	$0.00
Photographic films and chemicals	0.00%	0.000%	$1.30	0.00%	$0.00
Tires	0.00%	0.010%	$91.90	0.00%	$0.00

Table AE-6 – Forward Linkages Lincoln County Regional Economic Development Authority 2020			
Description	**Average RPC**	**Average RSC**	**(RPC-RSC)/RSC**
Other clay, ceramic, refractory minerals	24.65%	0.84%	2830.24%
Other nonmetallic minerals	63.74%	7.02%	807.96%
Other nonmetallic minerals and services	99.24%	12.06%	723.08%
Natural gas and crude petroleum	0.20%	0.03%	479.27%
Sand and gravel	2.30%	4.58%	-49.74%
Stone	25.34%	89.21%	-71.60%
Phosphate rock	10.97%	98.48%	-88.86%
Potash, soda, and borate mineral	7.41%	99.00%	-92.51%
Other chemical and fertilizer mineral	0.06%	0.94%	-93.76%
Support activities for oil and gas operations	0.03%	99.76%	-99.97%
Metal mining services	0.00%	99.79%	-100.00%

Appendix F: IMPLAN Results for the Las Vegas Global Economic Alliance

Table AF-1 – Top Industry Sectors Las Vegas Global Economic Alliance 2020					
Industry Sector	**Total Employment**	**Total Output**	**Intermediate Inputs**	**Value Added**	**Labor Income**
Owner-occupied dwellings	0	$11,048,653,328.51	$2,372,132,640.92	$8,676,520,687.59	$0.00
Other real estate	56,996	$10,935,286,780.64	$6,592,623,019.09	$4,342,663,761.55	$1,445,651,385.27
Hotels and motels, including casino hotels	70,816	$7,677,745,741.68	$2,079,586,804.99	$5,598,158,936.69	$3,868,134,143.86
Management of companies and enterprises	24,882	$5,777,107,432.50	$2,172,212,068.81	$3,604,895,363.69	$2,972,814,487.10
Hospitals	22,761	$4,567,004,701.85	$2,000,532,240.04	$2,566,472,461.81	$2,202,037,742.05
Tenant-occupied housing	12,830	$4,125,965,970.26	$519,571,571.18	$3,606,394,399.09	$320,095,797.11
Limited-service restaurants	41,719	$4,031,148,615.08	$1,851,560,028.52	$2,179,588,586.56	$967,696,882.28
*Employment and payroll of local govt, education	39,501	$3,652,565,166.81	$0.00	$3,652,565,166.81	$3,007,480,121.44
Nondepository credit intermediation and related activities	12,598	$3,577,928,126.14	$1,191,791,455.03	$2,386,136,671.11	$1,545,724,284.25

Table AF-2 – Commodity Industry Demand Las Vegas Global Economic Alliance 2020			
Description	**Gross Absorption**	**Regional Absorption**	**Total Leakage**
Sand and Gravel Mining	$74,260,402.26	$37,643,395.26	$36,617,007
Metal Mining Services	$136,045.85	$30,244.14	$105,801.71
Other chemical and fertilizer mineral mining	$1,004,853.48	$63,435.53	$941,417.95

Appendix G: IMPLAN Results for the Nevada 95-80 Regional Development Authority

Table AG-1 – Top 20 Industry Sectors Nevada 95-80 Regional Development Authority 2020	
Industry Sector	**Total Output**
Gold ore mining	$1,210,668,865.05
Metal mining services	$136,234,985.33
Owner-occupied dwellings	$116,989,819.03
Electric power transmission and distribution	$89,677,064.07
All other crop farming	$89,120,794.71
* Employment and payroll of local govt, education	$66,385,693.28
Construction of new power and communication structures	$57,618,490.01
Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	$53,775,486.84
* Employment and payroll of local govt, hospitals and health services	$52,783,030.62
Wholesale - Petroleum and petroleum products	$48,373,341.87
Silver ore mining	$47,639,220.75
Other real estate	$41,258,823.89
* Employment and payroll of local govt, other services	$36,020,417.61
Other basic inorganic chemical manufacturing	$34,510,839.92
Electric power generation - Fossil fuel	$34,460,130.42
Limited-service restaurants	$33,119,326.36
Plastics pipe and pipe fitting manufacturing	$30,600,378.84
* Employment and payroll of state govt, other services	$30,176,256.98
Wireless telecommunications carriers (except satellite)	$27,442,362.94
Retail - General merchandise stores	$25,812,321.53

Table AG-2 – Total Output and Employment for Mining Commodities Nevada 95-80 Regional Development Authority 2020		
Description	**Total Employment**	**Total Output**
Gold ore mining	2,245	$1,210,668,865.05
Metal mining services	333	$136,234,985.33
Silver ore mining	85	$47,639,220.75
Other nonmetallic minerals	52	$18,873,044.17
Stone mining and quarrying	20	$13,912,132.98
Oil and gas extraction	36	$12,338,364.35
Other chemical and fertilizer mineral mining	27	$10,221,639.10
Other nonmetallic minerals services	7	$2,803,552.79
Drilling oil and gas wells	6	$1,959,790.49
Support activities for oil and gas operations	3	$473,850.75

Table AG-3 – Backward Linkage of Gold Ore Mining Nevada 95-80 Regional Development Authority 2020			
Description	**RPC**	**Gross Absorption**	**Gross Inputs**
Coal	0.00%	0.04%	$516,552.11
Iron ore	0.00%	0.00%	$8,197.81
Other metal ore	0.00%	0.00%	$3,060.93
Preserved wood products	0.00%	0.03%	$413,353.52
Paperboard from pulp	0.00%	0.05%	$655,051.66
Paperboard containers	0.00%	0.12%	$1,436,046.20
Other basic organic chemicals	0.00%	1.78%	$21,559,836.75
Explosives	0.00%	0.88%	$10,703,106.68
Tires	0.00%	2.95%	$35,655,693.84
Iron and steel and ferroalloy products	0.00%	0.53%	$6,436,982.53

Table AG-4 – Backward Linkage of Silver Ore Mining Nevada 95-80 Regional Development Authority 2020			
Description	**RPC**	**Gross Absorption**	**Gross Inputs**
Coal	0.00%	0.04%	$19,826.22
Iron ore	0.00%	0.00%	$314.65
Other metal ore	0.00%	0.00%	$117.48
Preserved wood products	0.00%	0.03%	$15,865.27
Paperboard from pulp	0.00%	0.05%	$25,142.09
Paperboard containers	0.00%	0.12%	$55,118.10
Other basic organic chemicals	0.00%	1.74%	$827,506.31
Explosives	0.00%	0.86%	$410,805.03
Tires	0.00%	2.87%	$1,368,531.47
Iron and steel and ferroalloy products	0.00%	0.52%	$247,063.31

Table AG-5 – Forward Linkage of Mining Commodities Nevada 95-80 Regional Development Authority 2020			
Description	**Average RPC (Demand)**	**Average RSC (Supply)**	**(RPC-RSC)/RSC**
Silver ore	99.93%	5.31%	1782%
Gold ore	99.66%	9.12%	993%
Copper, nickel, lead, and zinc ore	98.83%	1.32%	7387%
Stone	98.14%	20.09%	389%
Metal mining services	97.84%	35.30%	177%

Appendix H: IMPLAN Results for the Northern Nevada Development Authority

Table AH-1 – Top 5 Industry Sectors Northern Nevada Development Authority 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Employment**
Storage battery manufacturing	$1,367,610,068.43	3,550	79	3,629	$1,168,953.19
Owner-occupied dwellings	$882,074,144.45	0	0	-	$0.00
Other real estate	$768,589,495.86	513	4367	4,880	$59,852,999.53
*Employment and payroll of state govt, other services	$727,622,403.04	6,727	0	6,727	$0.00
Warehousing and storage	$488,204,056.32	4,923	12	4,935	$420,606.43
Totals (All Industry Sectors)	**$4,283,893,790.36**	**74,697**	**24,887**	**99,584**	**$736,334,611.23**

Table AH-2 – Total Employment and Total Output by Commodity Produced by Industry Sector Northern Nevada Development Authority 2020		
Commodity Industry Sector	**Total Output**	**Total Employment**
Metal mining services	$105,420,515.62	247
Gold ore mining	$81,998,006.22	172
Oil and gas extraction	$76,467,365.01	225
Copper, nickel, lead, and zinc mining	$66,726,778.35	144
Sand and gravel mining	$36,329,130.94	103
Other nonmetallic minerals	$22,445,209.77	57
Silver ore mining	$15,779,202.67	27
Other clay, ceramic, refractory minerals mining	$9,109,939.69	23
Other nonmetallic minerals services	$7,282,724.35	24
Stone mining and quarrying	$7,207,183.49	13
Other metal ore mining	$6,071,718.54	14
Support activities for oil and gas operations	$4,421,951.39	30
Drilling oil and gas wells	$4,170,071.48	17

Table AH-3 – Backward Linkage Recommendations for Top Commodity Industry Sectors Northern Nevada Development Authority 2020						
Code	**Description**	**Gross Absorption**	**RPC**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Metal Mining Services						
3538	Noncomparable imports	0.00%	1.08%	$1,133,068.87	0.00%	$0.00
3163	Other basic organic chemicals	0.04%	1.27%	$1,336,004.54	0.00%	$568.53
3323	Lighting fixtures	0.01%	3.72%	$3,918,495.88	0.00%	$216.59
3297	Scales, balances, and miscellaneous general purpose machinery	0.10%	5.21%	$5,490,624.86	0.01%	$5,754.39
Gold Ore Mining						
3163	Other basic organic chemicals	0.04%	2.01%	$1,650,182.17	0.00%	$702.22
3194	Tires	0.04%	3.33%	$2,729,074.02	0.00%	$1,162.30
3160	Industrial gases	0.73%	3.65%	$2,995,359.22	0.03%	$21,892.55
3208	Lime	1.12%	5.77%	$4,731,747.10	0.07%	$52,936.52
Oil and Gas Extraction						
3215	Iron and steel and ferroalloy products	0.12%	1.39%	$1,060,462.45	0.00%	$1,302.84
3218	Steel wire	0.01%	1.55%	$1,186,109.01	0.00%	$159.61
Copper, Nickel, Lead, and Zinc						
3194	Tires	0.04%	1.97%	$1,313,529.22	0.00%	$559.43

Appendix I: IMPLAN Results for the Northeastern Nevada Regional Development Authority

Table AI-1 – Top 20 Industry Sectors Northeastern Nevada Regional Development Authority 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Employment**
Gold ore mining	$4,236,361,632.97	7,005	711	7,716	-$122,249.60
Metal mining services	$557,633,175.80	1,269	56	1,324	$6,787,432.54
Wholesale - Petroleum and petroleum products	$448,600,609.88	220	21	241	$265,246.00
Owner-occupied dwellings	$368,621,838.03	0	0	0	$0.00
Copper, nickel, lead, and zinc mining	$353,161,666.73	599	18	617	-$28,192.67
Electric power transmission and distribution	$257,059,443.34	185	4	189	$259,585.92
Construction of new power and communication structures	$227,054,268.89	609	64	673	$2,424,410.07
Lighting fixture manufacturing	$198,612,525.59	611	0	611	$0.00
Wholesale - Machinery, equipment, and supplies	$191,869,718.68	579	64	643	$283,173.27
Hotels and motels, including casino hotels	$183,165,825.74	2,115	13	2,127	$2,152,306.86
Other real estate	$149,848,056.89	170	732	902	$7,048,860.50
*Employment and payroll of local govt, education	$145,036,209.39	1,510	0	1,510	$0.00
*Employment and payroll of local govt, other services	$126,065,542.87	1,472	0	1,472	$0.00

Table AI-1 Cont'd – Top 20 Industry Sectors Northeastern Nevada Regional Development Authority 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Employment**
Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	$121,053,436.08	37	206	243	$12,481,455.89
Management of companies and enterprises	$118,467,480.63	187	131	317	-$48,710.05
Limited-service restaurants	$100,508,893.26	1,009	41	1,050	$483,163.21
*Employment and payroll of state govt, other services	$94,445,497.62	852	0	852	$0.00
Monetary authorities and depository credit intermediation	$85,048,527.21	206	14	221	$830,432.20
All other crop farming	$84,462,247.45	386	454	840	$10,503,184.18
Construction of other new residential structures	$81,755,800.76	194	35	230	$3,032,328.11
Total (All Industry Sectors)	**$10,906,830,201.30**	**34,917**	**7,394**	**42,311**	**$142,399,968.21**

Table AI-2 – Total Employment and Total Output by Commodity Produced by Industry Sector Northeastern Nevada Regional Development Authority 2020		
Commodity Industry Sector	**Total Output**	**Total Employment**
Gold ore mining	$4,236,361,632.97	7,716
Metal mining services	$557,633,175.80	1,324
Copper, nickel, lead, and zinc mining	$353,161,666.73	617
Other chemical and fertilizer mineral mining	$48,169,041.41	123
Stone mining and quarrying	$46,590,515.24	61
Other nonmetallic minerals	$37,688,452.79	91
Oil and gas extraction	$31,470,770.43	92
Sand and gravel mining	$18,378,867.48	54
Support activities for agriculture and forestry	$9,026,698.47	432
Other nonmetallic minerals services	$8,764,960.01	24
Support activities for oil and gas operations	$2,245,560.42	15
Drilling oil and gas wells	$1,621,437.09	6
Other metal ore mining	$1,140,146.72	3

Table AI-3 – Backward Linkages, Gold Ore Mining Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Lime	0.03%	5.02%	$212,515,989.70	0.00%	$54,218.30	$212,461,771.40
Industrial gases	3.49%	3.18%	$134,529,955.88	0.11%	$4,698,162.93	$129,831,792.95
Tires	0.00%	2.89%	$122,570,343.37	0.00%	$138.77	$122,570,204.60
Refined petroleum products	6.44%	2.06%	$87,445,891.88	0.13%	$5,632,741.72	$81,813,150.16
Other basic organic chemicals	0.00%	1.75%	$74,114,294.47	0.00%	$213.99	$74,114,080.48
Legal services	14.77%	1.53%	$64,650,861.89	0.23%	$9,549,882.53	$55,100,979.36
Wholesale services - Motor vehicle and motor vehicle parts and supplies	6.17%	1.25%	$53,035,636.14	0.08%	$3,274,334.46	$49,761,301.68
Explosives	0.00%	0.87%	$36,793,098.65	0.00%	$0.00	$36,793,098.65
Petrochemicals	0.01%	0.83%	$35,295,658.79	0.00%	$2,875.14	$35,292,783.65
Truck transportation services	32.34%	1.18%	$49,965,803.15	0.38%	$16,158,162.14	$33,807,641.01
Monetary authorities and depository credit intermediation	31.48%	0.93%	$39,408,547.44	0.29%	$12,406,968.60	$27,001,578.84
Other basic inorganic chemicals	3.61%	0.63%	$26,762,100.85	0.02%	$965,699.40	$25,796,401.45
Turned products and screws, nuts, and bolts	0.15%	0.59%	$24,854,159.06	0.00%	$38,451.79	$24,815,707.27
Insurance agencies, brokerages, and related services	42.43%	0.96%	$40,811,262.46	0.41%	$17,315,523.25	$23,495,739.21
Iron and steel and ferroalloy products	0.00%	0.52%	$22,127,830.74	0.00%	$162.41	$22,127,668.33

Table AI-3 Cont'd – Backward Linkages, Gold Ore Mining Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Services to buildings	31.65%	0.72%	$30,689,287.67	0.23%	$9,712,708.14	$20,976,579.53
Other motor vehicle parts	0.00%	0.46%	$19,371,719.87	0.00%	$300.55	$19,371,419.32
Other insurance	0.05%	0.46%	$19,285,659.78	0.00%	$9,463.03	$19,276,196.75
Coated and engraved products	0.01%	0.44%	$18,812,904.15	0.00%	$1,138.83	$18,811,765.32
Maintained and repaired nonresidential structures	52.08%	0.92%	$39,027,791.47	0.48%	$20,325,847.72	$18,701,943.75

Table AI-4 – Backward Linkages, Metal Mining Services Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Storage batteries	0.06%	15.65%	$87,243,690.74	0.01%	$52,904.93	$87,190,785.81
Scales, balances, and miscellaneous general purpose machinery	0.00%	5.30%	$29,536,797.79	0.00%	$816.90	$29,535,980.89
Lighting fixtures	0.87%	3.78%	$21,079,535.27	0.03%	$183,549.40	$20,895,985.87
All other miscellaneous wood products	0.27%	3.57%	$19,883,567.46	0.01%	$53,595.08	$19,829,972.38
Travel arrangement and reservation services	0.00%	2.70%	$15,031,761.75	0.00%	$0.00	$15,031,761.75
Preserved wood products	0.00%	2.64%	$14,705,654.51	0.00%	$0.00	$14,705,654.51
Spring and wire products	0.00%	2.53%	$14,104,470.35	0.00%	$471.97	$14,103,998.38
Petrochemicals	0.01%	2.43%	$13,527,362.32	0.00%	$1,101.92	$13,526,260.40
Truck transportation services	32.34%	3.12%	$17,403,098.42	1.01%	$5,627,890.84	$11,775,207.58
Air transportation services	12.13%	2.37%	$13,230,636.22	0.29%	$1,604,884.20	$11,625,752.02
Leasing of nonfinancial intangible assets	2.40%	1.53%	$8,510,966.14	0.04%	$204,143.56	$8,306,822.58
Sheet metal work (except stampings)	0.02%	1.46%	$8,137,786.24	0.00%	$1,565.03	$8,136,221.21
Other amusement and recreation	39.39%	2.37%	$13,229,729.02	0.93%	$5,210,777.54	$8,018,951.48
Maintained and repaired nonresidential structures	52.08%	2.72%	$15,170,671.39	1.42%	$7,900,953.26	$7,269,718.13
Other basic organic chemicals	0.00%	1.29%	$7,187,031.87	0.00%	$20.75	$7,187,011.12

Table AI-4 Cont'd – Backward Linkages, Metal Mining Services Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Monetary authorities and depository credit intermediation	31.48%	1.66%	$9,268,519.76	0.52%	$2,918,002.34	$6,350,517.42
Cutting tool and machine tool accessory	0.01%	1.11%	$6,168,368.10	0.00%	$629.17	$6,167,738.93
Noncomparable imports	0.00%	1.09%	$6,095,340.13	0.00%	$0.00	$6,095,340.13
Industrial gases	3.49%	0.91%	$5,078,211.38	0.03%	$177,345.37	$4,900,866.01

Table AI-5 – Backward Linkages, Wholesale and Petroleum and Petroleum Products Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Other insurance	0.05%	0.52%	$2,318,158.92	0.00%	$1,137.47	$2,317,021.45
Business support services	46.08%	0.72%	$3,214,828.38	0.33%	$1,481,452.83	$1,733,375.55
Other real estate services	55.75%	0.81%	$3,609,752.03	0.45%	$2,012,514.72	$1,597,237.31
Management of companies and enterprises	75.32%	1.06%	$4,773,103.38	0.80%	$3,595,027.34	$1,178,076.04
Warehousing and storage services	18.93%	0.32%	$1,439,182.67	0.06%	$272,508.72	$1,166,673.95
Automotive equipment rental and leasing services	12.65%	0.26%	$1,144,377.33	0.03%	$144,761.69	$999,615.64
Advertising, public relations, and related services	15.52%	0.25%	$1,120,610.63	0.04%	$173,863.92	$946,746.71
Legal services	14.77%	0.23%	$1,021,268.76	0.03%	$150,856.41	$870,412.35
Other textile products	0.01%	0.15%	$692,866.03	0.00%	$68.70	$692,797.33
Noncomparable imports	0.00%	0.13%	$597,377.02	0.00%	$0.00	$597,377.02
Wholesale services - Professional and commercial equipment and supplies	0.28%	0.13%	$580,265.24	0.00%	$1,620.82	$578,644.42
Monetary authorities and depository credit intermediation	31.48%	0.19%	$835,379.60	0.06%	$263,002.04	$572,377.56
Wireless telecommunications (except satellite)	0.05%	0.12%	$515,325.04	0.00%	$250.53	$515,074.51
Specialized design services	2.02%	0.11%	$511,965.27	0.00%	$10,318.22	$501,647.05
Wholesale services - Drugs and druggists	6.70%	0.11%	$492,976.17	0.01%	$33,037.18	$459,938.99
Electronic and precision equipment repair and maintenance	15.54%	0.12%	$522,847.90	0.02%	$81,241.82	$441,606.08

Table AI-5 Cont'd – Backward Linkages, Wholesale and Petroleum and Petroleum Products Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Insurance agencies, brokerages, and related services	42.43%	0.17%	$754,870.01	0.07%	$320,278.48	$434,591.53
US Postal delivery services	57.22%	0.23%	$1,010,494.51	0.13%	$578,238.32	$432,256.19

Table AI-6 – Backward Linkages, Copper, Nickel, Lead, Zinc Mining Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Custom computer programming services	5.42%	11.56%	$40,817,709.82	0.63%	$2,212,479.10	$38,605,230.72
Refined petroleum products	6.44%	2.28%	$8,038,783.83	0.15%	$517,810.41	$7,520,973.42
Tires	0.00%	1.60%	$5,637,430.67	0.00%	$6.38	$5,637,424.29
Maintained and repaired nonresidential structures	52.08%	1.66%	$5,860,274.60	0.86%	$3,052,057.13	$2,808,217.47
Explosives	0.00%	0.78%	$2,769,168.34	0.00%	$0.00	$2,769,168.34
Natural gas distribution	48.73%	1.35%	$4,773,005.34	0.66%	$2,326,020.49	$2,446,984.85
Other insurance	0.05%	0.67%	$2,377,306.96	0.00%	$1,166.49	$2,376,140.47
Industrial gases	3.49%	0.62%	$2,203,830.50	0.02%	$76,963.93	$2,126,866.57
Lime	0.03%	0.57%	$1,996,648.65	0.00%	$509.40	$1,996,139.25
Mining machinery	0.00%	0.54%	$1,922,091.34	0.00%	$32.50	$1,922,058.84
Truck transportation services	32.34%	0.79%	$2,805,234.37	0.26%	$907,169.08	$1,898,065.29
Wholesale services - Motor vehicle and motor vehicle parts and supplies	6.17%	0.55%	$1,942,387.42	0.03%	$119,919.86	$1,822,467.56
Other basic organic chemicals	0.00%	0.45%	$1,577,682.48	0.00%	$4.56	$1,577,677.92
Architectural, engineering, and related services	41.70%	0.59%	$2,070,576.38	0.25%	$863,517.77	$1,207,058.61
Construction machinery	0.01%	0.34%	$1,205,285.60	0.00%	$97.32	$1,205,188.28
Legal services	14.77%	0.39%	$1,385,690.18	0.06%	$204,686.81	$1,181,003.37
Iron and steel and ferroalloy products	0.00%	0.32%	$1,126,368.89	0.00%	$8.27	$1,126,360.62
Management of companies and enterprises	75.32%	1.21%	$4,255,338.11	0.91%	$3,205,054.58	$1,050,283.53

Table AI-6 Cont'd – Backward Linkages, Copper, Nickel, Lead, Zinc Mining Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Wholesale services - Machinery, equipment, and supplies	82.26%	1.57%	$5,548,468.56	1.29%	$4,563,934.90	$984,533.66
Services to buildings	31.65%	0.28%	$975,116.64	0.09%	$308,610.08	$666,506.56

Table AI-7 – Backward Linkages, Electric Power Transmission and Distribution Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Electricity	59.96%	52.19%	$134,160,968.23	31.30%	$80,447,267.87	$53,713,700.36
Refined petroleum products	6.44%	0.00%	$1,839.60	0.00%	$118.50	$1,721.10
Marketing research and all other miscellaneous professional, scientific, and technical services	10.85%	0.00%	$907.15	0.00%	$98.39	$808.76
Monetary authorities and depository credit intermediation	31.48%	0.00%	$900.19	0.00%	$283.41	$616.78
Legal services	14.77%	0.00%	$664.79	0.00%	$98.20	$566.59
Scientific research and development services	29.05%	0.00%	$775.05	0.00%	$225.15	$549.90
Other products and services of State Govt enterprises	1.59%	0.00%	$548.22	0.00%	$8.69	$539.53
Truck transportation services	32.34%	0.00%	$598.92	0.00%	$193.68	$405.24
Pipeline transportation services	11.52%	0.00%	$367.51	0.00%	$42.33	$325.18
Data processing, hosting, and related services	10.77%	0.00%	$355.92	0.00%	$38.32	$317.60
Water, sewage and other systems	86.80%	0.00%	$2,245.16	0.00%	$1,948.70	$296.46
Other real estate services	55.75%	0.00%	$550.55	0.00%	$306.94	$243.61
Advertising, public relations, and related services	15.52%	0.00%	$279.01	0.00%	$43.29	$235.72

Table AI-7 Cont'd – Backward Linkages, Electric Power Transmission and Distribution Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Scenic and sightseeing transportation services and support activities for transportation	66.96%	0.00%	$663.32	0.00%	$444.15	$219.17
Noncomparable imports	0.00%	0.00%	$178.55	0.00%	$0.00	$178.55
Other basic organic chemicals	0.00%	0.00%	$135.60	0.00%	$0.00	$135.60
Wired telecommunications	16.57%	0.00%	$152.51	0.00%	$25.27	$127.24
Employment services	93.61%	0.00%	$1,965.06	0.00%	$1,839.44	$125.62

Table AI-8 – Backward Linkages, Construction of New Power and Communication Structures Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Architectural, engineering, and related services	41.70%	1.49%	$3,377,142.45	0.62%	$1,408,410.98	$1,968,731.47
Prefabricated metal buildings and components	0.01%	0.86%	$1,941,221.10	0.00%	$143.14	$1,941,077.96
Refined petroleum products	6.44%	0.65%	$1,484,222.48	0.04%	$95,604.74	$1,388,617.74
Turned products and screws, nuts, and bolts	0.15%	0.53%	$1,199,528.26	0.00%	$1,855.79	$1,197,672.47
Fabricated structural metal products	0.01%	0.46%	$1,043,696.48	0.00%	$152.61	$1,043,543.87
Ready-mix concrete	27.67%	0.63%	$1,423,614.54	0.17%	$393,846.85	$1,029,767.69
Wholesale services - Other durable goods merchant wholesalers	59.11%	1.05%	$2,375,286.59	0.62%	$1,403,986.05	$971,300.54
Commercial and industrial machinery and equipment rental and leasing services	72.48%	1.27%	$2,886,179.57	0.92%	$2,091,801.96	$794,377.61
Truck transportation services	32.34%	0.46%	$1,044,867.21	0.15%	$337,893.77	$706,973.44
Plastics pipes and pipe fittings	0.02%	0.25%	$575,371.38	0.00%	$98.06	$575,273.32
Other plastics products	0.01%	0.25%	$572,590.32	0.00%	$71.50	$572,518.82
Wholesale services - Household appliances and electrical and electronic goods	41.25%	0.43%	$972,590.46	0.18%	$401,204.90	$571,385.56
Other communication and energy wires	0.00%	0.24%	$537,913.58	0.00%	$10.96	$537,902.62

Table AI-8 Cont'd – Backward Linkages, Construction of New Power and Communication Structures Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Dimension lumber	0.00%	0.22%	$496,053.59	0.00%	$21.78	$496,031.81
Legal services	14.77%	0.24%	$544,325.09	0.04%	$80,404.82	$463,920.27
Other real estate services	55.75%	0.43%	$984,944.25	0.24%	$549,127.69	$435,816.56
Petroleum lubricating oil and grease	0.13%	0.19%	$421,709.57	0.00%	$528.53	$421,181.04
Metal windows and doors	0.02%	0.18%	$406,891.18	0.00%	$76.72	$406,814.46

Table AI-9 – Backward Linkages, Wholesale Machinery, Equipment, and Supplies Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Advertising, public relations, and related services	15.52%	2.05%	$3,938,759.65	0.32%	$611,102.70	$3,327,656.95
Other real estate services	55.75%	3.75%	$7,187,952.09	2.09%	$4,007,438.53	$3,180,513.56
Warehousing and storage services	18.93%	1.75%	$3,347,407.51	0.33%	$633,830.40	$2,713,577.11
Management consulting services	7.70%	1.42%	$2,722,365.12	0.11%	$209,739.56	$2,512,625.56
Management of companies and enterprises	75.32%	4.05%	$7,769,870.57	3.05%	$5,852,145.85	$1,917,724.72
Other insurance	0.05%	0.94%	$1,800,543.21	0.00%	$883.49	$1,799,659.72
Wholesale services - Drugs and druggists sundries	6.70%	0.78%	$1,499,733.33	0.05%	$100,505.78	$1,399,227.55
Wholesale services - Professional and commercial equipment and supplies	0.28%	0.66%	$1,268,300.69	0.00%	$3,542.66	$1,264,758.03
Legal services	14.77%	0.74%	$1,420,666.99	0.11%	$209,853.40	$1,210,813.59
Wireless telecommunications (except satellite)	0.05%	0.61%	$1,160,333.11	0.00%	$564.11	$1,159,769.00
Wholesale services - Wholesale electronic markets and agents and brokers	26.12%	0.64%	$1,230,801.38	0.17%	$321,428.53	$909,372.85
Nondepository credit intermediation and related activities	17.49%	0.57%	$1,096,657.35	0.10%	$191,837.50	$904,819.85
Accounting, tax preparation, bookkeeping, and payroll services	49.23%	0.91%	$1,742,402.62	0.45%	$857,789.82	$884,612.80
Data processing, hosting, and related services	10.77%	0.43%	$825,697.49	0.05%	$88,888.45	$736,809.04
Plates	0.04%	0.37%	$713,468.24	0.00%	$255.04	$713,213.20

Table AI-9 Cont'd – Backward Linkages, Wholesale Machinery, Equipment, and Supplies Northeastern Nevada Regional Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Monetary authorities and depository credit intermediation	31.48%	0.53%	$1,017,354.92	0.17%	$320,293.22	$697,061.70
Other computer related services, including facilities management services	11.94%	0.41%	$781,675.90	0.05%	$93,340.88	$688,335.02
Semiconductors and related devices	0.01%	0.35%	$676,543.60	0.00%	$79.49	$676,464.11

Table AI-10 – Forward Linkages, Mining and Natural Resource Extraction Sectors (All) Northeastern Nevada Regional Development Authority 2020		
Description	**Average RPC**	**Average RSC**
Coal	0.00%	0.00%
Iron ore	19.94%	0.09%
Other chemical and fertilizer mineral	10.42%	1.61%
Copper, nickel, lead, and zinc ore	99.34%	2.38%
Other nonmetallic minerals	59.79%	7.84%
Other clay, ceramic, refractory minerals	37.20%	8.53%
Gold ore	99.32%	8.93%
Silver ore	99.08%	10.89%
Sand and gravel	32.55%	13.13%
Other metal ore	36.98%	17.36%
Stone	95.13%	18.31%
Natural gas and crude petroleum	30.06%	20.10%
Metal mining services	99.22%	29.81%
Uranium-radium-vanadium ore	92.68%	37.78%
Other nonmetallic minerals services	52.75%	52.65%
Phosphate rock	7.86%	72.74%
Potash, soda, and borate mineral	6.33%	88.34%
Oil and gas wells	14.24%	95.90%
Support activities for oil and gas operations	8.79%	96.54%

Appendix J: IMPLAN Results for the Southwest Central Regional Economic Development Authority

Table AJ-1 – Top 20 Industry Sectors Southwest Central Regional Economic Development Authority 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Employment**
Gold ore mining	$593,602,529.30	952	198	1,150	-$8,824.95
Scientific research and development services	$388,270,388.86	1,269	477	1,745	$5,570,482.66
Owner-occupied dwellings	$212,508,307.12	0	0	0	$0.00
Electric power transmission and distribution	$179,431,828.76	133	0	133	$74,324.78
Other real estate	$114,647,490.85	104	666	770	$5,390,421.25
Facilities support services	$106,825,438.48	291	185	477	$3,319,328.52
* Employment and payroll of local govt, other services	$70,912,844.76	717	0	717	$0.00
Other clay, ceramic, refractory minerals mining	$66,389,359.75	152	8	159	-$29,410.97
Hospitals	$54,756,090.53	346	1	347	-$399,561.71
Retail - Nonstore retailers	$54,117,859.55	86	247	333	$671,576.67
* Employment and payroll of local govt, education	$51,758,532.00	786	0	786	$0.00
Limited-service restaurants	$47,314,878.33	479	30	509	$531,890.90
Metal mining services	$43,515,744.45	97	21	118	$777,325.04
Construction of new power and communication structures	$39,264,865.52	126	30	156	$702,870.73
Investigation and security services	$35,131,986.68	285	117	402	$2,117,840.69
Petroleum refineries	$35,120,267.65	3	8	11	$286,046.81
Automobile manufacturing	$34,884,153.29	28	3	31	$126,951.71

Table AJ-1 Cont'd – Top 20 Industry Sectors Southwest Central Regional Economic Development Authority 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Employment**
Retail - General merchandise stores	$34,303,876.89	380	9	389	$58,118.92
Hotels and motels, including casino hotels	$33,791,636.51	413	9	422	$2,460,919.76
Gambling industries (except casino hotels)	$32,777,257.02	347	11	358	$1,372,906.12
Total (All Industry Sectors)	**$2,229,325,336.30**	**13,152**	**4,874**	**18,025**	**$97,094,222.16**

Table AJ-2 – Total Employment and Total Output by Commodity Produced by Industry Sector Southwest Central Regional Economic Development Authority 2020		
Commodity Industry Sector	**Total Output**	**Total Employment**
Gold ore mining	$593,602,529.30	1150
Other clay, ceramic, refractory minerals mining	$66,389,359.75	159
Metal mining services	$43,515,744.45	118
Stone mining and quarrying	$12,647,591.30	19
Oil and gas extraction	$10,945,494.37	32
Other chemical and fertilizer mineral mining	$7,588,727.06	20
Other nonmetallic minerals	$6,636,253.14	19
Other nonmetallic minerals services	$1,137,936.84	4
Drilling oil and gas wells	$658,383.91	2
Support activities for oil and gas operations	$537,156.68	4

Table AJ-3 – Backward Linkages, Gold Ore Mining Southwest Central Regional Economic Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Tires	0.00%	3.08%	$18,270,423.25	0.00%	$0.00	$18,270,423.25
Other basic organic chemicals	0.00%	1.86%	$11,047,529.86	0.00%	$47.52	$11,047,482.34
Explosives	0.00%	0.92%	$5,484,405.66	0.00%	$0.00	$5,484,405.66
Iron and steel and ferroalloy products	0.00%	0.56%	$3,298,390.31	0.00%	$45.68	$3,298,344.63
Coated and engraved products	0.00%	0.47%	$2,804,264.98	0.00%	$44.60	$2,804,220.38
Conveyor and conveying equipment	0.00%	0.29%	$1,711,826.73	0.00%	$15.47	$1,711,811.26
Motor vehicle transmission and power train parts	0.00%	0.23%	$1,337,264.13	0.00%	$0.09	$1,337,264.04
Motor vehicle gasoline engines and engine parts	0.00%	0.17%	$1,003,355.32	0.00%	$6.50	$1,003,348.82
Motor vehicle electrical and electronic equipment	0.00%	0.10%	$599,928.28	0.00%	$0.00	$599,928.28
Fabricated structural metal products	0.00%	0.07%	$427,282.98	0.00%	$4.94	$427,278.04
Paperboard from pulp	0.00%	0.06%	$335,656.66	0.00%	$0.00	$335,656.66
Coal	0.00%	0.05%	$264,687.76	0.00%	$0.00	$264,687.76
Scales, balances, and miscellaneous general purpose machinery	0.00%	0.04%	$226,600.90	0.00%	$0.59	$226,600.31
Preserved wood products	0.00%	0.04%	$211,807.51	0.00%	$0.67	$211,806.84
Noncomparable imports	0.00%	0.03%	$177,404.38	0.00%	$0.00	$177,404.38
Ferrous metals	0.00%	0.03%	$177,047.52	0.00%	$0.00	$177,047.52

Table AJ-3 Cont'd – Backward Linkages, Gold Ore Mining Southwest Central Regional Economic Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Other miscellaneous chemical products	0.00%	0.02%	$119,720.68	0.00%	$0.38	$119,720.30
Dimension lumber	0.00%	0.00%	$21,946.28	0.00%	$0.68	$21,945.60
Other metal ore	0.00%	0.00%	$1,568.46	0.00%	$0.00	$1,568.46

Table AJ-4 – Backward Linkages, Other Clay, Ceramic, Refractory Minerals Mining Southwest Central Regional Economic Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Other financial investment services	17.21%	4.70%	$3,117,853.04	0.81%	$536,655.72	$2,581,197.32
Maintained and repaired nonresidential structures	63.04%	3.32%	$2,206,014.10	2.10%	$1,390,668.50	$815,345.60
Other basic organic chemicals	0.00%	3.06%	$2,033,486.22	0.00%	$8.75	$2,033,477.47
Management of companies and enterprises	18.95%	2.92%	$1,937,540.45	0.55%	$367,123.97	$1,570,416.48
Other nonmetallic minerals services	33.97%	2.23%	$1,477,423.71	0.76%	$501,862.98	$975,560.73
Other nonmetallic minerals	63.52%	2.10%	$1,391,559.34	1.33%	$883,894.10	$507,665.24
Accounting, tax preparation, bookkeeping, and payroll services	11.69%	1.94%	$1,286,913.35	0.23%	$150,434.90	$1,136,478.45
Electricity transmission and distribution	99.70%	1.83%	$1,215,993.85	1.83%	$1,212,381.23	$3,612.62
Refined petroleum products	73.00%	1.58%	$1,048,175.66	1.15%	$765,147.36	$283,028.30
Other insurance	8.33%	1.39%	$922,720.49	0.12%	$76,882.90	$845,837.59
Natural gas distribution	50.01%	1.36%	$904,711.97	0.68%	$452,419.58	$452,292.39
Other basic inorganic chemicals	1.03%	1.28%	$850,065.48	0.01%	$8,766.98	$841,298.50
Architectural, engineering, and related services	50.68%	1.05%	$695,535.61	0.53%	$352,463.36	$343,072.25
Iron and steel and ferroalloy products	0.00%	1.05%	$693,883.56	0.00%	$9.61	$693,873.95
Wholesale services - Machinery, equipment, and supplies	8.55%	0.99%	$659,637.21	0.09%	$56,386.39	$603,250.82
Legal services	7.80%	0.83%	$553,748.32	0.07%	$43,178.87	$510,569.45
Wholesale services - Petroleum and petroleum products	56.60%	0.77%	$507,745.10	0.43%	$287,383.23	$220,361.87

Table AJ-4 Cont'd – Backward Linkages, Other Clay, Ceramic, Refractory Minerals Mining Southwest Central Regional Economic Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Commercial and industrial machinery and equipment rental and leasing services	90.72%	0.74%	$493,016.99	0.67%	$447,244.16	$45,772.83
Insurance agencies, brokerages, and related services	70.59%	0.72%	$477,084.40	0.51%	$336,788.52	$140,295.88

Table AJ-5 – Backward Linkages, Metal Mining Services Southwest Central Regional Economic Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Storage batteries	0.59%	17.81%	$7,752,071.71	0.10%	$45,366.29	$7,706,705.42
Scales, balances, and miscellaneous general purpose machinery	0.00%	6.03%	$2,624,503.53	0.00%	$6.87	$2,624,496.66
Lighting fixtures	0.00%	4.30%	$1,873,030.22	0.00%	$3.12	$1,873,027.10
All other miscellaneous wood products	0.90%	4.06%	$1,766,762.04	0.04%	$15,906.64	$1,750,855.40
Truck transportation services	38.98%	3.55%	$1,546,359.01	1.39%	$602,813.11	$943,545.90
Maintained and repaired nonresidential structures	63.04%	3.10%	$1,347,995.84	1.95%	$849,774.87	$498,220.97
Travel arrangement and reservation services	85.71%	3.07%	$1,335,652.97	2.63%	$1,144,738.58	$190,914.39
Preserved wood products	0.00%	3.00%	$1,306,676.59	0.00%	$4.12	$1,306,672.47
Spring and wire products	1.11%	2.88%	$1,253,258.14	0.03%	$13,918.20	$1,239,339.94
Petrochemicals	0.07%	2.76%	$1,201,978.98	0.00%	$892.31	$1,201,086.67
Air transportation services	11.31%	2.70%	$1,175,613.27	0.31%	$132,963.52	$1,042,649.75
Other amusement and recreation	88.13%	2.70%	$1,175,532.66	2.38%	$1,036,041.97	$139,490.69
Monetary authorities and depository credit intermediation	13.07%	1.89%	$823,557.89	0.25%	$107,669.92	$715,887.97
Leasing of nonfinancial intangible assets	5.05%	1.74%	$756,245.17	0.09%	$38,206.43	$718,038.74
Sheet metal work (except stampings)	0.27%	1.66%	$723,086.13	0.01%	$1,978.14	$721,107.99
Other basic organic chemicals	0.00%	1.47%	$638,606.48	0.00%	$2.75	$638,603.73
Cutting tool and machine tool accessory	0.03%	1.26%	$548,092.72	0.00%	$174.05	$547,918.67

Table AJ-5 Cont'd – Backward Linkages, Metal Mining Services Southwest Central Regional Economic Development Authority 2020						
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**	**GI-RI**
Insurance agencies, brokerages, and related services	70.59%	1.25%	$544,244.39	0.88%	$384,198.82	$160,045.57
Noncomparable imports	0.00%	1.25%	$541,603.79	0.00%	$0.00	$541,603.79
Waste management and remediation services	98.85%	1.22%	$530,388.91	1.21%	$524,274.38	$6,114.53

Table AJ-6 – Forward Linkages Southwest Central Regional Economic Development Authority 2020		
Description	**Average RPC**	**Average RSC**
Natural gas and crude petroleum	27.79%	70.94%
Coal	0.00%	0.00%
Copper, nickel, lead, and zinc ore	99.69%	2.34%
Iron ore	77.86%	15.18%
Gold ore	99.73%	9.10%
Silver ore	99.97%	12.62%
Uranium-radium-vanadium ore	92.77%	44.32%
Other metal ore	0.00%	0.00%
Stone	97.77%	21.79%
Sand and gravel	33.29%	92.73%
Other clay, ceramic, refractory minerals	92.46%	6.71%
Potash, soda, and borate mineral	14.91%	99.12%
Phosphate rock	25.09%	98.38%
Other chemical and fertilizer mineral	8.88%	1.22%
Other nonmetallic minerals	63.52%	23.62%
Oil and gas wells	22.51%	99.75%
Support activities for oil and gas operations	8.25%	99.53%
Metal mining services	84.15%	49.12%
Other nonmetallic minerals services	33.97%	99.64%

Appendix K: IMPLAN Results for the State of Nevada

Table AK-1 – Top 20 Industry Sectors State of Nevada 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Employment**
Owner-occupied dwellings	$15,345,473,625.75	-	-	-	$0.00
Other real estate	$14,811,682,092.62	15,772	64,821	80,593	$693,685,717.57
Hotels and motels, including casino hotels	$8,862,171,828.93	81,546	1,710	83,256	$458,763,175.66
Management of companies and enterprises	$7,241,979,481.60	23,985	6,745	30,730	-$240,859,279.95
Hospitals	$6,488,803,702.11	33,182	72	33,254	$10,186,102.31
Gold ore mining	$6,215,601,931.89	10,066	1,513	11,579	-$171,502.90
Limited-service restaurants	$5,225,057,754.59	50,046	3,992	54,038	$84,654,281.15
Tenant-occupied housing	$5,174,344,391.34	3,463	13,919	17,382	$159,874,665.19
Insurance carriers, except direct life	$5,151,927,820.50	4,265	3,260	7,525	$18,304,785.74
*Employment and payroll of local govt, education	$4,914,639,001.97	54,001	-	54,001	$0.00
*Employment and payroll of local govt, other services	$4,321,049,583.65	33,297	-	33,297	$0.00
Nondepository credit intermediation and related activities	$4,280,757,666.47	12,692	2,250	14,942	$188,368,368.31
Monetary authorities and depository credit intermediation	$4,222,948,584.86	8,521	1,066	9,587	$82,640,392.24
Insurance agencies, brokerages, and related activities	$4,156,968,438.90	9,396	4,928	14,324	$26,635,294.40
Offices of physicians	$4,146,498,842.64	21,808	6,688	28,496	$364,726,326.07

Table AK-1 Cont'd – Top 20 Industry Sectors State of Nevada 2020					
Industry Sector	**Total Output**	**Wage and Salary Employment**	**Proprietor Employment**	**Total Employment**	**Proprietor Employment**
Construction of other new residential structures	$4,076,097,660.41	9,788	1,767	11,555	$91,746,913.77
Retail - Nonstore retailers	$4,071,456,375.29	6,011	14,906	20,917	$131,159,756.26
Full-service restaurants	$3,903,675,100.12	46,240	4,126	50,366	$67,991,606.95
Gambling industries (except casino hotels)	$3,395,203,857.85	24,925	2,912	27,837	$234,490,297.98
Scientific research and development services	$3,197,159,092.39	10,848	4,640	15,488	$140,710,752.70
Total (All Industry Sectors)	**$283,884,943,747.46**	**1,291,189**	**442,654**	**1,733,843**	**$10,483,111,255**

Table AK-2- Total Output of Mining related Industry Sectors State of Nevada 2020		
Description	**Total Output**	**Total Employment**
Gold ore mining	$6,215,601,931.89	11,578
Metal mining services	$960,712,886.16	2,331
Copper, nickel, lead, and zinc mining	$419,888,445.08	761
Oil and gas extraction	$359,763,336.95	1,056
Other nonmetallic minerals	$150,740,070.77	392
Sand and gravel mining	$145,604,265.77	410
Stone mining and quarrying	$100,831,492.51	149
Other chemical and fertilizer mineral mining	$82,892,524.75	222
Other clay, ceramic, refractory minerals mining	$75,499,299.44	182
Silver ore mining	$63,418,423.43	112
Other nonmetallic minerals services	$48,948,516.49	147
Drilling oil and gas wells	$23,560,410.31	90
Support activities for oil and gas operations	$21,854,579.38	145
Other metal ore mining	$7,211,865.26	16

Table AK-3 – Backward Linkages, Gold Ore Mining State of Nevada 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Tires	0.45%	2.96%	$183,901,569.41	0.01%	$827,581.51
Other basic organic chemicals	0.07%	1.79%	$111,199,289.27	0.00%	$80,152.81
Explosives	0.00%	0.89%	$55,203,472.55	0.00%	$0.00
Petrochemicals	0.42%	0.85%	$52,956,750.11	0.00%	$223,198.69
Iron and steel and ferroalloy products	0.27%	0.53%	$33,200,060.39	0.00%	$90,159.08
Electroplated, anodized, and colored metal	1.99%	0.32%	$19,680,636.48	0.01%	$391,768.13
Conveyor and conveying equipment	0.14%	0.28%	$17,230,450.43	0.00%	$24,692.28
Motor vehicle transmission and power train parts	0.05%	0.22%	$13,460,277.80	0.00%	$6,323.37
Mining machinery	0.78%	0.17%	$10,249,426.42	0.00%	$79,764.19
Motor vehicle gasoline engines and engine parts	0.23%	0.16%	$10,099,307.27	0.00%	$23,211.07
Steel wire	0.50%	0.09%	$5,426,996.27	0.00%	$27,196.90
Iron and steel forgings	1.17%	0.06%	$3,892,722.31	0.00%	$45,519.56
Paperboard from pulp	0.03%	0.05%	$3,378,563.59	0.00%	$926.67
Hand Tools	0.26%	0.05%	$3,377,140.82	0.00%	$8,732.76
Overhead cranes, hoists, and monorail systems	0.23%	0.05%	$2,775,347.65	0.00%	$6,298.84
Coal	0.00%	0.04%	$2,664,223.69	0.00%	$0.00
Scales, balances, and miscellaneous general purpose machinery	0.19%	0.04%	$2,280,859.09	0.00%	$4,394.02

Table AK-3 Cont'd – Backward Linkages, Gold Ore Mining State of Nevada 2020					
Description	**RPC**	**Gross Absorption**	**Gross Inputs**	**Regional Absorption**	**Regional Inputs**
Non Comparable imports	0.00%	0.03%	$1,785,669.81	0.00%	$0.00
Gaskets, packings, and sealing devices	1.24%	0.01%	$871,710.19	0.00%	$10,846.93
Dimension lumber	1.21%	0.00%	$220,901.03	0.00%	$2,683.48