# MINERAL-RESOURCE POTENTIAL OF PROPOSED U.S. BUREAU OF LAND MANAGEMENT EXCHANGE OF LANDS WITH NEW MEXICO STATE LAND OFFICE [1]

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## SUMMARY

*Mineral resources* are the naturally occurring concentrations of materials (solids, gas, or liquid) in or on the earth's crust that can be extracted economically under current or future economic conditions. Most of the state's mineral production comes from oil, gas, coal, copper, potash, industrial minerals and aggregates. Oil and gas are the most important extractive industries in New Mexico in terms of production value and revenues generated, and are being evaluated in a separate report. The *mineral-resource potential* of an area is the probability or likelihood that a mineral will occur in sufficient quantities so that it can be extracted economically under current or future conditions, and includes the occurrence of undiscovered concentrations of metals, nonmetals, industrial materials, and energy resources. The mineral-resource potential is not a measure of the quantities of the mineral resources, but is a measure of the *potential* of occurrence. Factors that could preclude development of the resource, such as the feasibility of extraction, land ownership, accessibility of the minerals, or the cost of exploration, development, production, processing, or marketing, are not considered in assessing the mineral-resource potential. The proposed action is a land exchange that calls for transfer of federal surface/federal minerals from the Bureau of Land Management (BLM) to the State of New Mexico. The New Mexico State Land Office (SLO), in return, will transfer State lands in the Sabinoso Wilderness Area and Rio Grande del Norte National Monument to the BLM. This report assesses the mineral-resource potential of the BLM lands, i.e., an assessment of selected economic mineral commodities that are most likely to be produced in the near future. The BLM grouped the 423 individual parcels into 27 areas, designated A through AA. The assessment for each area is summarized in Appendix 1 and for each individual parcel is in Appendix 2. As geologic mapping progresses at more detailed scales (i.e., 1:24,000), the mineral-resource potential in most areas of New Mexico will need to be updated. Furthermore, this assessment is based upon a literature search and experience of the author, but still requires field verification.

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# INTRODUCTION

## Purpose and scope of this assessment

The U.S. Bureau of Land Management (BLM) is developing an Environmental Assessment (EA) under provisions of the National Environmental Policy Act (NEPA), which requires the assessment of mineral-resource potential for federal surface and federal minerals for the land exchange. The proposed action is a land exchange that calls for a transfer of federal surface/federal minerals lands from the BLM to the State of New Mexico. The New Mexico State Land Office (SLO), in return, will transfer State lands Sabinoso Wilderness Area and Rio Grande del Norte National Monument (McLemore, 2018a) to the BLM. This report assesses the mineral-resource potential of the BLM lands in New Mexico (Appendix 1), and includes an assessment of selected economic mineral commodities that are most likely to be produced in the near future, for these federal lands that are available for land exchange with the State Land Office (SLO). The BLM grouped the 423 individual parcels into 27 areas, designated A through AA (Fig. 1). The assessment for each area is summarized in Appendix 1 and for each individual parcel is in Appendix 2. Most of the effort for this report was synthesis and summary of previous work, and creation of various geodatabases and GIS layers for use by the New Mexico Bureau of Geology and Mineral Resources (NMBGMR), BLM and SLO in their evaluation efforts. The ESRI program ArcMap was the GIS program used to create the maps needed for this assessment.

## Historic and Present Mining Activity

New Mexico's mineral wealth is among the richest of any state in the United States. Oil and gas are the most important extractive industries in New Mexico in terms of production value and revenues generated, and are being evaluated in a separate report. In 2016, New Mexico ranked 11$^{th}$ in coal production, and 20$^{th}$ in nonfuel minerals production in the United States. Most of the state’s mineral production comes from coal, copper, potash, industrial minerals and aggregates (Tables 1, 2). Other important commodities include a variety of industrial minerals (potash, perlite, cement, zeolites, etc.), sulfuric acid, molybdenum, gold, uranium, and silver. There are 246 mining districts and prospect areas described in New Mexico, summarized in McLemore (2017) and the geodatabase included with the GIS data (Fig. 2). Mining history of New Mexico is described by Jones (1904), Finlay (1922), Christiansen (1974), McLemore et al.

(1996a), McLemore (2017), McLemore et al. (2017) and other reports cited in McLemore (2017).

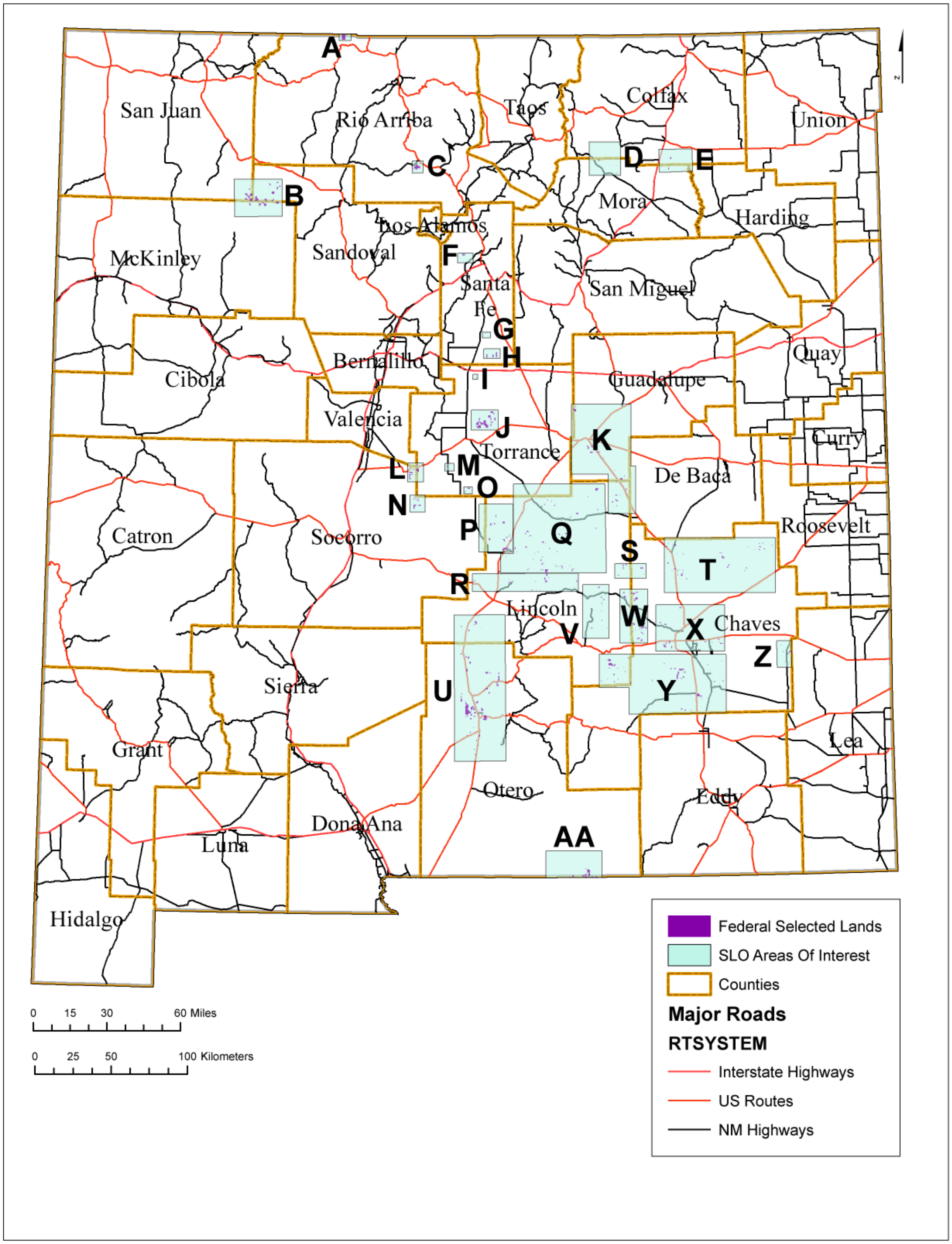


FIGURE 1. BLM areas of proposed lands to be transferred to the SLO (Appendices 1, 2).

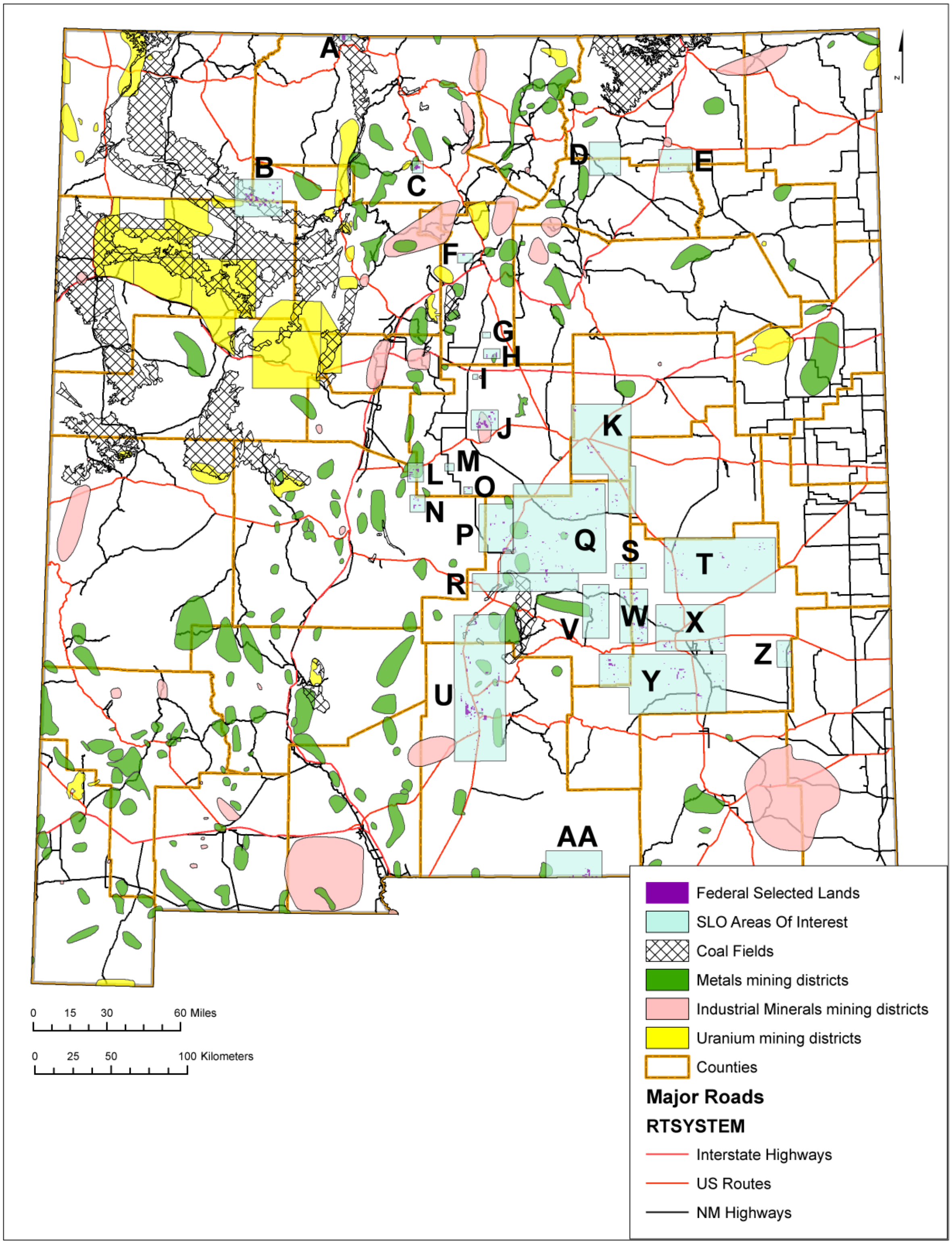


FIGURE 2. Coal fields, mining districts and prospect areas in New Mexico. Specific details on each mining district or prospect area, including names, are in the GIS data, McLemore (2017), and accompanying data found at http://geoinfo.nmt.edu/repository/index.cfml?rid=20170001.

TABLE 1. Estimated total production of major commodities in New Mexico, in order of estimated cumulative value (data from USGS, 1902–1927; USBM, 1927–1990; Kelley, 1949; Northrop, 1996; Harrer, 1965; USGS, 1965; Howard, 1967; Harben et al., 2008; Energy Information Administration, 2015; New Mexico Energy, Minerals and Natural Resources Department, 1986–2017; McLemore, 2017). Figures are subject to change as more data are obtained. Estimated cumulative value is in real, historic dollars at the time of production and is not adjusted for inflation.

| COMMODITY | YEARS OF PRODUCTION | ESTIMATED QUANTITY OF PRODUCTION | ESTIMATED CUMULATIVE VALUE ($) |
|---|---|---|---|
| Coal | 1882–2016 | >1.47 billion short tons | >$22 billion |
| Copper | 1804–2016 | >11.9million tons | >$22.5 billion |
| Potash | 1951–2016 | 114 million short tons | >$15.8 billion |
| Uranium | 1948–2002 | >347 million pounds | >$4.8 billion |
| Industrial minerals* | 1997–2016 | >42.9 million short tons | >$2.8 billion |
| Aggregates** | 1951–2016 | >685 short tons | >$2.67 billion |
| Molybdenum | 1931–2013 | >176 million pounds | >$852 million |
| Gold | 1848–2016 | >3.3 million troy ounces | >$514 million |
| Zinc | 1903–1991 | >1.51 million tons | >$337 million |
| Silver | 1848–2016 | >119 million troy ounces | >$285 million |
| Lead | 1883–1992 | >367,000 tons | >$56.7 million |
| Iron | 1888–2016 | >6.7 million long tons | >$23 million |
| Fluorspar | 1909–1978 | >721,000 tons | $12 million |
| Manganese | 1883–1963 | >1.9 million tons | $5 million |
| Barite | 1918–1965 | >37,500 tons | >$400,000 |
| Tungsten | 1940–1958 | 113.8 tons (>60% $WO_3$) | na |
| Niobium-tantalum | 1953–1965 | 34,000 pounds of concentrates | na |
| TOTAL | 1804–2016 | — | >$70 billion |

*Industrial minerals include the combined total of several industrial minerals (e.g., perlite, cement, decorative stone, pumice, zeolites, etc.), but excluding potash and aggregates.
** Aggregates include only sand and gravel from 1951–1997, after 1997 aggregates include crushed stone and scoria. na–not available.

TABLE 2. Summary of mineral production in New Mexico in 2016, excluding oil and natural gas (New Mexico Energy, Minerals and Natural Resources Department, 2017, https://wwwapps.emnrd.state.nm.us/ocd/ocdpermitting/Reporting/Production/ProductionInjectionSummaryReport.aspx). na—not available.

| MINERAL | PRODUCTION IN 2016 | RANK IN THE U.S. | PRODUCTION VALUE IN NM IN 2016 | EMPLOYMENT IN NM (# FULL TIME JOBS) | STATE REVENUE GENERATED FROM EXTRACTIVE INDUSTRIES | FEDERAL REVENUE GENERATED FROM EXTRACTIVE INDUSTRIES |
|---|---|---|---|---|---|---|
| Copper | 383,618,474 lbs | 2 | $842,913,365 | 1,638 | $6,820,883 | — |
| Coal | 14,681,937 short tons | 11 | $392,338,603 | 1,088 | $13,642,134 | $7,189,610 |
| Gold | 22,142 troy oz | — | $27,641,699 | — | $230,525 | — |
| Industrial minerals | 1,288,684 short tons | — | $114,996,639 | 470 | $225,813 | $368,877 |
| Aggregates | 10,833,266 short tons | — | $84,059,547 | 1,044 | $2,105,478 | — |
| Other metals (iron, manganese) | 24,702 short tons | — | $222,317 | 20 | $1,083,176 | — |
| Potash | 631,154 short tons | 1 | $268,838,554 | 791 | $4,267,331 | $5,247,792 |
| Silver | 293,070 troy oz | — | $5,025,050 | — | $24,217 | — |
| Uranium | none | — | — | 11 | — | — |
| Total 2016 | — | 20 (excluding oil, gas, and coal) | $1,736,035,774 | 5,692 | $28,399,557 | $12,806,279 |

## Definitions of Mineral Resources and Mineral-Resource Potential

In industry, *minerals* refer to any rock, mineral, or other naturally occurring material of economic value, including metals, industrial minerals, energy minerals, gemstones, and aggregates. *Mineral resources* are the naturally occurring concentrations of materials (solids, gas, or liquid) in or on the earth's crust that can be extracted economically under current or future economic conditions. Reports describing mineral resources vary from simple inventories of known mineral deposits to detailed geologic investigations.

A *mining district*, as used in this report and in McLemore (2017), is a group of mines and/or mineral deposits that occur in a geographically defined area (including coal fields) that are determined locally by geologic and other criteria (distribution of mines, mineral deposits and occurrences, mineralogy, faults, lithology, stratigraphic horizons, common mineralization processes, age, etc.) and has had some mineral production. A *prospect area* is an area defined by geologic criteria (distribution of mines deposits and occurrences, mineralogy, faults, lithology, stratigraphic horizons, age, etc.) that has had *no* mineral production. Mining districts and prospect areas are part of the New Mexico Mines Database, which consists of a finite collection of tables that are linked to one another through use of unique alphanumeric mining district identification number (*DISTRICT ID*). Each district and prospect area is identified by a unique *DISTRICT ID*, termed "primary key" in the database that allows for information to be queried, entered without redundancy, and reported as standard output. Mining districts, coal fields, and prospect areas are polygons in the accompanying GIS data.

A *mineral occurrence* is any locality where a useful mineral or material occurs. A *mineral prospect* is any occurrence that has been developed by underground or above ground techniques or by subsurface drilling. These two terms do not have any resource or economic implications. A *mine* is any opening or excavation in the ground for extracting minerals, even if no actual mineral production occurred, and includes excavations currently producing a useful mineral or commodity. A *quarry* is any open or surface working, usually for the extraction of sand and gravel, building stone, slate, limestone, etc. A *mineral deposit* is any occurrence of a valuable commodity or mineral that is of sufficient size and grade (concentration) for potential economic development under past, present, or future favorable conditions. An *ore deposit* is a well-defined mineral deposit that has been tested and found to be of sufficient size, grade, and accessibility to be extracted and processed at a profit over a specific time. Mineral deposits are not found just anywhere in the world. Instead, they are relatively rare and their formation and distribution depends upon specific natural geologic conditions or processes to form. Mineral deposits require a source of constituent elements, transport and concentration mechanisms, and preservation from geochemical and mechanical destruction. The requirement that an ore deposit must be extracted at a profit makes them even rarer. Mineral deposits also form at various geologic times through a combination of geological processes that are closely related in time. Thus, mineral deposits are commonly clustered in geological provinces (i.e., mineral or mining districts) in terms of both location and time. Since an ore deposit is a subset of a mineral deposit, we shall use mineral deposit in most instances in this report. Mineral deposits include *industrial minerals* and rocks, which are any rock, mineral, or other naturally occurring substance of economic value, excluding most metals and gemstones. Industrial minerals and rocks are used in the manufacture of many products, from ceramics to plastics and refractories to paper. Mines, prospects, occurrences, exploration sites, mills, tailings, processing facilities and locally waste rock piles are given a unique Mine Identification Number in the New Mexico Mines Database and are point data in the accompanying GIS data (see below for more discussion).

The *mineral-resource potential* of an area is the probability or likelihood that a mineral will occur in sufficient quantities so that it can be extracted economically under current or future conditions, including the occurrence of undiscovered concentrations of metals, nonmetals, industrial materials, and energy resources (Taylor and Steven, 1983; Goudarzi, 1984; McLemore, 1985). Mineral-resource potential is preferred in describing an area, whereas mineral-resource favorability is used in describing a specific rock type or geologic environment (Goudarzi, 1984). The mineral-resource potential is not a measure of the quantities of the mineral resources, but is a measure of the *potential* of occurrence. Factors that could preclude development of the resource, such as the feasibility of extraction, land ownership, accessibility of the minerals, or the cost of exploration, development, production, processing, permitting, bonding, or marketing, are not considered in assessing the mineral-resource potential. Mineral-resource potential is expressed as polygons in the accompanying GIS data.

On federal land, the Mining Act of 1872 and subsequent legislation designated minerals as locatable, leasable, or saleable (see definitions at http://www.blm.gov/id/st/en/prog/energy___minerals/minerals.html). *Locatable minerals* are any minerals on federal land that are not leasable or salable, and are managed under the Mining Act of 1872 and subsequent federal regulations. Typical locatable minerals are gold, silver, copper, lead, zinc, molybdenum, uranium, barite, gypsum, gemstones, and certain varieties of high calcium limestone. A locatable mining claim, also known as an unpatented mining claim, provides the right to extract minerals, but no land ownership is conveyed.

*Leasable minerals* on federal land include oil and gas, oil shale, geothermal resources, potash, sodium, native asphalt, solid and semisolid bitumen, bituminous rock, phosphate, sulfur, and coal that are managed by the BLM under the Mineral Leasing Act of 1920, other leasing acts, and BLM regulations. *Salable minerals*, also known as mineral materials, are common varieties of minerals and building materials such as sand, stone, gravel, pumice, pumicite, cinders, humate, and clay and are managed under the Materials Act of 1947, as amended by subsequent legislation.

In addition, minerals are owned by private individuals or companies and are typically obtained by actual miners by staking mining leases. *Patented mining claims* are previous locatable mining claims where the federal government has issued a mining patent, which gives the owner full title (ownership) to the land surface, minerals, and other resources on the claim, as specified under the Mining Act of 1872 and subsequent legislation. However, the Interior and Related Agencies Appropriation Act of 1994 included a moratorium on the acceptance of new mineral patent applications, starting October 1, 1994. Most federal homestead and other federal land patents did not include the federal ownership of the minerals and only the surface ownership was transferred; the mineral ownership remained with the federal government. These mixed ownership lands are known as *split-estate lands*.

Other types of mining leases exist on non-federal lands. The SLO offers mining leases to mining companies for minerals on state trust land (http://www.nmstatelands.org/). The various Native American tribes throughout New Mexico control their mineral resources and offer mining leases. Private landowners that also own the mineral rights can offer mining leases. Many mining companies also privately own some of the land with mineral resources.

## Mineral economics

The process from initial discovery of a mineral occurrence to a profitable mine is long and involves many stages, which have changed over the years (Fig. 3). Most discoveries found during the prospecting or exploration stage never become mines. In order for a mineral occurrence to become a mine, it is necessary to define the location, geologic, geotechnical, geochemical, quantity, quality, and many more characteristics, especially the costs involved in the various stages of mining (exploration, development, closure and post closure). Today, most mines must have a mine closure plan and must be permitted before production can begin, which typically can take as long as ten years or even longer. Mining sites generally are very complex with a variety of specialized sampling and monitoring requirements. The lifetime of a mine extends from the exploration phase (occurrences, prospects, exploration sites) to development (mines) to closure and post-closure, and can involve a timeframe of many years.

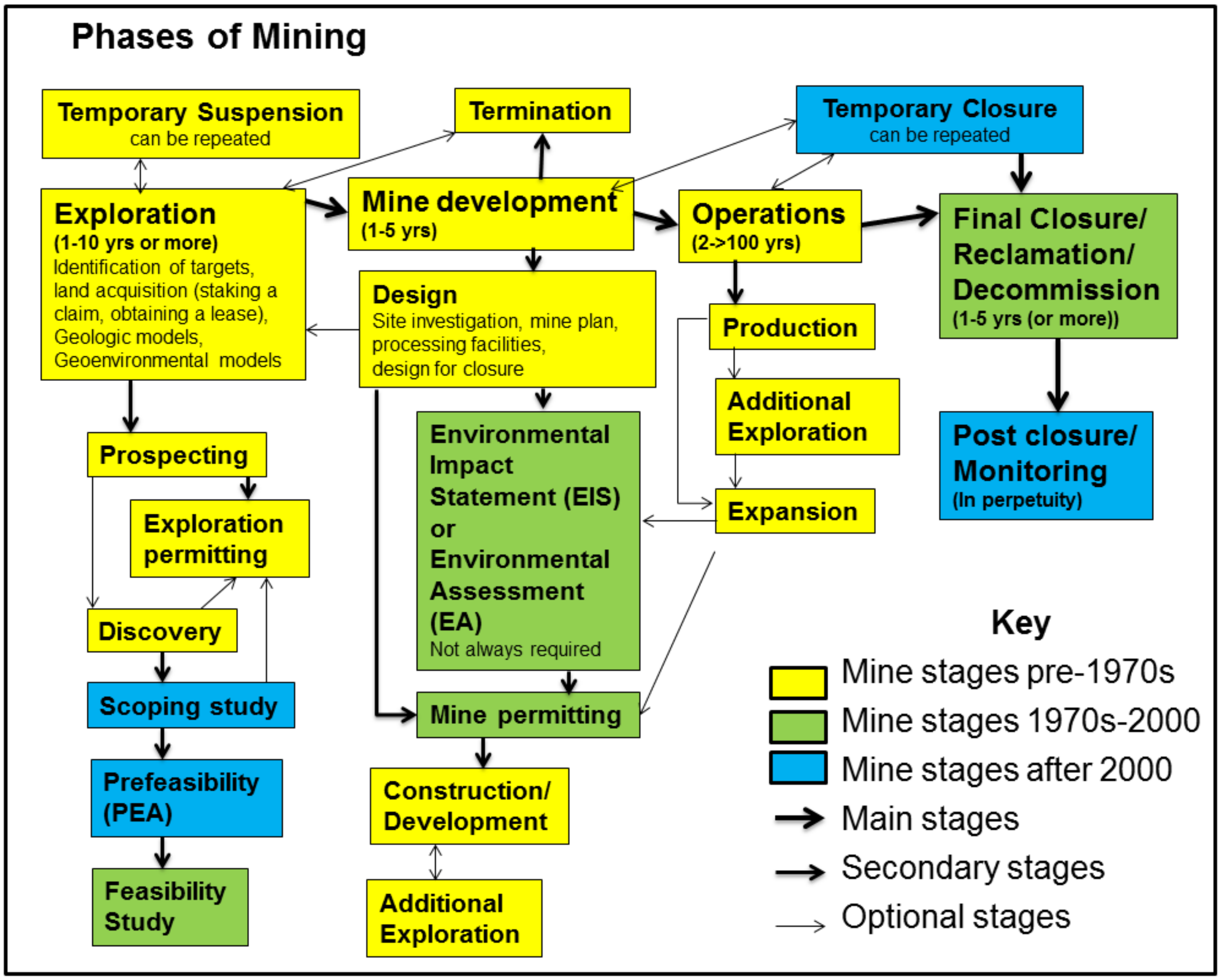


FIGURE 3. Stages of mining through history.

## METHODS OF ASSESSMENT

### Classification of mineral-resource potential

Classification of mineral-resource potential differs from the classification of mineral resources and reserves. Quantities of mineral resources are classified according to the availability of geologic data (assurance), economic feasibility (identified or undiscovered), and as economic or uneconomic. Mineral-resource potential is a qualitative judgement of the probability of the existence of a commodity and is classified as high, moderate, low, or no potential according to the availability of geologic data and relative probability of occurrence (Fig. 4).

DEFINITIONS OF LEVEL OF RESOURCE POTENTIAL

N **No mineral-resource potential** is a category reserved for a specific type of resource in a well-defined area with no evidence of mineral resources.

L **Low mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate geologic environment where the existence of economic mineral resources is unlikely and is assigned to areas of no or dispersed mineralized rocks.

M **Moderate mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for mineral-resource occurrence.

H **High mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence and development. Assignment of high mineral-resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

DEFINITIONS OF LEVEL OF CERTAINTY

A Available information is not adequate for the determination of the level of mineral-resource potential.

B Low, available information suggests the level of mineral-resource potential.

C Moderate, available information gives a good indication of the level of mineral-resource potential.

D High, available information clearly defines the level of mineral-resource potential.

<table>
<tr><td rowspan="5">↑<br>*INCREASING LEVEL OF RESOURCE POTENTIAL*</td><td rowspan="5">U/A<br>Unknown Potential</td><td>H/B<br>High Potential</td><td>H/C<br>High Potential</td><td>H/D<br>High Potential</td></tr>
<tr><td>M/B<br>Moderate Potential</td><td>M/C<br>Moderate Potential</td><td>M/D<br>Moderate Potential</td></tr>
<tr><td>L/B<br>Low Potential</td><td>L/C<br>Low Potential</td><td>L/D<br>Low Potential</td></tr>
<tr><td rowspan="2">L/B<br>Low Potential</td><td rowspan="2">L/C<br>Low Potential</td><td>N/D<br>No Potential</td></tr>
<tr><td>N/D<br>No Potential</td></tr>
<tr><td colspan="5">*INCREASING LEVEL OF CERTAINTY* →</td></tr>
</table>

FIGURE 4. Classification of mineral-resource potential and certainty of assurance (from Goudarzi, 1984).

*High mineral-resource potential* is assigned to areas where there are known mines or deposits where the geologic, geochemical, or geophysical data indicate an excellent probability that mineral deposits occur. All active and producing properties fall into this category, and also includes active exploration projects that are in the permitting process. All identified deposits in known mining districts with significant past production or in areas of known mineralization fall into this category, unless mined out. Speculative deposits, such as reasonable extensions of known producing mining districts and identified deposits or partially defined deposits with past exploration within geologic trends are classified as high mineral-resource potential when sufficient data indicate a high probability of occurrence. This assignment, like other classifications, can be revised when new information, new genetic models, or changes in economic conditions develop. Some commodities and areas are assigned a very high mineral-resource potential in this report in order to designate current mineral production areas or areas likely to produce in the near future.

*Moderate mineral-resource potential* is assigned to areas where geologic, geochemical, or geophysical data suggest a reasonable probability that undiscovered mineral deposits occur in formations or geologic settings known to contain economic deposits elsewhere. Areas with multiple active or closed mining claims and areas of past exploration efforts would be included as having a moderate mineral-resource potential. Speculative deposits in known mining districts or mineralized areas are assigned a moderate potential if evidence for a high potential of economic deposits is inconclusive. This assignment, like other classifications, can be revised when new information, new genetic models, or changes in economic conditions develop.

*Low mineral-resource potential* is assigned to areas where limited available data imply the occurrence of mineralization, but the data are insufficient to indicate a high or moderate probability for the occurrence of an economic deposit. This includes speculative deposits in geologic settings not known to contain economic deposits, but which are similar to geologic settings of known economic deposits. Areas with scattered active or closed mining claims and areas with above-background chemical values are classified as having a low mineral-resource potential. Additional data are generally needed to better classify such areas.

*No mineral-resource potential* is assigned to areas where sufficient information indicates that an area is unfavorable for economic mineral deposits. This evaluation may include areas with dispersed, but uneconomic mineral occurrences as well as areas that have been depleted of their mineral resources. Areas with unfavorable geologic environments for specific mineral resources are assigned a no mineral-resource potential. Use of this classification implies a high level of geologic assurance to support such an evaluation, and it is assigned for potential deposits that are too deep to be extracted economically, even though there may not be a high level of geologic assurance. These economic depths vary according to the commodity, and current and future economic conditions.

*Unknown mineral-resource* potential is assigned to areas where necessary geologic, geochemical, and geophysical data are inadequate to classify an area otherwise. This assessment is assigned to areas where the degree of geologic assurance is low and any other classification would be misleading.

## Methods of mineral-resource assessment

This report assesses the potential of mineral resources on the surface and within the subsurface within specific areas in New Mexico, excluding oil, gas, helium, and carbon dioxide potential (subject of a separate report). The evaluation of mineral-resource potential involves a complex process based on geologic analogy and probability of promising or favorable geologic environments with geologic settings (geologic models) that contain known economic deposits, as described in Goudarzi (1984) and McLemore (1985). Such subjective assessments or judgments depend upon available information concerning the area, as well as current knowledge and understanding of known deposits. The mineral resources were assessed by compilation and integration of all available published and unpublished geologic, geochemical, geophysical, and production data. Most commodities were evaluated at the mining district or prospect area scale (as defined by McLemore, 2017), although some industrial minerals have potential outside of known mining districts, which are identified by polygons indicating the mineral-resource potential. The mineral-resource potential described in this report is adequate to the district scale (approximately at a scale of 1:24,000), unless otherwise stated.

In general, the process of determining mineral-resource potential for each commodity is to identify favorable geologic settings, known mines, deposits, unmined deposits, mining claims and favorable areas, and then to identify areas of high, moderate, and low for a given resource.

## Selection of Mineral Commodities

Although, a wide range of mineral commodities are found in New Mexico, due to time-constraints, this report focuses on selected minerals most likely to be economic under current or foreseeable economic conditions. Minerals evaluated for this report are generally those that are (1) currently being produced, (2) could support new mining activity, or (3) are considered critical minerals (see below). Favorable geology, type of mineral deposit, alteration, mining districts, mining claims, historical production and exploration data are among the most important factors in selection of these minerals. The other commodities should be evaluated in the future. Oil, gas, carbon dioxide, and helium mineral-resource potential is evaluated in a separate report. The selected commodities, including critical minerals, evaluated in this report are listed in Table 3.

TABLE 3. Commodities found in New Mexico selected for evaluation in this report. Critical minerals are designated by Schulz et al. (2017) and Department of Interior (2018-03219/draft-list-of-critical-minerals).

| COMMODITY CLASS | COMMODITY | IS IT A CRITICAL MINERAL? |
|---|---|---|
| Metals | Copper (Cu) | |
| | Gold and silver (Au, Ag) | |
| | Molybdenum (Mo) | |
| | Platinum group elements (PGE: Pd, Pt, Os, Ir, Rh) | Yes |
| | Aluminum | Yes |
| | Antimony (Sb) | Yes |
| | Chromium | Yes |
| | Cobalt (Co) | Yes |
| Industrial minerals | Aggregates (sand and gravel) | |
| | Arsenic | Yes |
| | Barium (barite) (Ba) | Yes |
| | Beryllium (Be) | Yes |
| | Bismuth | Yes |
| | Cesium and rubidium | Yes |
| | Clay | |
| | Diatomite | |
| | Fluorine (fluorite)(F) | Yes |
| | Gallium (Ga) | Yes |
| | Garnet | Yes |
| | Germanium (Ge) | Yes |
| | Graphite (carbon) | Yes |
| | Gypsum | |
| | Hafnium (Hf) | Yes |
| | Helium | Yes |
| | Humate | |
| | Indium (In) | Yes |
| | Iron (Fe), iron oxide and magnetite (Fe) | |

| COMMODITY CLASS | COMMODITY | IS IT A CRITICAL MINERAL? |
|---|---|---|
| | Limestone and dolomite | |
| | Lithium (Li), strontium (Sr), bromine (Br), boron (B) | Yes |
| | Magnesium (Mg) | Yes |
| | Manganese (Mn) | Yes |
| | Mica | |
| | Niobium, tantalum (Nb, Ta) | Yes |
| | Perlite | |
| | Potash (K) | Yes |
| | Pumice | |
| | Rare earth elements (REE), including yttrium (Y) | Yes |
| | Rhenium (Re) | Yes |
| | Salt | |
| | Scandium (Sc) | Yes |
| | Selenium (Se) | Yes |
| | Silica sand | |
| | Stone | |
| | Tellurium (Te) | Yes |
| | Tin (Sn) | Yes |
| | Titanium (Ti) | Yes |
| | Tungsten (W) | Yes |
| | Vanadium (V) | Yes |
| | Zeolites | |
| | Zirconium (Zr) | Yes |
| Gemstones | Gemstones (including mineral collecting) | |
| Uranium | Uranium (U) | Yes |
| Coal | Coal | |

## Critical minerals

Our society is currently demanding more technologies like computers, cell phones, solar panels and wind turbines for electricity, batteries, and electric cars. Other technologies are being developed like water purification, desalination, carbon capture and storage, and even better light bulbs and they all require nontraditional minerals and commodities in their manufacture. Traditional commodities, like copper, iron for steel, and cement are required, but other nontraditional commodities, often called critical minerals, are also required. *Critical minerals* are mineral resources that are essential to our economy and whose supply may be disrupted; many critical minerals are 100% imported into the U.S. (Committee on Critical Mineral Impacts of the U.S. Economy, 2008; Schulz et al., 2017). The criticality of a commodity changes with time as supply and society's needs evolve.

Many of these minerals and commodities are not like traditional precious and base metals and energy minerals, where a market is already established and the commodity is traded world-wide. Many critical minerals and commodities are similar to industrial minerals and are dependent upon a specific market with customer-specified criteria being established. Some of these commodities do not require large quantities of production to meet the demand. For example, in the 1980s, approximately 12 elements were used to manufacture computer chips. Today more than 60 different elements are used in fabricating computer chips, and these same computer chips are essential in many everyday technologies that we depend upon. Substitution of other materials in many of these components is not an option. Although, recycling and conservation will play a part, most of these critical minerals will have to be mined, and some of these deposits are potentially found in New Mexico. Many challenges exist in mining these commodities, including potential environmental issues. Therefore, the mineral-resource potential of selected critical minerals is evaluated in this report as well as traditional commodities (Table 3).

## FORMAT OF THIS REPORT AND ACCOMPANYING GIS DATA

This report differs from previous mineral-resource assessments in that support maps and other data are in accompanying GIS data. Specific information required to properly evaluate the mineral-resource assessment is organized in layers in the GIS data and described below. This report is organized by BLM areas A through AA (Fig. 1) instead of by commodities. The mineral-resource potential determinations for each commodity for each area are in Appendix 1 and the mineral-resource potential determinations for each of the 423 parcels are in Appendix 2. The Reasonably Foreseeable Development (RFD) is discussed in a separate chapter in this report.

## GIS Layers and sources of data

### Sources of data

Data used in this report have been compiled from literature reviews, field examinations, and unpublished data by the author and include geologic maps, mineral occurrence records, mineral-resource assessments, production records, and evaluation of the NURE and other geochemical and geophysical data. Additional sources include:

- official government publications (including NMBGMR, U.S. Geological Survey (USGS), U.S. Bureau of Mines, BLM, U.S. Forest Service published reports)
- scientific journals
- NMBGMR mining archives
- university theses and other project works
- USGS MRDS database (https://mrdata.usgs.gov/mrds/)
- USGS prospect- and mine-related features on USGS topographic maps database (https://mrdata.usgs.gov/usmin/)
- USGS major mineral deposits database (https://mrdata.usgs.gov/major-deposits/)
- BLM official land records (https://glorecords.blm.gov/default.aspx)
- BLM LR2000 mining claims database (https://reports.blm.gov/reports.cfm?application=LR2000)
- New Mexico Mining and Minerals Division mine registration database (http://www.emnrd.state.nm.us/MMD/mmdonline.html)
- New Mexico State Mine Inspector annual reports

- Mine Safety and Health Administration mines database (https://arlweb.msha.gov/OpenGovernmentData/OGIMSHA.asp#msha-datasets)
- Office of Surface Mining Reclamation and Enforcement Abandoned Mine Land Inventory System (AMLIS; https://amlis.osmre.gov/QueryAdvanced.aspx)
- Office of Surface Mining Reclamation and Enforcement National Mine Map Repository (https://mmr.osmre.gov/MultiPub.aspx)
- U.S. Forest Service public GIS data
- county courthouse records
- other public information.

Several general reports describing the mineral resources of New Mexico, some including more detailed descriptions of many of the mining districts, can be found in Lindgren et al. (1910), Howard (1967), North and McLemore (1986), McLemore and Chenoweth (1989, 2017), McLemore (1984, 2001), Bartsch-Winkler and Donatich (1995), McLemore et al. (1984, 1986a, b, c, d, e, 1996a, 2001, 2002, 2005a,b), Bartsch-Winkler (1997), and numerous other reports listed in the references cited. Two additional publications were used in compiling this report that describes the types of deposits in New Mexico and their economic significance (McLemore, 2017; McLemore et al., 2017).

Mineral production by commodity from New Mexico is summarized in Table 1, and metals production by mining district is in the *Production* geodatabase included with the GIS data. However, mining and production records are generally poor, particularly for earliest mining activities, and many early records are conflicting. Nonetheless, these production figures are the best data available and were obtained from published and unpublished sources (USGS, 1902–1927; USBM, 1927–1990; New Mexico Energy, Minerals and Natural Resources Department, 1990–2017; NMBGMR unpubl. data). Historic production figures are subject to change as new data are obtained. Most resource or reserve data presented here are historical data and are provided for information purposes only and do not conform to Canadian National Instrument NI 43-101 requirements (http://web.cim.org/standards/documents/Block484_Doc111.pdf, accessed 10/8/14), unless otherwise stated. Historic and recent production and reserve/resource data are reported in metric or English units according to the original publication to avoid conversion errors.

**Geology and deposit types**

Layers from the state geologic map (New Mexico Bureau of Geology and Mineral Resources, 2003), which is at a scale of 1:500,000, are shown in the GIS data and used to identify favorable formations, where appropriate. Known areas of alteration are identified. As geologic mapping progresses at more detailed scales (i.e., 1:24,000), the mineral-resource potential in most areas of New Mexico will need to be updated.

Numerous classifications have been applied to mineral deposits to aid in exploration and evaluation of mineral resources (Lindgren et al., 1910; Lindgren, 1933; Eckstrand, 1984; Guilbert and Park, 1986; Cox and Singer, 1986; Roberts and Sheahan, 1988; Sheahan and Cherry, 1993; Dill, 2010; McLemore et al., 2017; McLemore, 2017). The USGS Mineral Deposit Models are "an organized arrangement of information describing the essential characteristics or properties of a class of mineral deposits. Models themselves can be classified according to their essential attributes (for example: descriptive, grade-tonnage models, genetic, geoenvironmental, geophysical, probability of occurrence, and quantitative process models)" (https://minerals.usgs.gov/products/depmod.html). They are a tool for assessing areas for undiscovered mineral deposits and were used in this assessment along with McLemore et al. (2017), and are summarized in Appendix 3.

**Mining districts**

Mining districts and prospect areas are defined by McLemore (2017), shown in Figure 2 and the GIS data. However, not all sand and gravel, crushed stone, and dimension stone operations are located in a specific mining district or prospect area, even if they were actually mined, because these low-value commodities are not constrained by criteria that defines a mining district. Undoubtedly new occurrences of metals, industrial minerals and energy minerals will be located that also are not in a mining district or prospect area designated in this resource map and new mining districts or prospect areas will be added in the future. File and Northrop (1966) recognized a Guadalupe Mountains district in Otero County, but there is no evidence of mineral deposits in that exact area and that district is no longer included as a district in this report.

Names of mining districts are generally from File and Northrop (1966), McLemore and Chenoweth (1989, 2017), McLemore (2001), McLemore et al. (2002, 2005a, b), McLemore and Lueth (2017), McLemore and Austin (2107) and McLemore (2017). The naming of a mining district or prospect area is a complex and sometimes an arbitrary and emotional issue. File and Northrop (1966) found five factors that enter into the naming of a mining district or prospect area: (1) lode and placer mining claim names, (2) survey names, (3) post office names, (4) agency names, and (5) names from other sources. These are in themselves complicating factors, and become more so when local custom imposes a local name for a place officially named something else on a topographic map or in the official government records. Some of the challenges in identifying a unique mining district and prospect area name include synonyms or aliases, spelling variations, confusion with names of mining camps and subdistricts, legislative changes in the county boundaries, and the same name applied to different areas. Thus the DISTRICT ID becomes important to uniquely identify a particular mining district. Most of the known synonyms or aliases are in the district details geodatabase in the GIS data and are in McLemore (2017).

There are five categories of coal fields, mining districts and prospect areas:

- **Metals** that are economically important in New Mexico include copper, gold, silver, and molybdenum. Gold and silver resources are described by McLemore (2001) and all of the metallic deposits are described by McLemore and Lueth (2017). Metals are locatable minerals under the federal classification system.
- **Industrial minerals** are described by McLemore and Austin (2017). Many industrial minerals are locatable minerals under the federal classification system; leasable commodities include potash, sodium, native asphalt, solid and semisolid bitumen, bituminous rock, phosphate, and sulfur. Salable minerals include common varieties of minerals and building materials such as stone, pumice, pumicite, cinders, and clay. Gemstones, locatable minerals, are included in the database as industrial minerals.
- **Aggregates**, as used in this report, refers to any of several hard, inert materials, such as sand, gravel, slag, or crushed stone, used for mixing with a cementing material to form concrete, mortar, or plaster; or used alone, as in railroad ballast or graded fill (Lindvall, 1965; McLemore and Austin, 2017). Aggregates are used predominantly for construction purposes and there are three general types: (1) construction sand and gravel, (2) crushed stone, and (3) lightweight aggregates (Austin and Barker, 1990). Aggregates are some of the most abundant natural resources and are a major basic raw material used by construction, agriculture, and industries employing complex chemical and metallurgical processes. The largest demand for aggregates in New

Mexico is for highway construction and then for building construction. Some aggregates are also considered industrial minerals and rocks. Aggregates, including sand, gravel, and crushed stone, are salable minerals under the federal classification system.

- **Uranium** districts are described in McLemore and Chenoweth (1989; 2017). Uranium is a locatable mineral under the federal classification system.
- **Coal** fields are described in Hoffman (1996, 2014, 2017). Coal is a leasable mineral under the federal classification system.

### New Mexico Mines Database

The NMBGMR maintains the New Mexico Mines Database, which is a relational database that includes information on active and historical mines, prospects, occurrences, exploration sites, mills, tailings, processing facilities and locally waste rock piles in New Mexico (McLemore et al., 2002, 2005a, b; McLemore, 2017). Mines, prospects, occurrences, exploration sites, mills, tailings, processing facilities and locally waste rock piles are given a unique Mine Identification Number in the New Mexico Mines Database and are point data in the accompanying GIS data in New Mexico and consists of a prefix NM (for New Mexico), two letter abbreviation that represents the county followed by a unique number. Locations of mines were obtained from sources listed above.

### Active mines

The New Mexico Mining and Minerals Division (NMMMD) maintains a database of active mines (http://www.emnrd.state.nm.us/MMD/mmdonline.html). These data were incorporated into the New Mexico Mines Database and shown in Figure 5. The mine identification numbers, prefixed by NM, are from the New Mexico Mines Database (McLemore et al., 2002, 2005a, b; McLemore, 2017) and refer to the mines listed in the text and in the accompanying GIS data.

### Exploration areas (past, active)

Past and current active exploration areas are included as mines with unique mine identification numbers in the New Mexico Mines Database and are shown in Figure 5. The New

Mexico Mining and Minerals Division (NMMMD) maintains a database of active permits in New Mexico (http://www.emnrd.state.nm.us/MMD/mmdonline.html), which are included in this study. NMMMD data were supplemented with additional exploration projects that have not yet applied for exploration permits with NMMMD, but are reported by various companies as areas of active exploration.

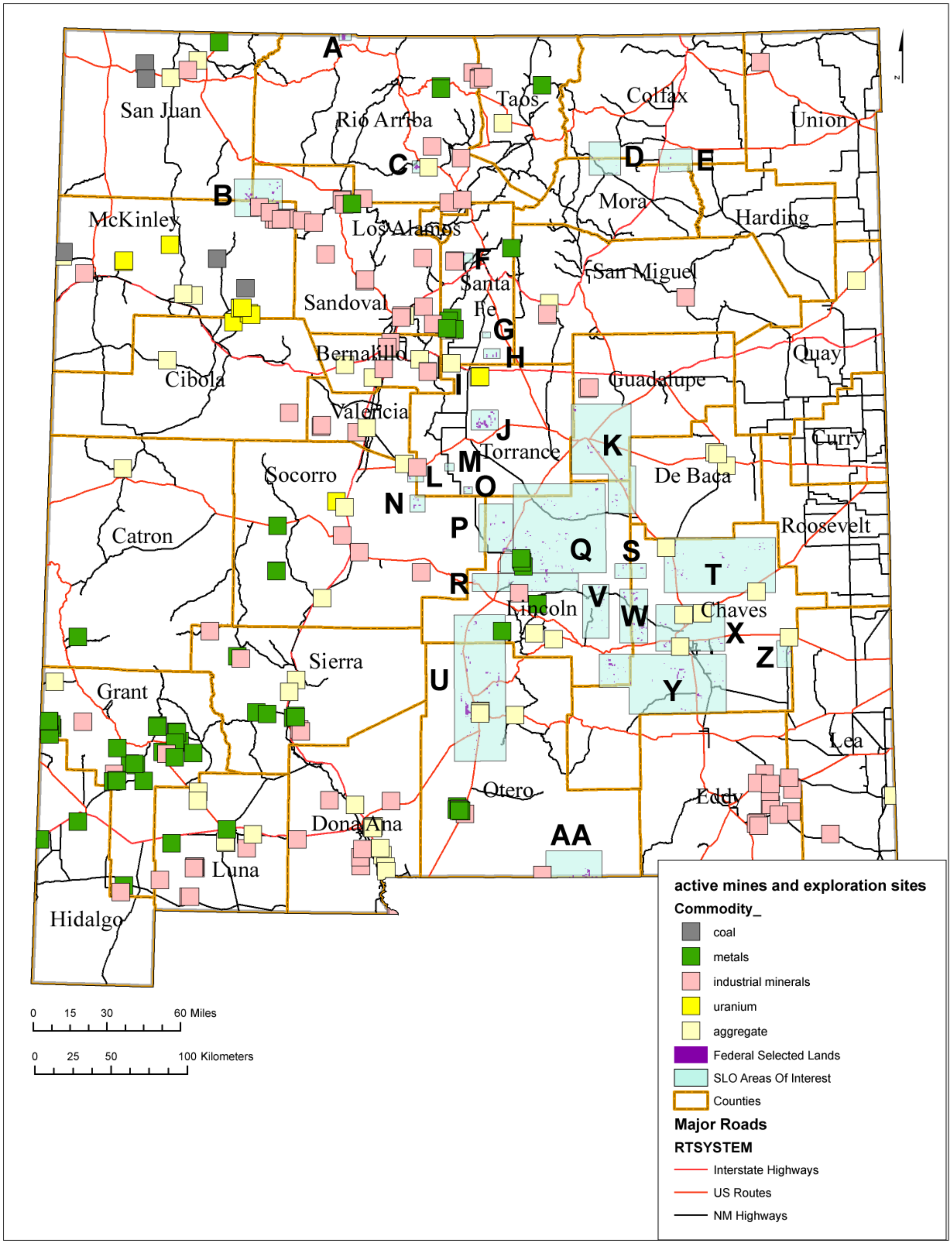


FIGURE 5. Active mines and exploration sites in New Mexico. Exploration sites are defined in this study as areas where a company or prospector is exploring for a commodity (including but

not limited to permitted sites with NMMMD; see text). Not all aggregates producers are shown. Specific details on each mine**,** including names, are in the GIS data and McLemore (2017).

**Mining claims**

The presence of mining claims indicates that someone had indications that some locatable commodity could be present; however most mining claims do not indicate any economic potential without significant exploration efforts. Locations of historical and active mining claims were obtained from the USGS (Causey and Frank, 2006; Causey, 2011) and the BLM LR2000 (https://www.blm.gov/lr2000/). However, the LR2000 database only identifies township, range, and sections that contain mining claims. The BLM converted the township, range and section of mining claims into latitude and longitude for entering into GIS. The actual location description of individual mining claims can only be obtained from the actual claim owner or from each county courthouse.

**Known Potash Leasing Area**

The Potash Enclave, also designated the Designated Potash Area (DPA) (formerly the Known Potash Leasing Area or KPLA; 2012 Secretarial Order for Co-Development of Oil and Gas and Potash Resources in Southeast New Mexico, http://www.blm.gov/nm/st/en/prog/energy/2012_secretarial_order.html, accessed 1/29/16), consists of that part of the Carlsbad potash district where federal and state lands require competitive bidding for mineral leases, under the BLM oversight. The DPA was first established in 1939 to withdraw oil and gas leasing from the area and was modified in 2012.

**Mt. Taylor TCP**

The Mt. Taylor Traditional and Cultural Property (TCP) is listed by the State Register of Cultural Properties to protect the cultural significance of the Mt. Taylor area (http://www.nmhistoricpreservation.org/documents/cprc/passage_release.pdf). The effect of the Mt. Taylor TCP on mining, especially mining uranium, is unknown.

**Geodatabases**

Three geodatabases are included with the GIS data, which are from McLemore (2017): DistrictDetails, Production, and DistrictEvolution. The DistrictDetails geodatabase describes the mining districts and prospect areas in New Mexico. Fields are described in Appendix 4. The Production geodatabase includes reported and estimated base and precious metals production by district (non-confidential data). The DistrictEvolution geodatabase describes the evolution of the definition of mining districts in New Mexico through time. Number refers to the number listed by that author. Note that the coal fields are not included in the DistrictDetails geodatabase, but are included as a separate layer in the GIS coal fields shapefile. These data are also included in the data repository for McLemore (2017; http://geoinfo.nmt.edu/repository/index.cfml?rid=20170001).

## MINERAL-RESOURCE POTENTIAL OF SELECTED FEDERAL LANDS

Specific mineral-resource assessment by commodity for each area (Fig. 1) is briefly described below. Known mineral resources in New Mexico are described by references listed in the references cited and in McLemore (2017), Hoffman (2017), McLemore and Lueth (2017), McLemore and Austin (2017), and McLemore and Chenoweth (2017), and references cited within those reports. Selected maps are included in the discussions below; more details are in the GIS data.

### Area A

Area A is in T32N, R1-2W, north of Dulce in northern Rio Arriba County, along the border with Colorado (Fig. 6), and is entirely within the Monero coal field (DIS146; Hoffman, 1991, 1996, 2017). Although there are no active mines in Area A (Fig. 5), two inactive mines are found in the area: Jaramillo (NMRA0151), which produced crushed stone (andesite) in the past, and a gravel pit (NMRA0379). There are no mining claims in Area A.

The mineral-resource potential is low with a low level of certainty for coal in area A, moderate with a high level of certainty for humate in and near Cretaceous coal deposits (Hoffman et al., 1996) and moderate with a high level of certainty for uranium in sandstones in the Jurassic Morrison Formation (McLemore and Chenoweth, 1989, 2017). The mineral-resource potential for vanadium, selenium, and molybdenum associated with sandstone uranium deposits is unknown with a low level of certainty. The mineral-resource potential for crushed stone (intrusive andesite, geologic unit Tim) as aggregates is high with a high level of certainty in the northern portion of area A (McLemore et al., 1986e), however some of the andesite dikes are considered sacred by the Jicarilla Apache Indian tribe. A sample of Cretaceous Lewis Shale was collected south of Area A, west of Dulce, and tested for use as expanded shale for use as aggregates and found suitable for light-weight aggregates use (Foster, 1966); therefore, the mineral-resource potential for clay (i.e., expanded shale) in Cretaceous shales in Area A is unknown with a low level of certainty (McLemore et al., 1986e).

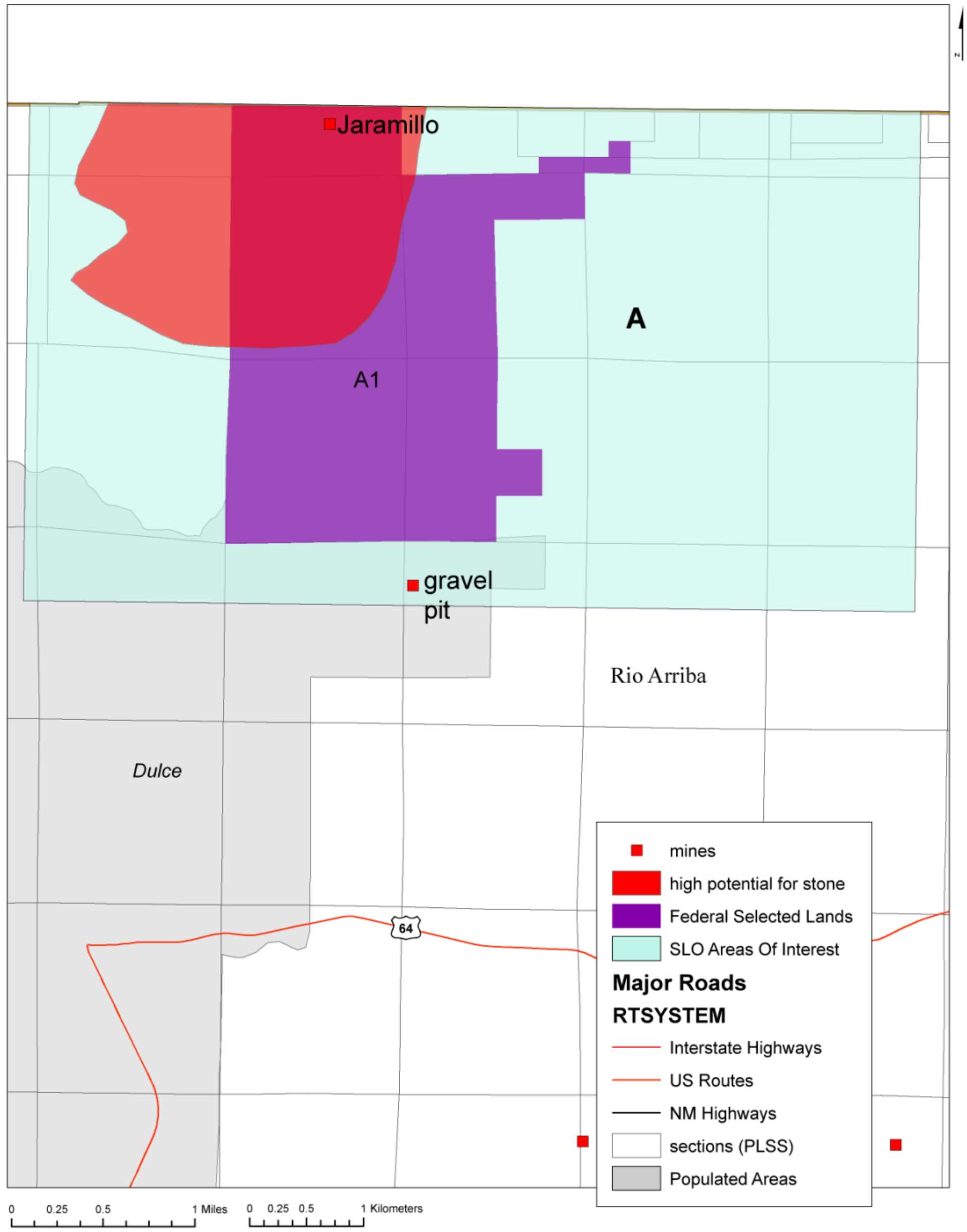


FIGURE 6. Mines and mineral-resource potential for crushed stone (andesite) in Area 1. See Figure 1 for location of Area A. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area B

Area B is in T20-22N, R6-8W in the Bisti and Star Lake coal fields (DIS150, DIS158; Hoffman, 1996, 2017), north of Pueblo Pintada, in the southeastern part of the San Juan Basin in San Juan, Sandoval, and McKinley Counties (Fig. 7). The Chaco Canyon uranium district (DIS116; McLemore and Chenoweth, 1989, 2017) is in the western portion of Area B. One uranium occurrence and three humate mines and occurrences are found in the area (Fig. 7). The Double Tree humate mine (NMMK0715) is considered an active mine (Fig. 5) even though it is not currently in production, because the mine has not completed reclamation and closure. Mining claims have been staked in Area B in the past.

The mineral-resource potential is moderate to low-moderate with a moderate level of certainty for coal (Fig. 9; Hoffman et al., 1996), high with a high level of certainty for humate and limestone in portions of Area B (Fig. 8), and moderate for uranium in sandstones in the Jurassic Morrison Formation with a moderate level of certainty, with the exception of the Chaco Canyon uranium district, which has a high mineral-resource potential with a high level of certainty for uranium in sandstones in the Jurassic Morrison Formation (Fig. 10; McLemore and Chenoweth, 1989, 2017). The mineral-resource potential for vanadium, selenium, and molybdenum associated with sandstone uranium deposits is unknown with a low level of certainty. A small area south of Area B has a low mineral-resource potential with a moderate level of certainty for REE, titanium, and zircon (REE-Ti-Zr) in Cretaceous beach placer sandstone deposits in the Pictured Cliffs Sandstone (McLemore, 2010a, 2015b); therefore Area B has an unknown mineral-resource potential with a low level of certainty for REE-Ti-Zr in Cretaceous beach placer sandstone deposits in the Pictured Cliffs Sandstone (Fig. 9). The major drainage in Area B has a high mineral-resource potential with a high level of certainty for sand and gravel (aggregates; Fig. 10).

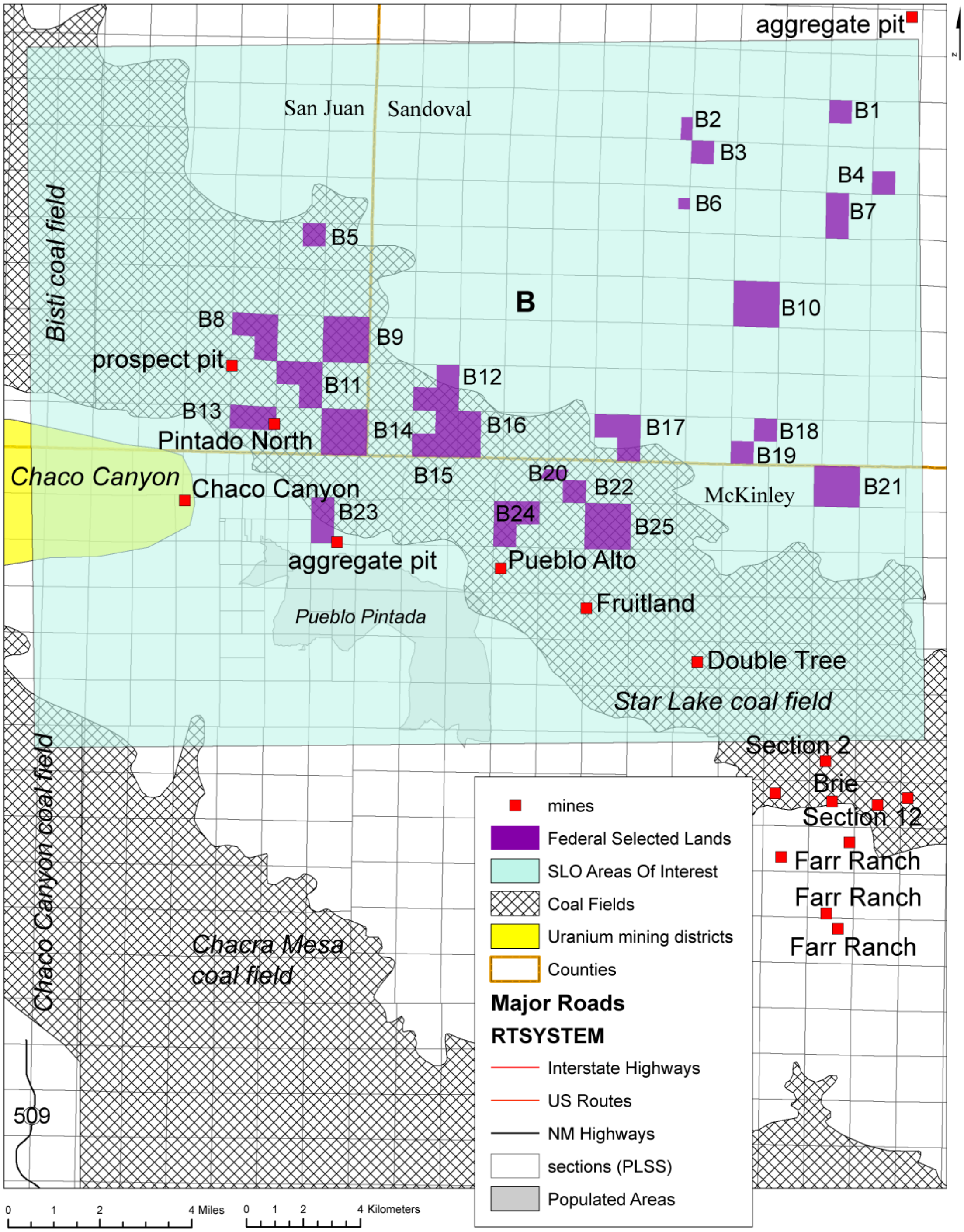


FIGURE 7. Mines, coal fields and mining districts in Area B. The Chaco Canyon mine is a uranium occurrence; whereas the Pintado North, Pueblo Alto, Fruitland and Double Tree mines are humate mines or occurrences. See Figure 1 for location of Area B. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

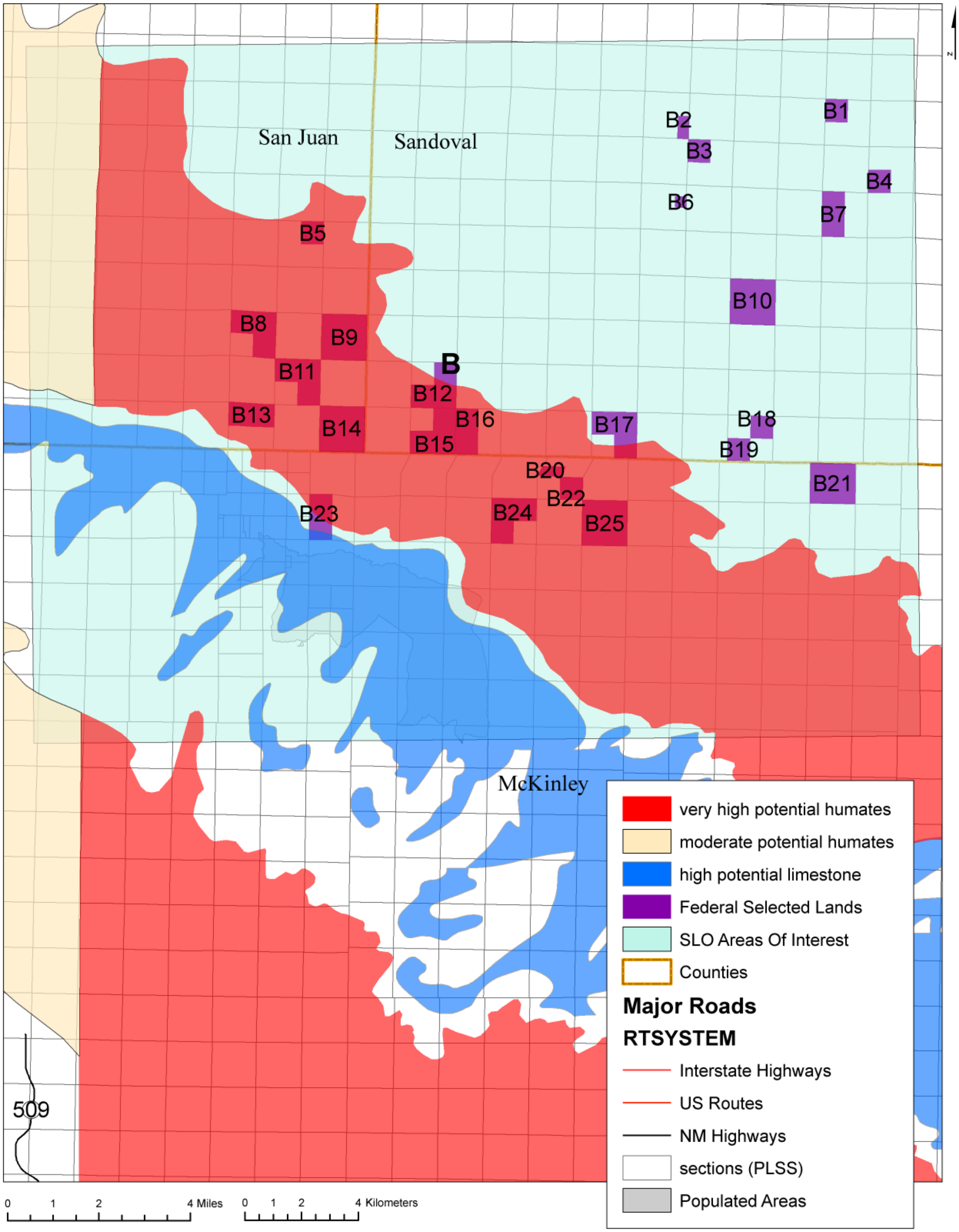


FIGURE 8. Mineral-resource potential for humates and limestone in Area B. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

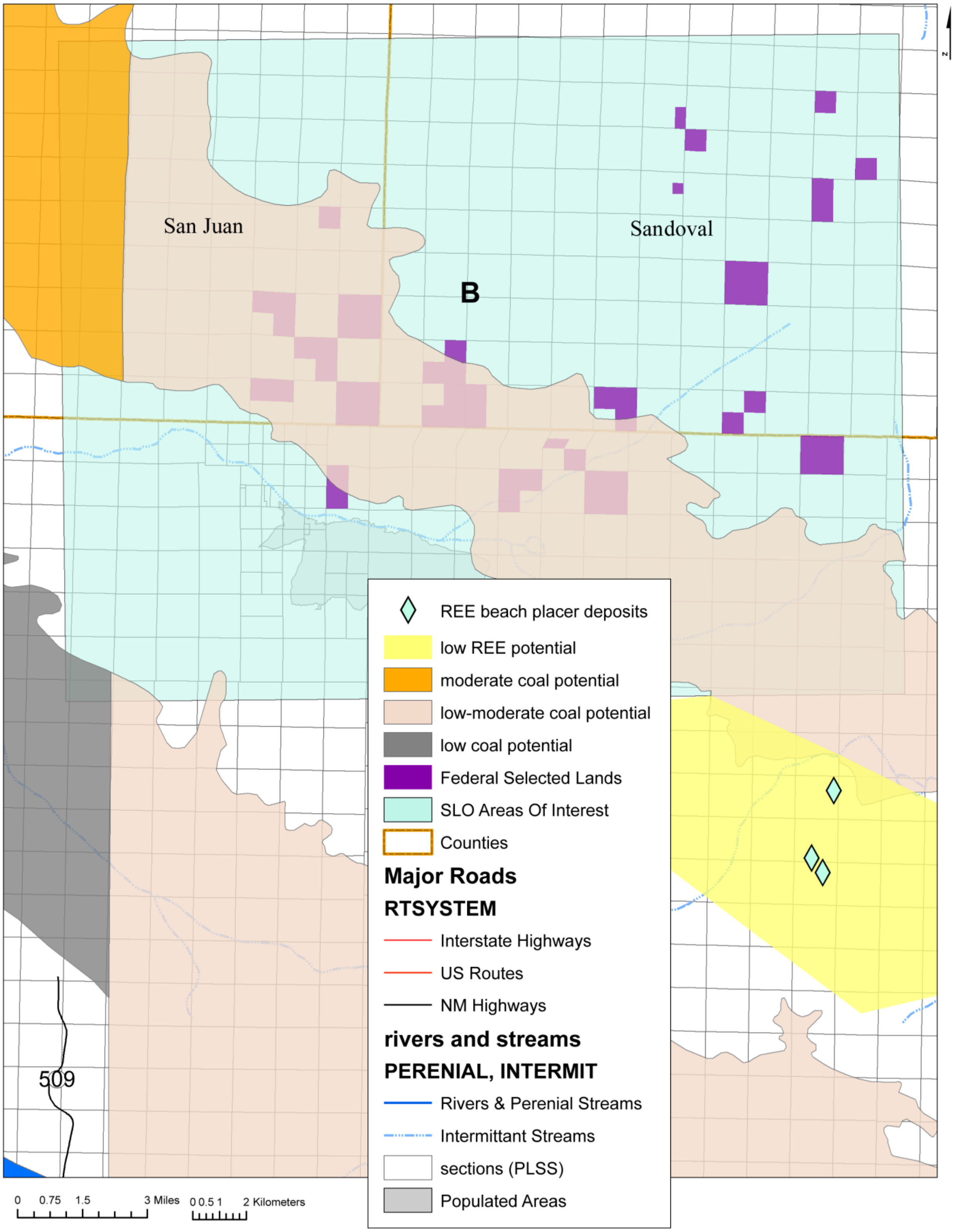


FIGURE 9. Mineral-resource potential for coal and REE-Ti-Zr Cretaceous beach placer sandstone deposits in Area B. Note that Area B (light blue-green) has an unknown mineral-resource potential for REE-Ti-Zr in Cretaceous beach placer sandstone deposits in the Pictured

Cliffs Sandstone. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

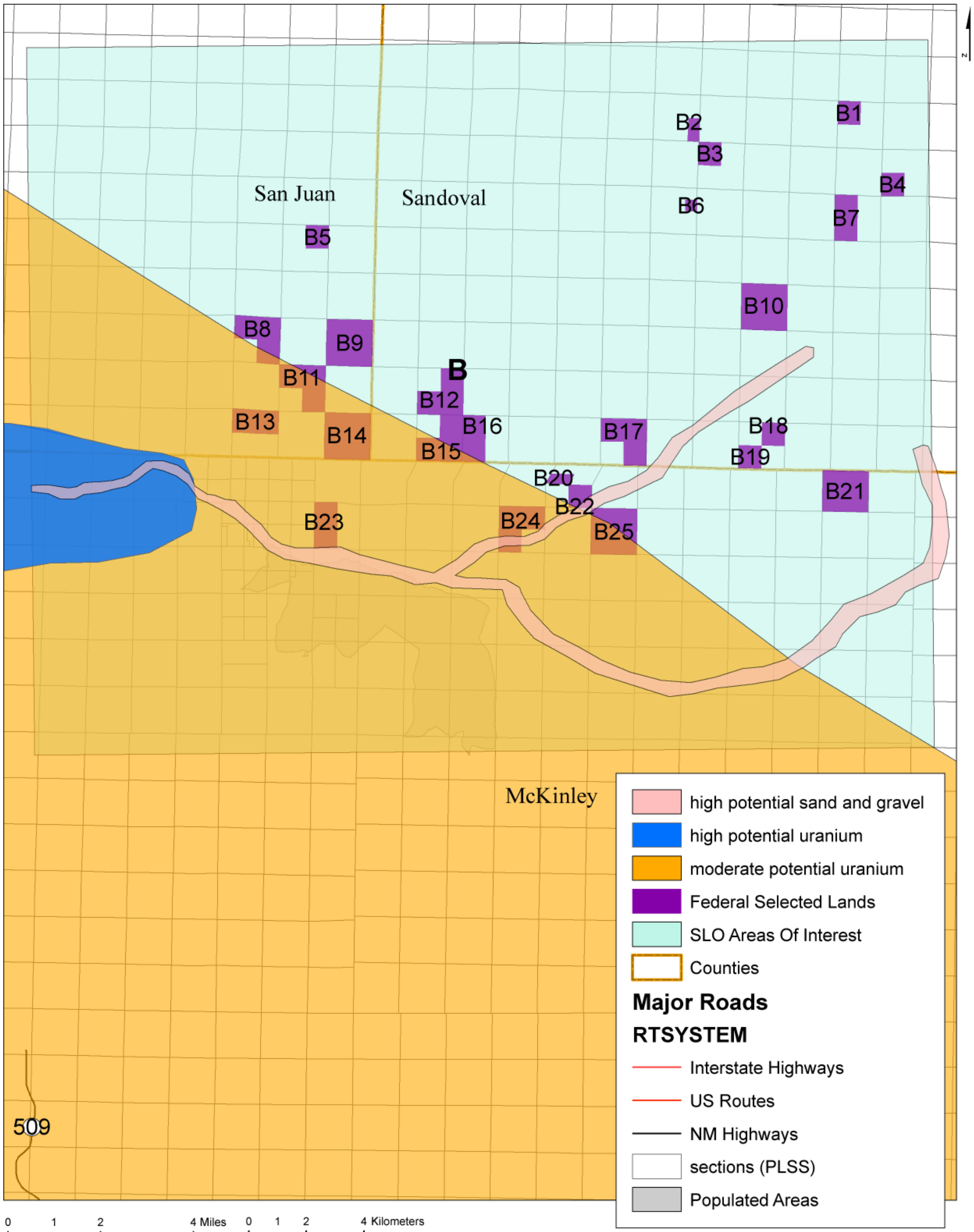


FIGURE 10. Mineral-resource potential for uranium and sand and gravel (aggregates) in Area B. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area C

Area C is in T32N, R5E, on an uplifted region on the southeast flank of the Chama Basin, north of Calones and includes part of the Abiquiu Reservoir in Rio Arriba County. The Chama Placers mining district (DIS149) is within Area C and Box Canyon uranium district (DIS138) lies to the west (Fig. 11; Johnson, 1972; McLemore, 1983, 1994, 2001, 2017). Although there are no active mines in Area C (Fig. 5), two inactive mines and occurrences are in the area: JC Roybal (NMRA0018, a uranium occurrence) and an unknown occurrence for chert (NMRA0299). There are no mining claims in Area C.

The Chama Placers district has a moderate mineral-resource potential with a moderate level of certainty for placer gold deposits along drainages. There is a high potential with a high level of certainty for basalt, andesite, and scoria (stone, aggregates) in Area C. There is a high potential with a high level of certainty for sand and gravel (aggregates) along two river channels in the northern part of Area C, but the rest of Area C has no sand and gravel mineral-resource potential with a high level of certainty, because most of the streams or rivers are within steep walled canyons, where extraction would be difficult. There is an unknown mineral-resource potential with a low level of certainty for mineral collecting of chert near the unknown mine (NMRA0299).

## Area D

Area D is in T22-24N, R17-19E on the southern flank of the Cimarron Arch, which separates the Las Vegas and Raton Basins, and includes the small village of Ocate. There are no mining districts, mining claims, or active mines (Fig. 5) in Area D, although several cinder and basalt quarries and occurrences are found in the area (Fig. 12).

There is a high mineral-resource potential with a high level of certainty for basalt, andesite, scoria and crushed stone (aggregates) throughout Area D and a high mineral-resource potential with a high level of certainty for sand and gravel (aggregates) along the arroyo in the southern part of Area D (Fig. 13). There is a low mineral-resource potential with a low level of certainty for uranium in eastern portion of Area D (McLemore and Chenoweth, 1989, 2017).

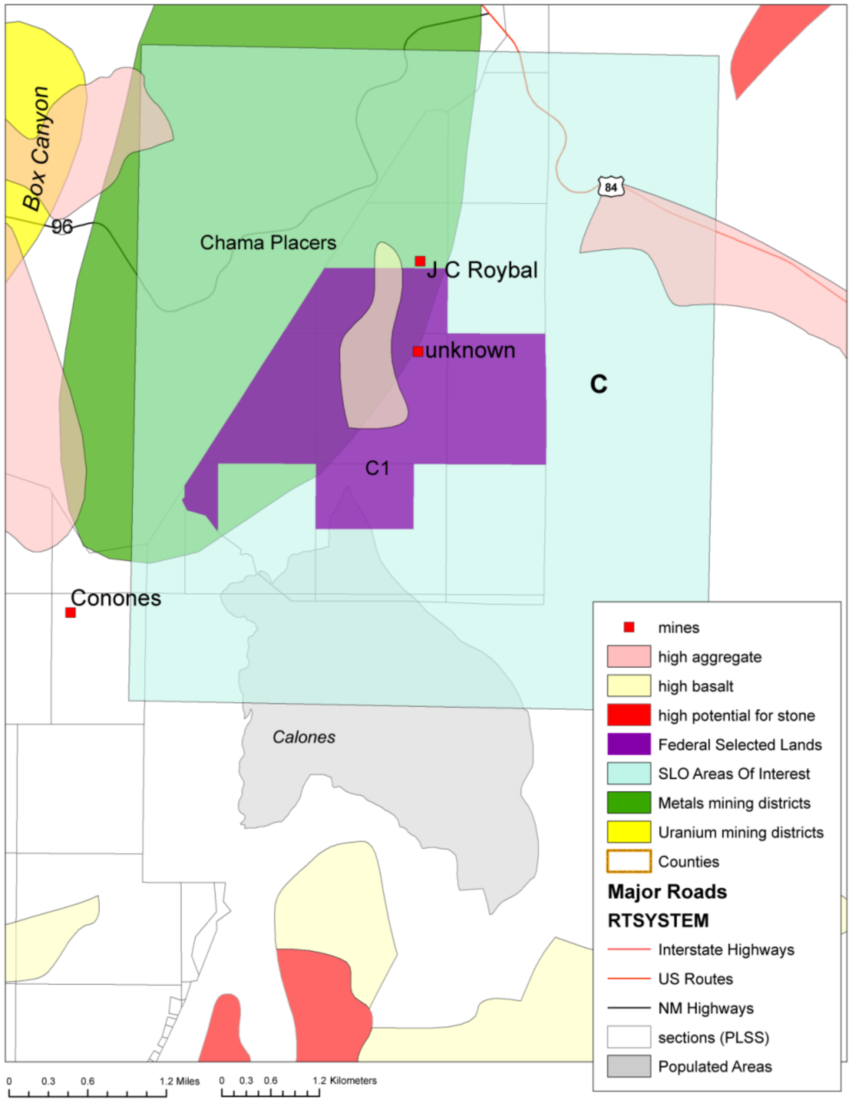


FIGURE 11. Mines, mining districts, and mineral-resource potential for aggregates, basalt, and stone in Area C. Note that the Chama Placers mining district has a moderate mineral-resource potential for placer gold deposits. See Figure 1 for location of Area C. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

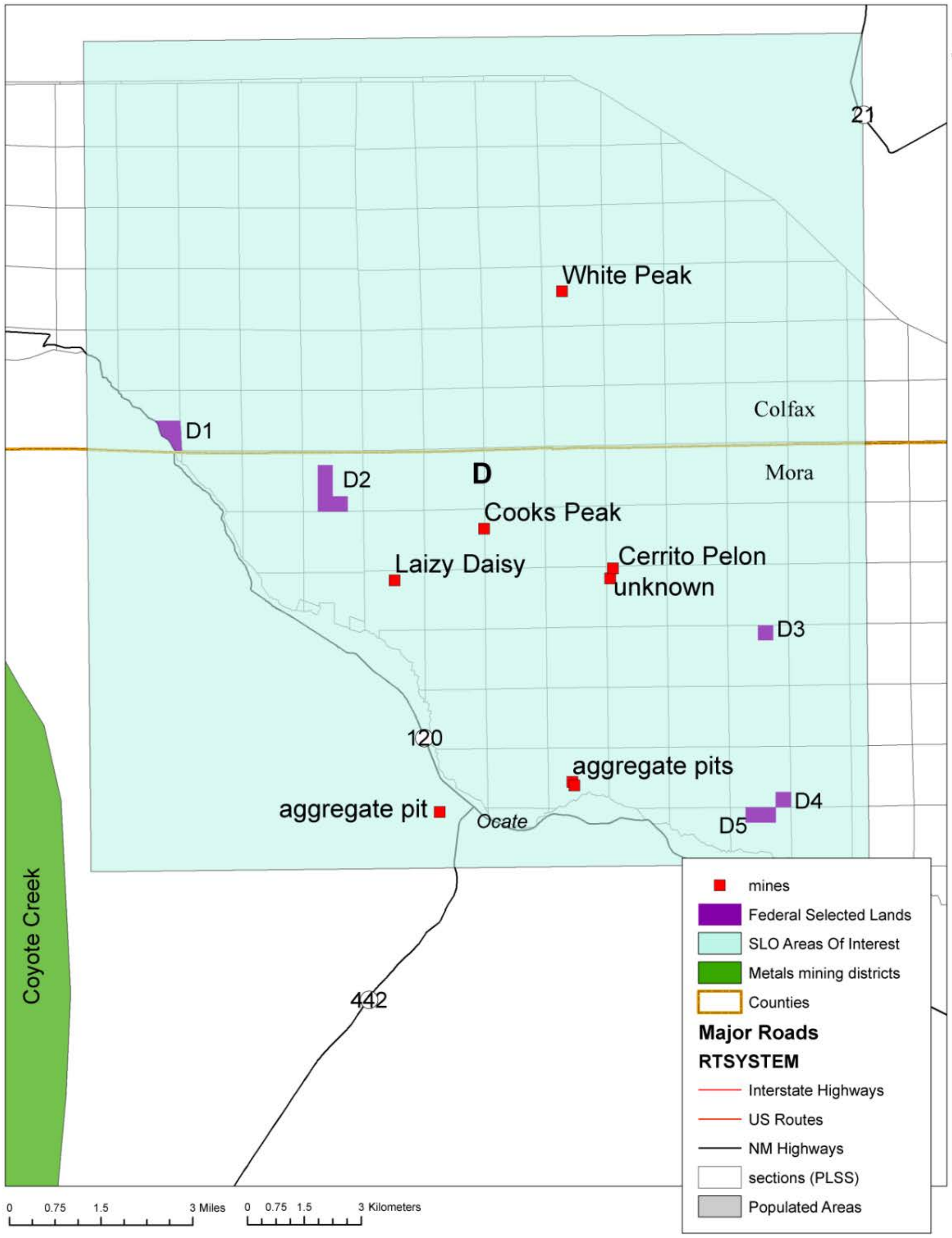


FIGURE 12. Mines in Area D. See Figure 1 for location of Area D. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

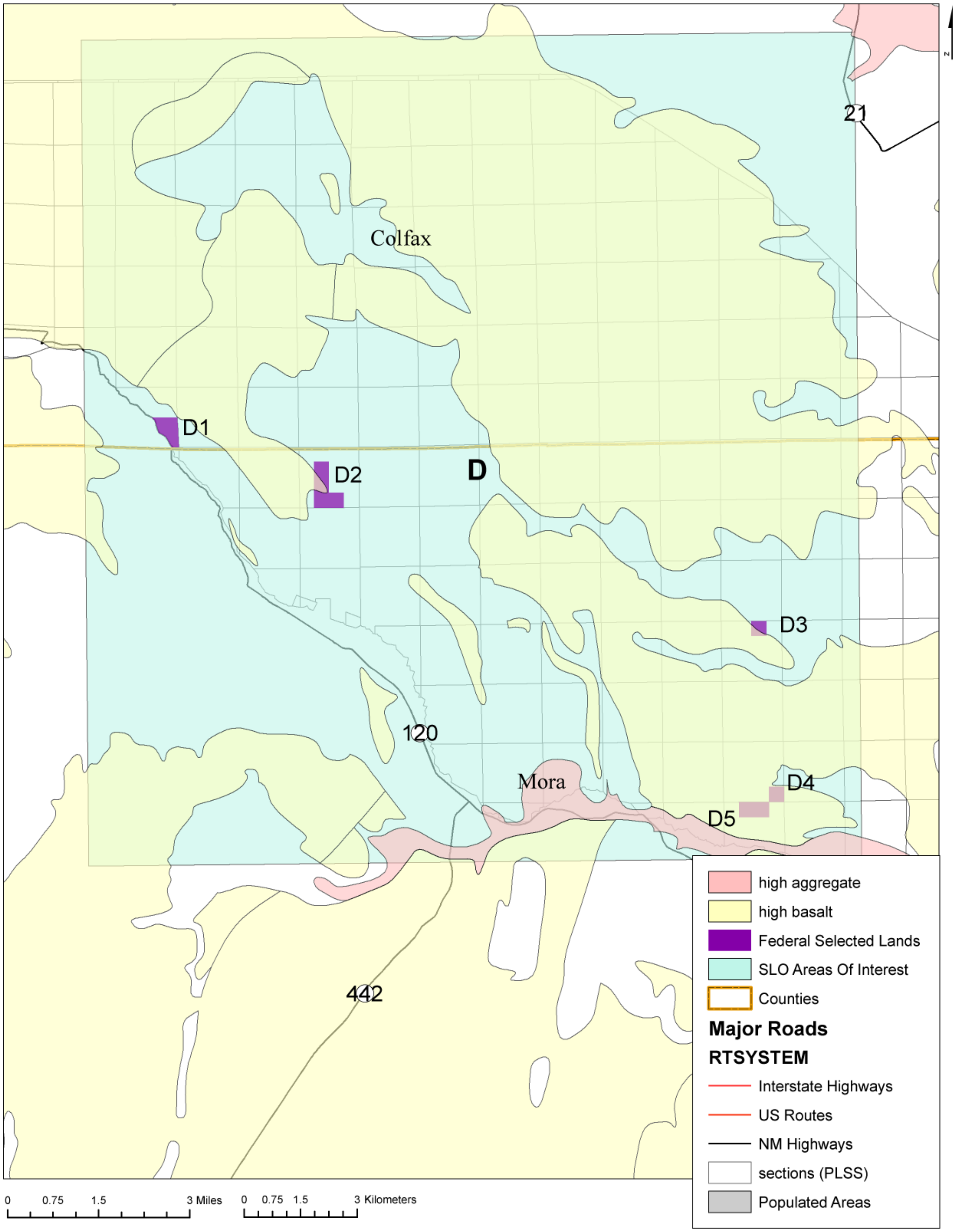


FIGURE 13. Mineral resource-potential for basalt, andesite and scoria (stone) and sand and gravel (aggregates) in Area D. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area E

Area E is in T23N, R22E on the southern flank of the Cimarron Arch, south of Springer along I-25 in Colfax and Mora Counties (Fig. 14). There are no active mines (Fig. 5), mining districts, or mining claims in Area E. One gravel pit (NMCO0191) once produced aggregates.

The mineral-resource potential for sand and gravel (aggregates) is high with a high level of certainty along three arroyos and streams (Fig. 14). All of Area E has a low mineral-resource potential with a moderate level of certainty for uranium (McLemore and Chenoweth, 1989, 2017).

## Area F

Area F is in T17N, R8E on the northern flank of the Espanola Basin, north of Santa Fe in Santa Fe County (Fig. 15). There are no mining districts or active mines (Fig. 5) in Area F, but past mining claims were staked in the southwestern corner of Area F. Five (NMSF0049, NMSF0196, NMSF0197, NMSF0198, NMSF0199) sand and gravel mines are in Area F and additional sand and gravel mines lie adjacent to Area F.

The mineral-resource potential for sand and gravel (aggregates) is high with a high level of certainty in the eastern half of Area F. The mineral-resource potential for basalt, andesite, and scoria (crushed stone, aggregates) is high with a high level of certainty in the western half of Area F (Fig. 15). The mineral-resource potential for pumice is high with a high level of certainty in the northwestern corner of Area F (McLemore, 2017; McLemore and Austin, 2017).

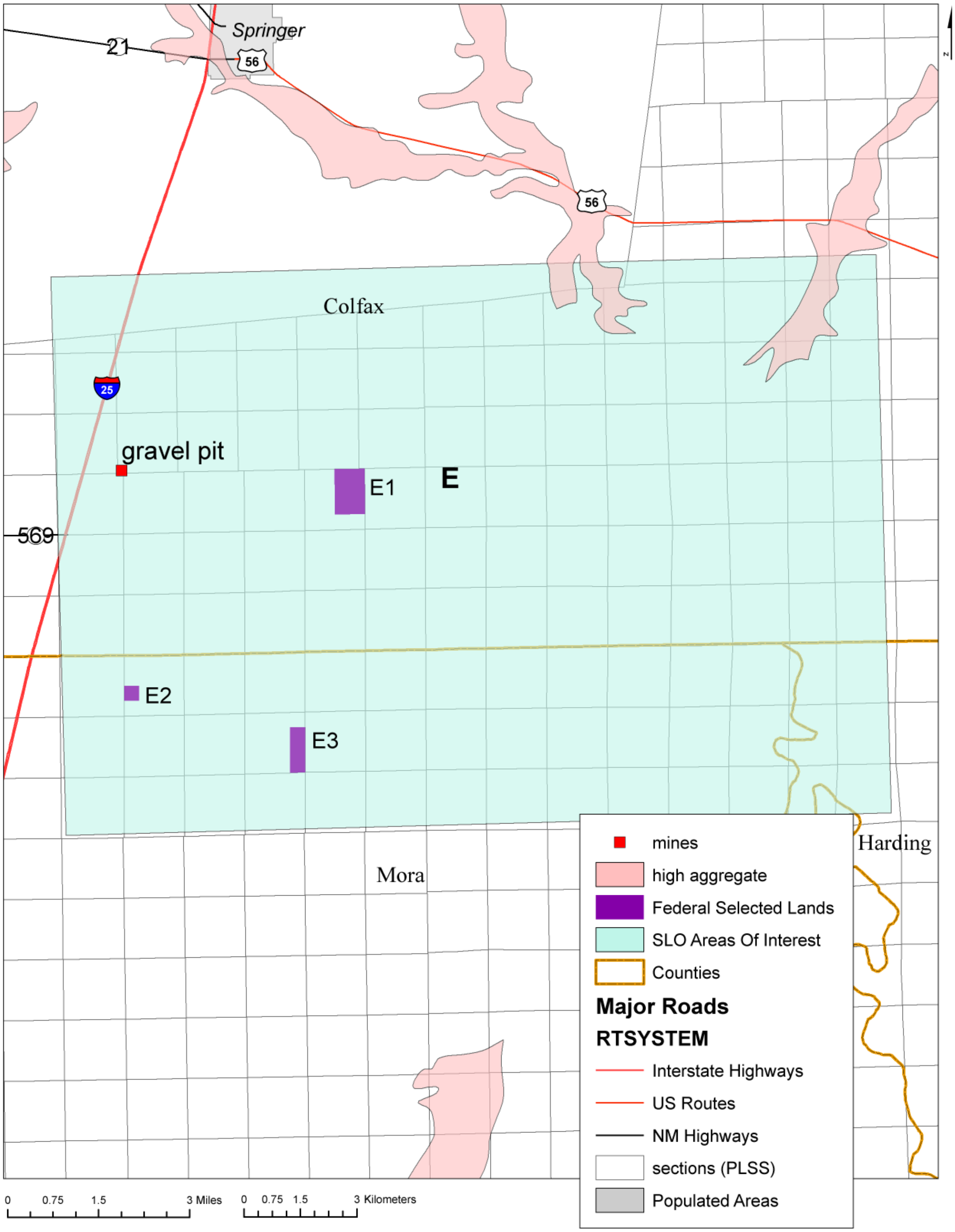


FIGURE 14. Mines and mineral-resource potential for sand and gravel (aggregates) in Area E. All of Area E has a low mineral-resource potential for uranium. See Figure 1 for location of Area

E. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

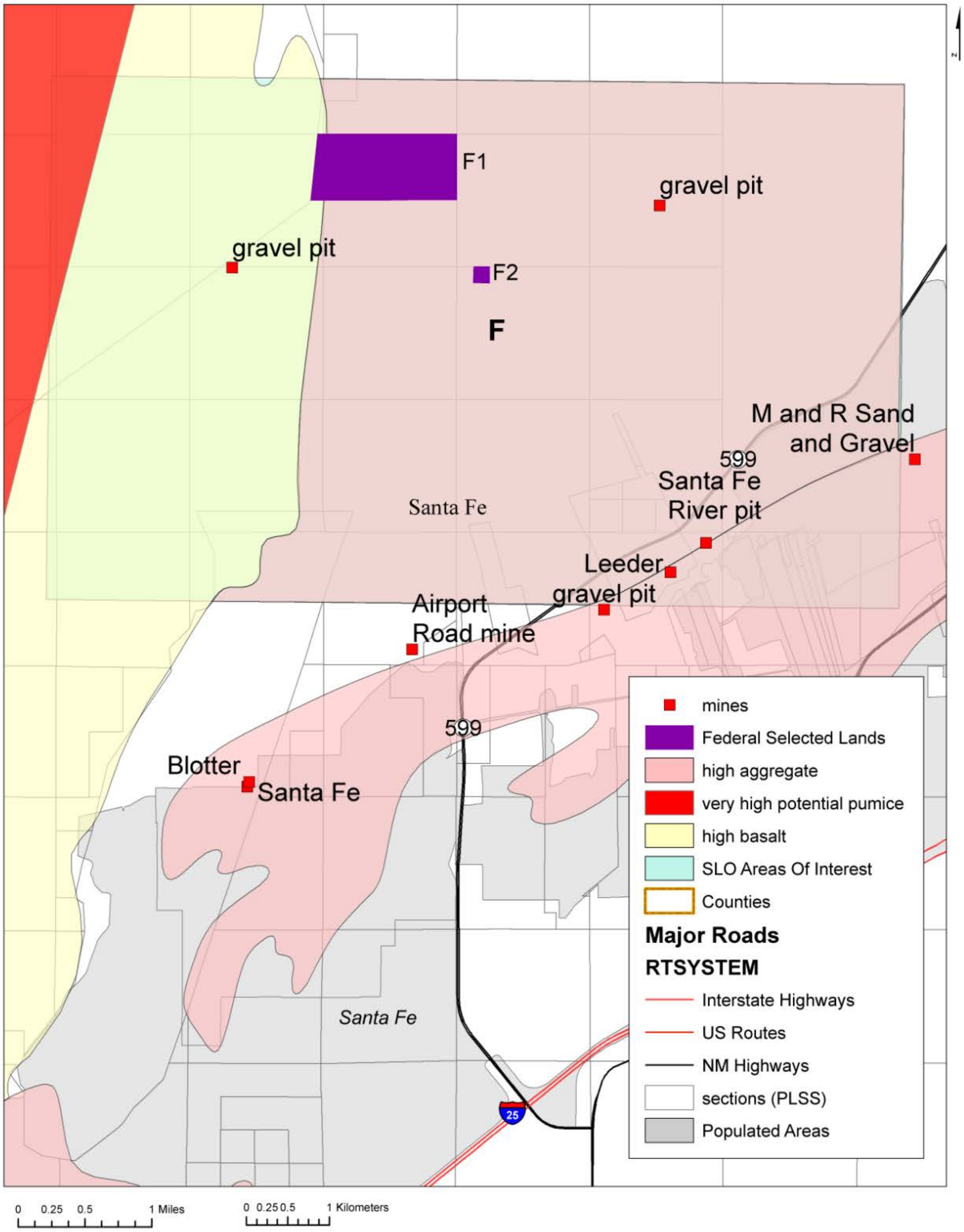


FIGURE 15. Mines and mineral-resource potential for sand and gravel (aggregates) and pumice in Area F. See Figure 1 for location of Area F. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area G

Area G is in T12N, R10E on the southeastern flank of the Espanola Basin, south of Santa Fe in Santa Fe County. There are no active mines (Fig. 5), inactive mines or occurrences, mining districts, or mining claims in Area G.

The mineral-resource potential for sand and gravel (aggregates) is moderate with a moderate level of certainty in most of Area G where Quaternary sediments are exposed (Fig. 16). The mineral-resource potential for gypsum and limestone is high with a high level of certainty and moderate with a moderate level of certainty for silica sand within a small area in the northern part of Area G where the San Rafel Group (Entrada Sandstone, Todilto Formation) is exposed (Fig. 16). The mineral-resource potential for stone (crushed and dimension) is high with a high level of certainty in the northeastern portion of Area G (Fig. 16).

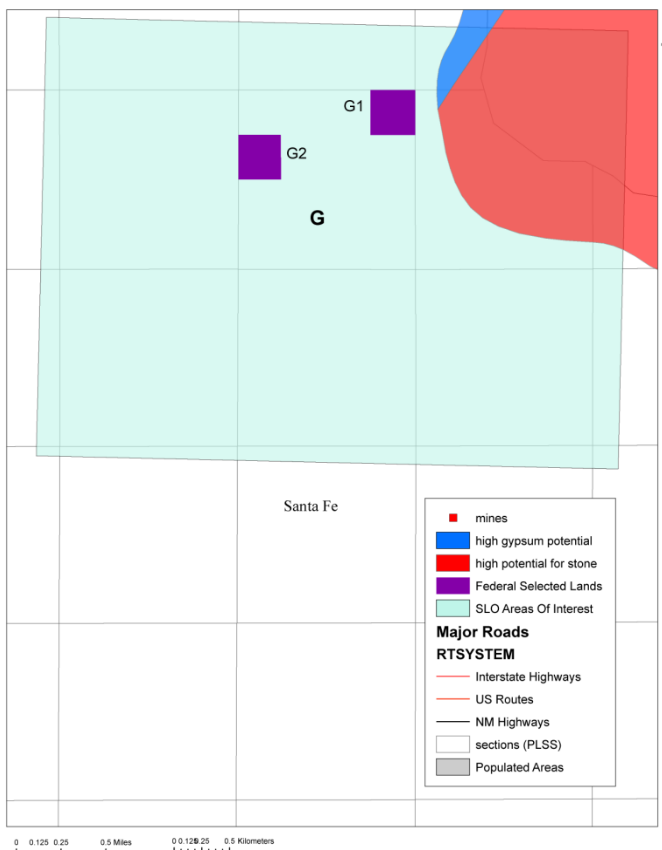


FIGURE 16. Mineral-resource potential for Area G. See Figure 1 for location of Area G. The mineral-resource potential for sand and gravel is moderate with a moderate level of certainty in most of Area G. The mineral-resource potential for gypsum and limestone is high with a high level of certainty and moderate with a moderate level of certainty for silica sand within a small area in the northern part of Area G where the San Rafel Group (Entrada Sandstone, Todilto

Formation) is exposed. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area H

Area H is in T10N, R10E in the southern Espanola Basin and Pedernal Uplift, north of Moriarty in Santa Fe County. The El Cuervo Butte mining district (DIS182) is in Area H and individual BLM land parcels fall within the district (Fig.17; North and McLemore, 1985; McLemore, 2017). Rio Grande Rift (RGR) barite-fluorite veins are found in the El Cuervo Butte mining district. There are no active mines (Fig. 5) or mining claims, but several mines and occurrences are found in Area H.

The mineral-resource potential for barite, fluorite, and galena is moderate with a high level of certainty in the El Cuervo Butte mining district (Fig. 17), but there is no economic market currently for small veins of barite, fluorite, or galena. The mineral-resource potential is moderate with a moderate level of certainty for sand and gravel (aggregates) in the western part of Area H, high with a high level of certainty for limestone where the San Andres Limestone is exposed (Fig. 18), high with a high level of certainty for gypsum where the Yeso Formation is exposed, moderate with a moderate level of certainty for silica sand where the Glorieta Sandstone is exposed, and high with a high level of certainty for stone (crushed and dimension; Fig. 19).

## Area I

Area I is in T9N, R9E on the western Pedernal Uplift, south of Moriarty in Torrance County. The Lobo Hill mining district (DIS256) lies east of Area I, where episyenites and REE-Th-U veins are found (Fig. 20; McLemore, 1984, 2018b; McLemore et al., 1999; McLemore and Lueth, 2017). The episyenites and Proterozoic host rocks are currently quarried for crushed stone. Although there are no active mines in Area I (Fig. 5), there are six sand and gravel (aggregates) mines (NMTO0180, NMTO0181, NMTO0188, NMTO0221, NMTO0253, NMTO0254) in the area. Mining claims have been staked in the eastern half of Area I.

The mineral-resource potential in the Lobo Hill district (DIS256) is very high with a high level of certainty for crushed stone, and moderate with a moderate level of certainty for REE-Th-U (McLemore et al., 1999; McLemore, 2015b; McLemore and Lueth, 2017). However in Area I, there is unknown mineral-resource potential with a low level of certainty for REE-Th-U and uranium. The mineral-resource potential for sand and gravel (aggregates) is high with a high level of certainty in Area I.

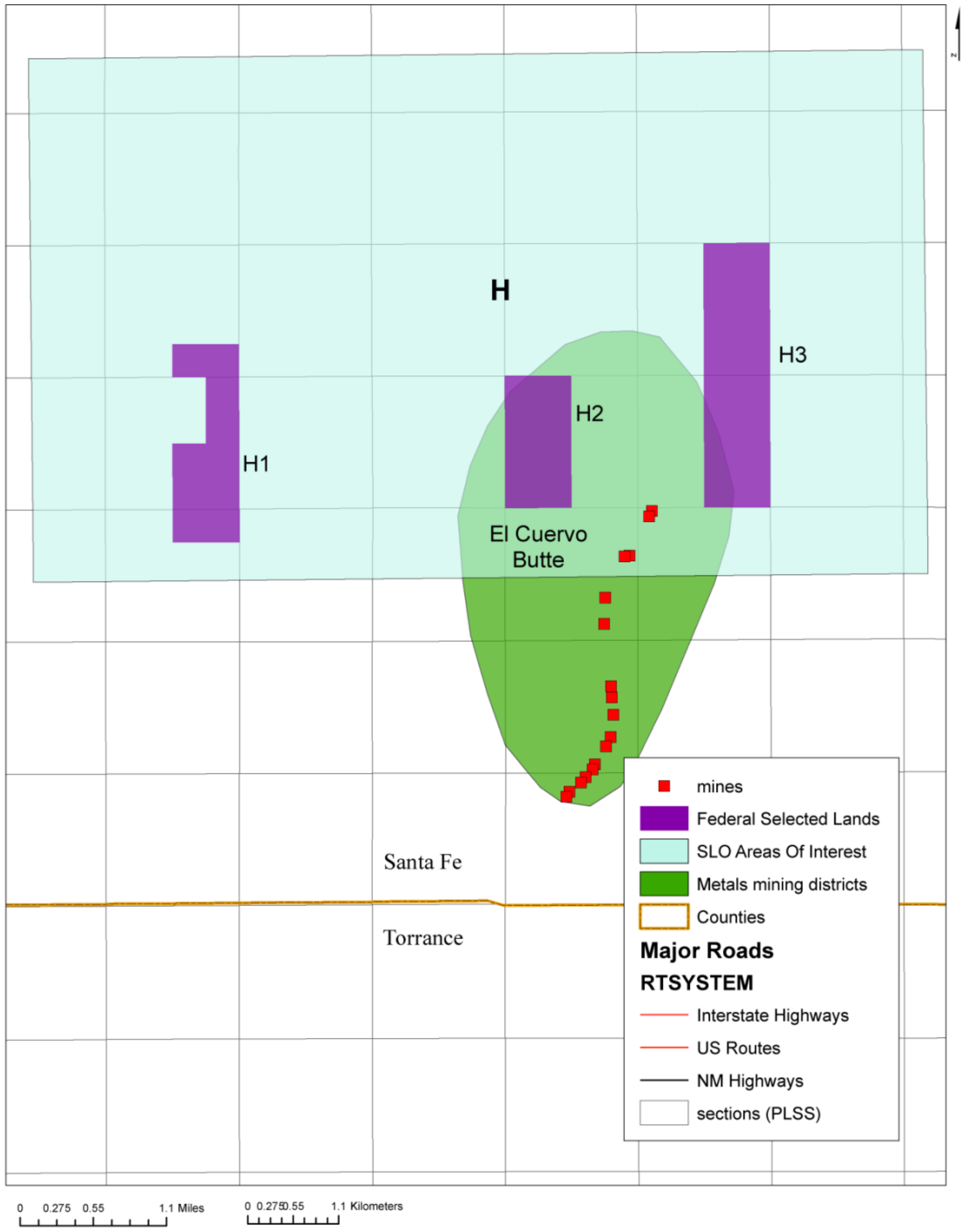


FIGURE 17. Mines and mining districts in Area H. Note that the mineral-resource potential for barite, fluorite, and galena is moderate in the El Cuervo Butte mining district. See Figure 1 for location of Area H. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

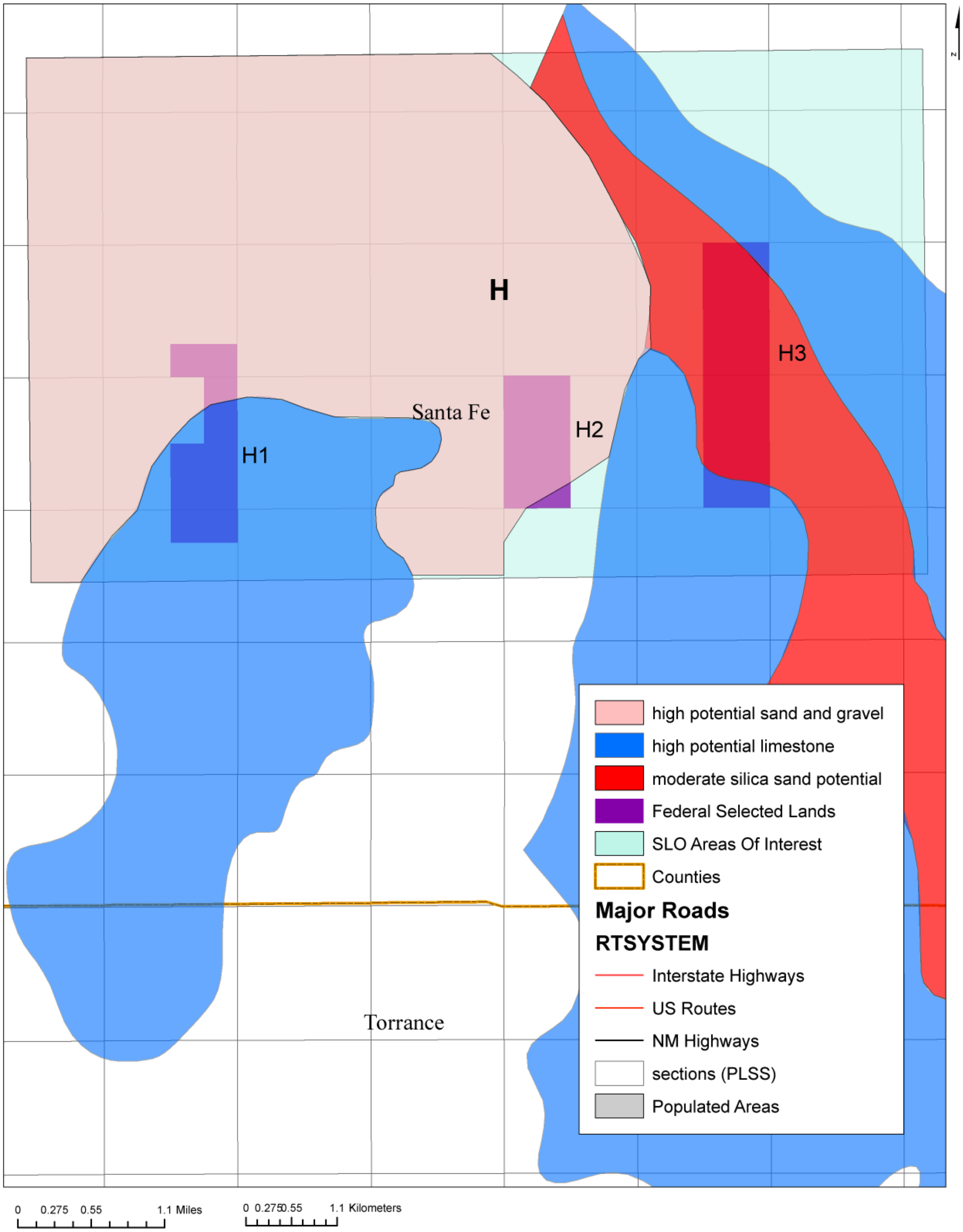


FIGURE 18. Mineral-resource potential for sand and gravel, limestone, and silica sand in Area H. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

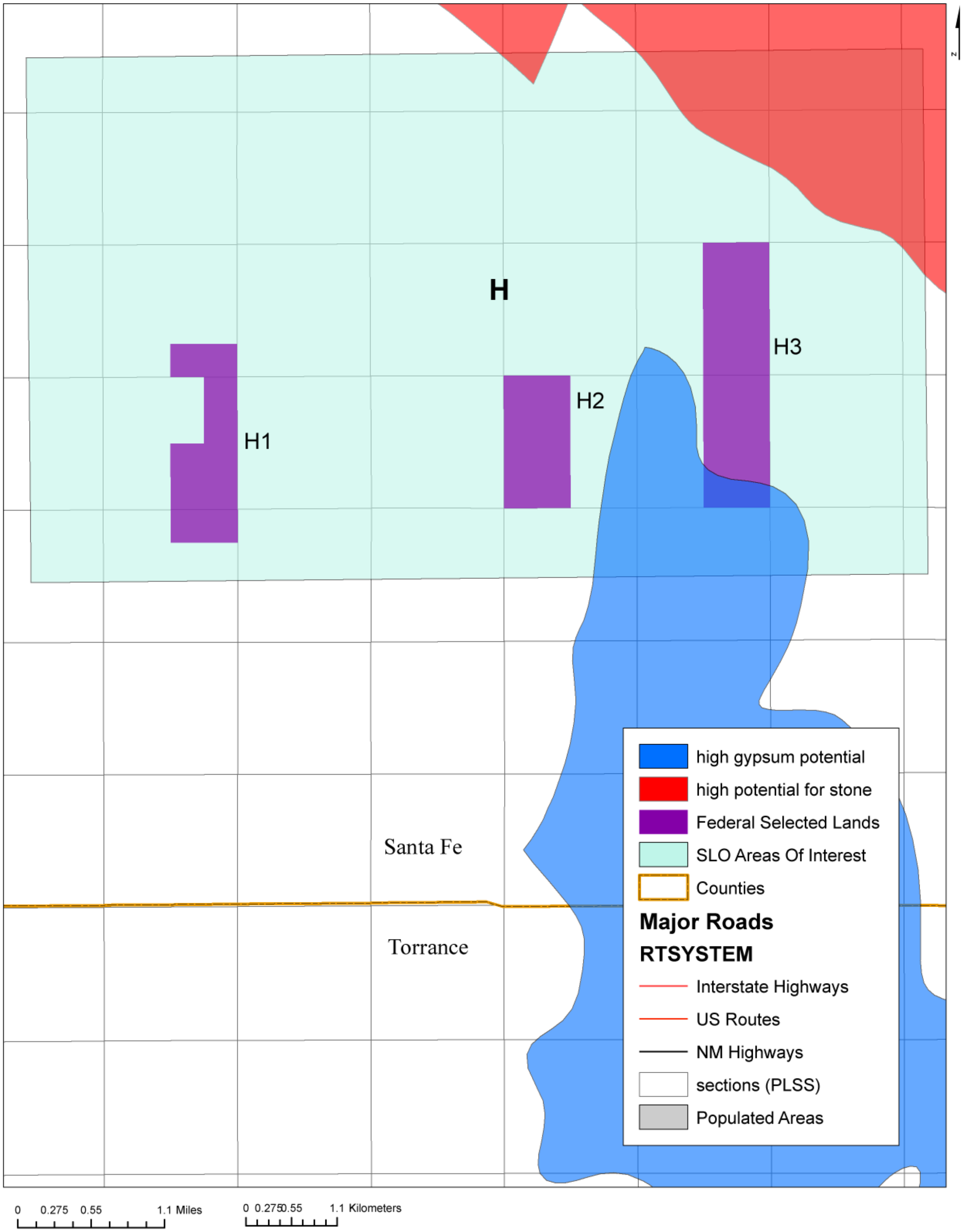


FIGURE 19. Mineral-resource potential for gypsum and stone in Area H. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

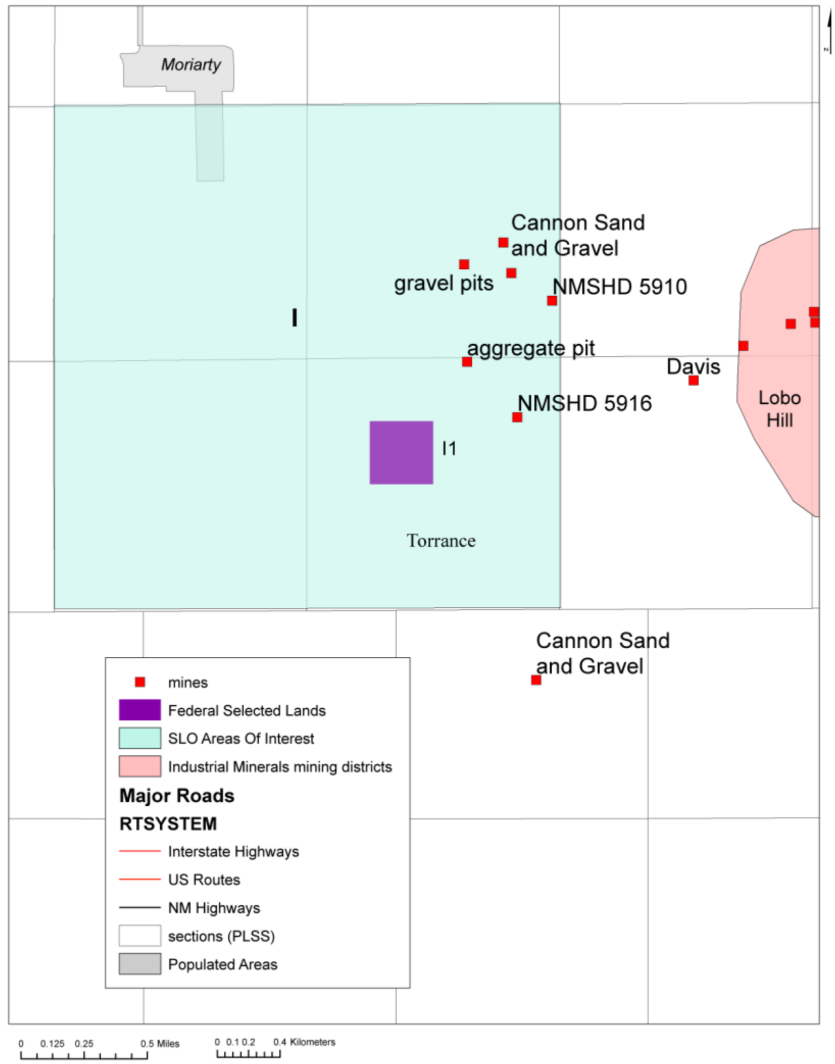


FIGURE 20. Mines in Area I. Note that the mineral-resource potential for sand and gravel (aggregates) is high in Area I. See Figure 1 for location of Area I. The mineral-resource potential is very high for crushed stone, and moderate for REE-Th in the Lobo Hill mining district. There is unknown mineral-resource potential with a low level of certainty for REE-Th-U in Area I. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area J

Area J is in T5-6N, R9-10E in the Estancia Basin, south of Estancia in Torrance County (Fig. 21). The playa lake deposits in the Estancia Salt mining district (DIS243) are in Area J (Jones, 1904; McLemore, 1984; McLemore and Austin, 2017). Although there are no active mines in Area J (Fig. 5), mining claims have been staked in the eastern part of Area J. Two gravel mines are in the area (NMTO0251, NMTO0252). In addition to halite, blödite ($Na_2Mg(SO_4)_2 \cdot 4H_2O$) and glauberite ($Na_2Ca(SO_4)_2$) have been found in the Estancia playa lakes, indicating a potential source for sodium.

The Estancia Salt mining district has a high mineral-resource potential with a high level of certainty for salt, moderate with a moderate level of certainty for sodium, and unknown with a low level of certainty potential for lithium, strontium, bromine, and boron (Fig. 22). The mineral-resource potential is moderate with a moderate level of certainty for silica sand in two small areas of Area J, and the mineral-resource potential is moderate with a moderate level of certainty for gypsum (Fig. 23). The mineral-resource potential is unknown with a low level of certainty for uranium in playa lake deposits in the Estancia Salt mining district.

## Area K

Area K is T1S-T5N, R16-19E in the Permian and Tucumcari Basins, near Vaughn in Lincoln and Guadalupe Counties. There are no mining districts, active mines, or mining claims in Area K, but there are several inactive mines and occurrences in the area (Fig. 24).

The mineral-resource potential is high with a high level of certainty for limestone in the Ogallala (as caliche) and San Andres Formations (Fig. 25; Bartsch-Winkler and Donatich, 1995; McLemore and Austin, 2017), is high with a high level of certainty for sand and gravel (aggregates) in Quaternary pediment deposits, and moderate with a moderate level of certainty for gypsum (Fig. 25). The mineral-resource potential is high with a high level of certainty for stone (crushed and dimension) in the northern portion of Area K.

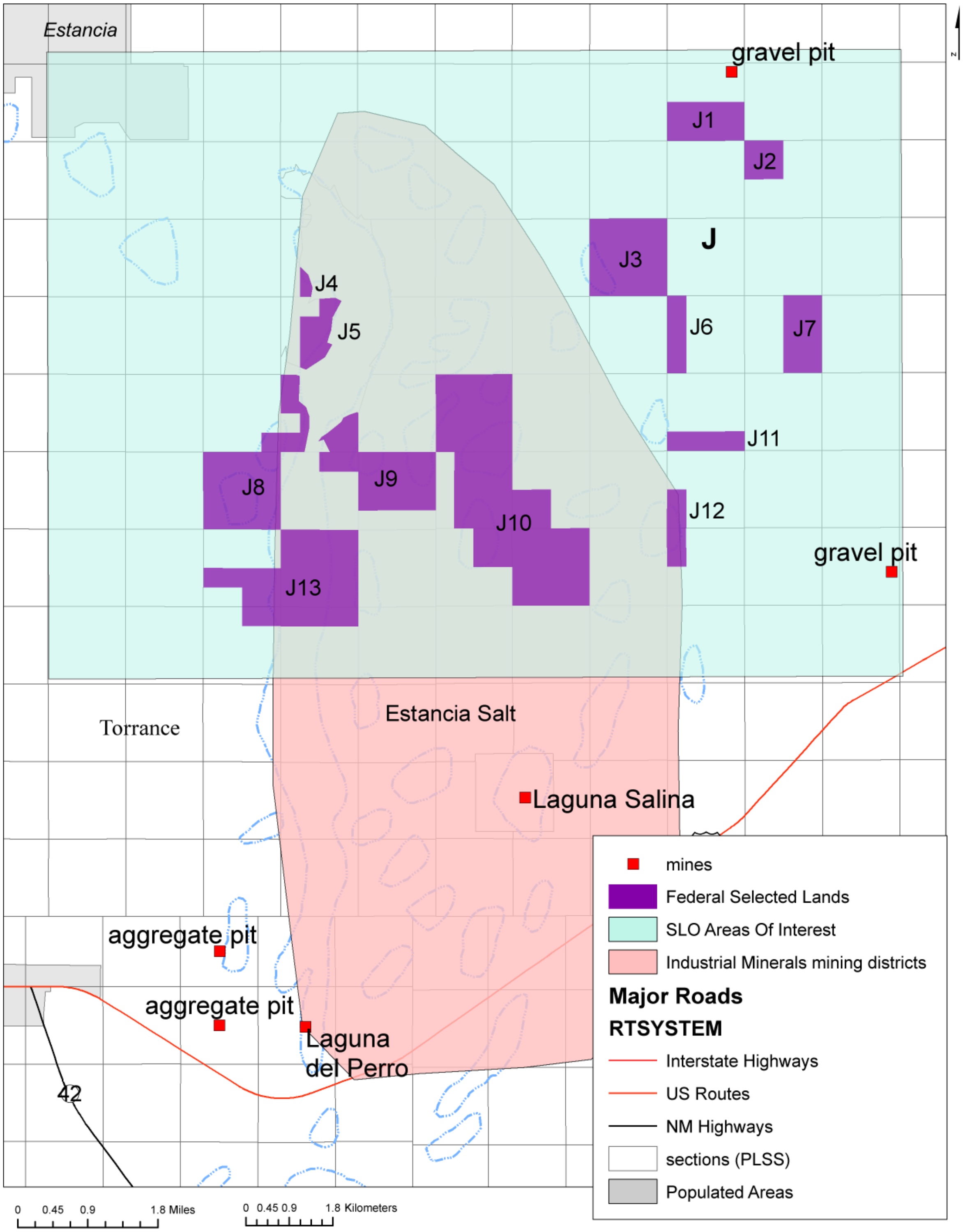


FIGURE 21. Mines and mining districts in Area J. See Figure 1 for location of Area I. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

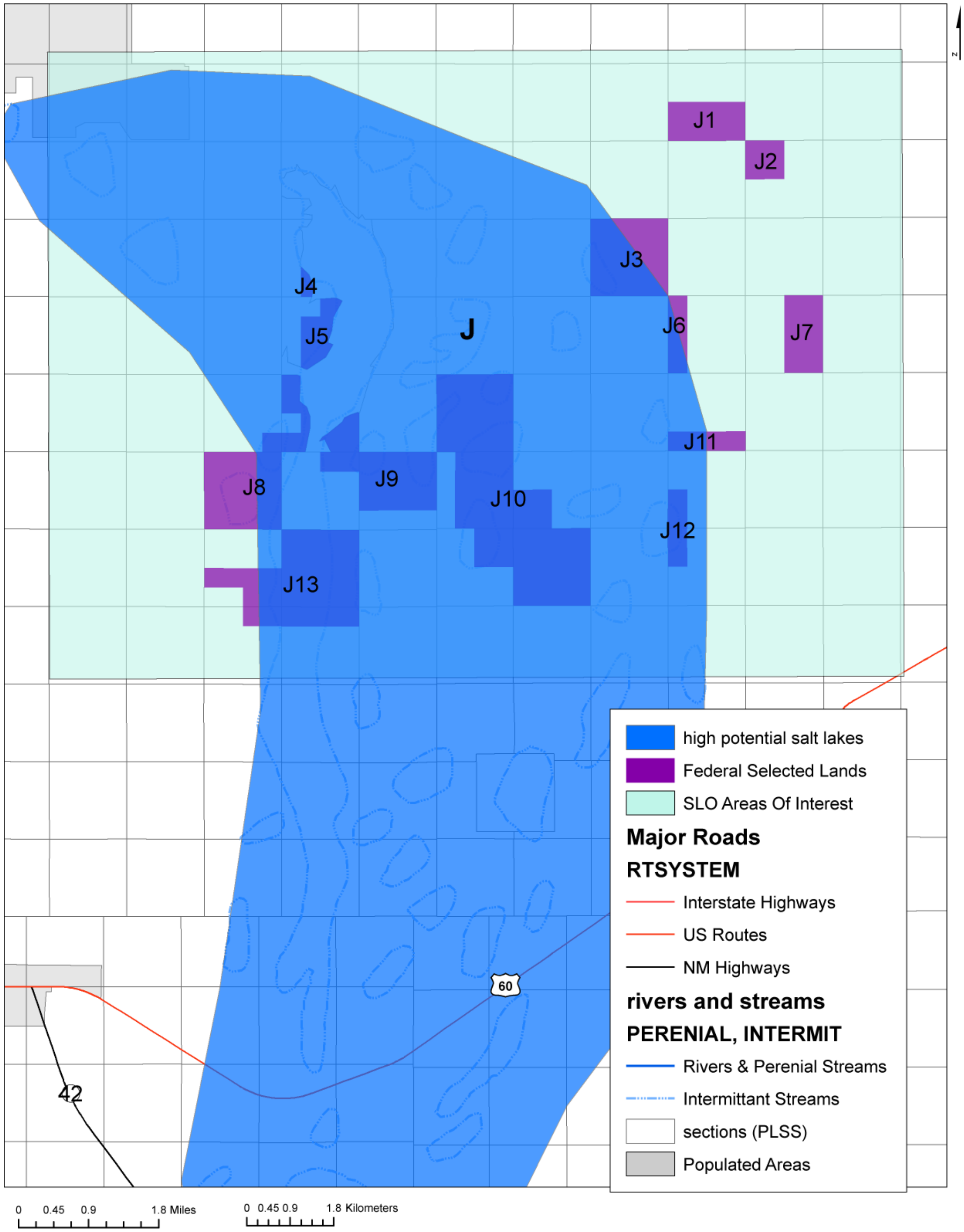


FIGURE 22. Mineral-resource potential for salt in Area J. Note that the Estancia Salt mining district has a high mineral-resource potential for salt, moderate for sodium, and unknown potential for lithium, strontium, bromine and boron. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

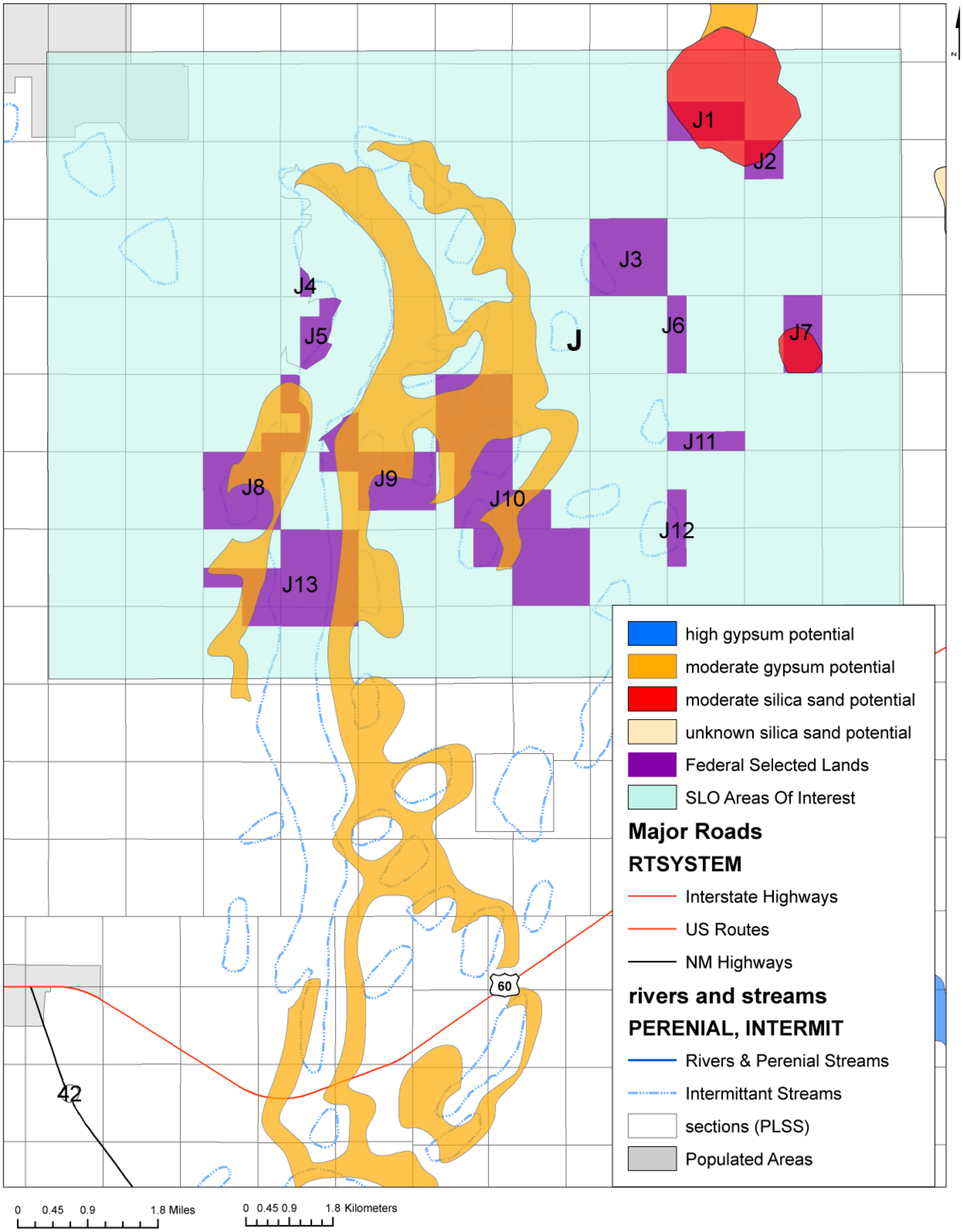


FIGURE 23. Mineral-resource potential for gypsum and silica sand in Area J. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

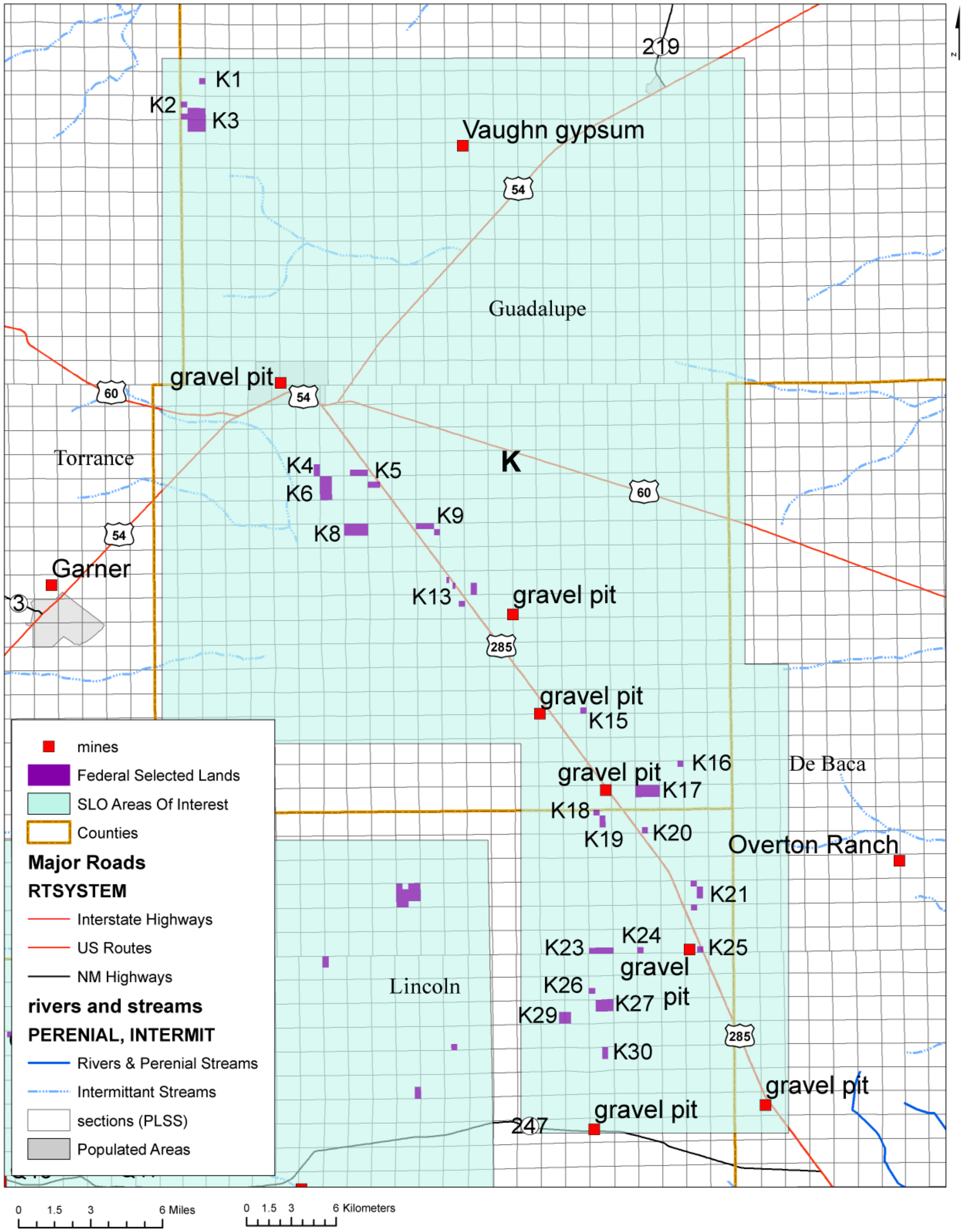


FIGURE 24. Mines in Area K. See Figure 1 for location of Area K. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

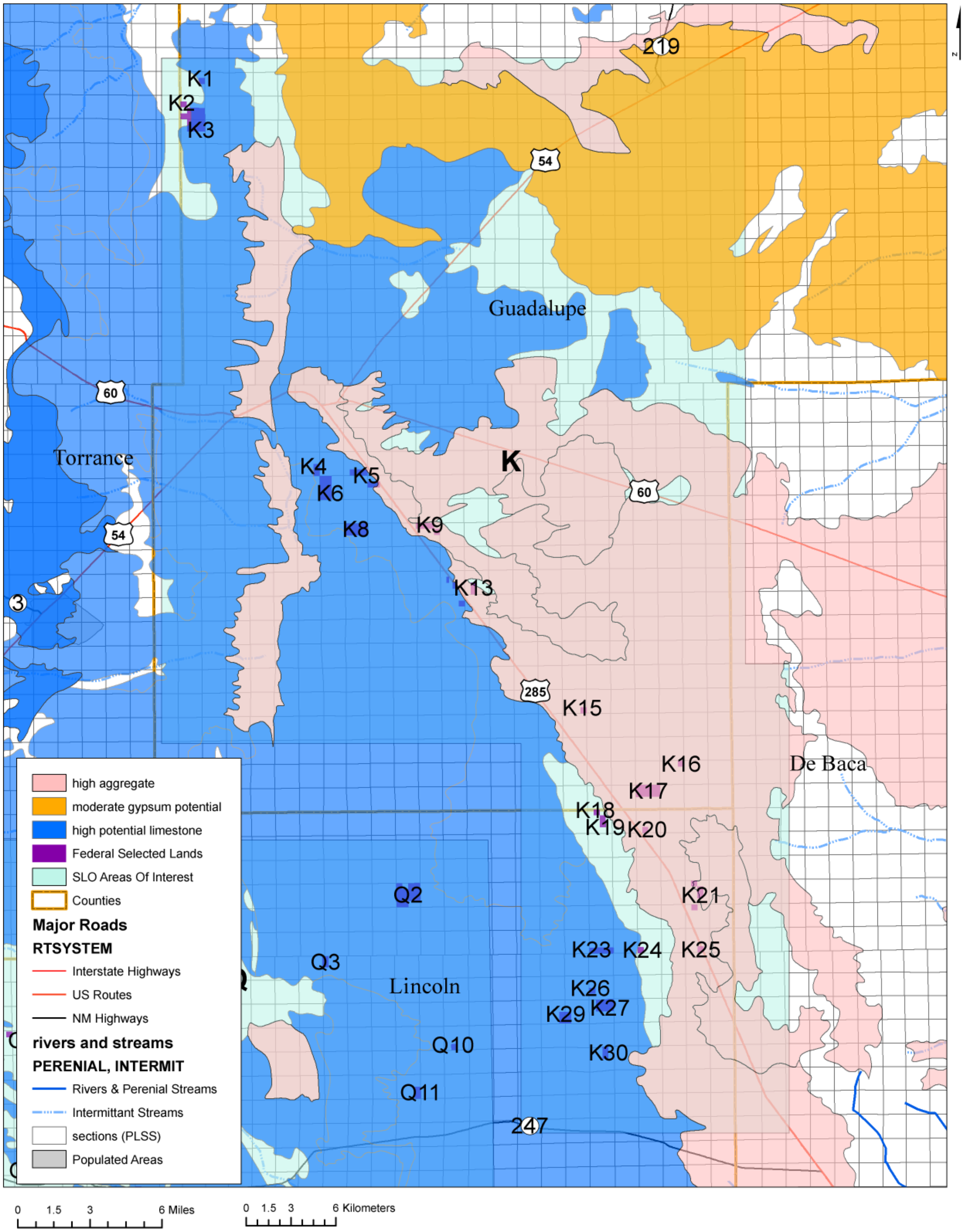


FIGURE 25. Mineral-resource potential for sand and gravel (aggregates), limestone, and gypsum in Area K. See Figure 1 for location of Area K. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area L

Area L is in T2-3N, R5E near Scholle, in the Los Pinos Mountains in Torrance, Socorro, and Valencia Counties. The Scholle mining district (DIS246) lies within Area L (Fig. 26), and mines, occurrences, and mining claims are found in Area L. There are no active mines in Area L (Fig. 5). Small, uneconomic stratabound, sedimentary-copper deposits in the Scholle mining district are restricted predominantly to the lower member of the Abo Formation, with minor occurrences in the upper member of the Bursum Formation and the Meseta Blanca Sandstone Member of the Yeso Formation (McLemore, 1984; 2016b).

The mineral-resource potential is low with a moderate level of certainty for copper, silver, and gold in the Scholle district. The mineral-resource potential is high with a high level of certainty for stone (crushed and dimension) in central portion of Area L (McLemore and Austin, 2017). The mineral-resource potential is high for gypsum with a high level of certainty in southeastern portion of Area L and high with a high level of certainty for limestone in western and southeastern portion of Area L.

## Area M

Area M is in T3N, R7E in the Estancia Basin, south of Mountainair in Torrance County. There are no active or inactive mines or occurrences, mining districts, or mining claims in Area M (Fig. 29; McLemore, 1984).

The mineral-resource potential for gypsum is high with a high level of certainty in the Yeso Formation in the northern part of Area M (Fig. 29). The mineral-resource potential for limestone is high with a high level of certainty in the San Andres and Yeso Formations and moderate to high with a moderate level of certainty for silica sand in the Glorieta Sandstone in Area M (Fig. 30).

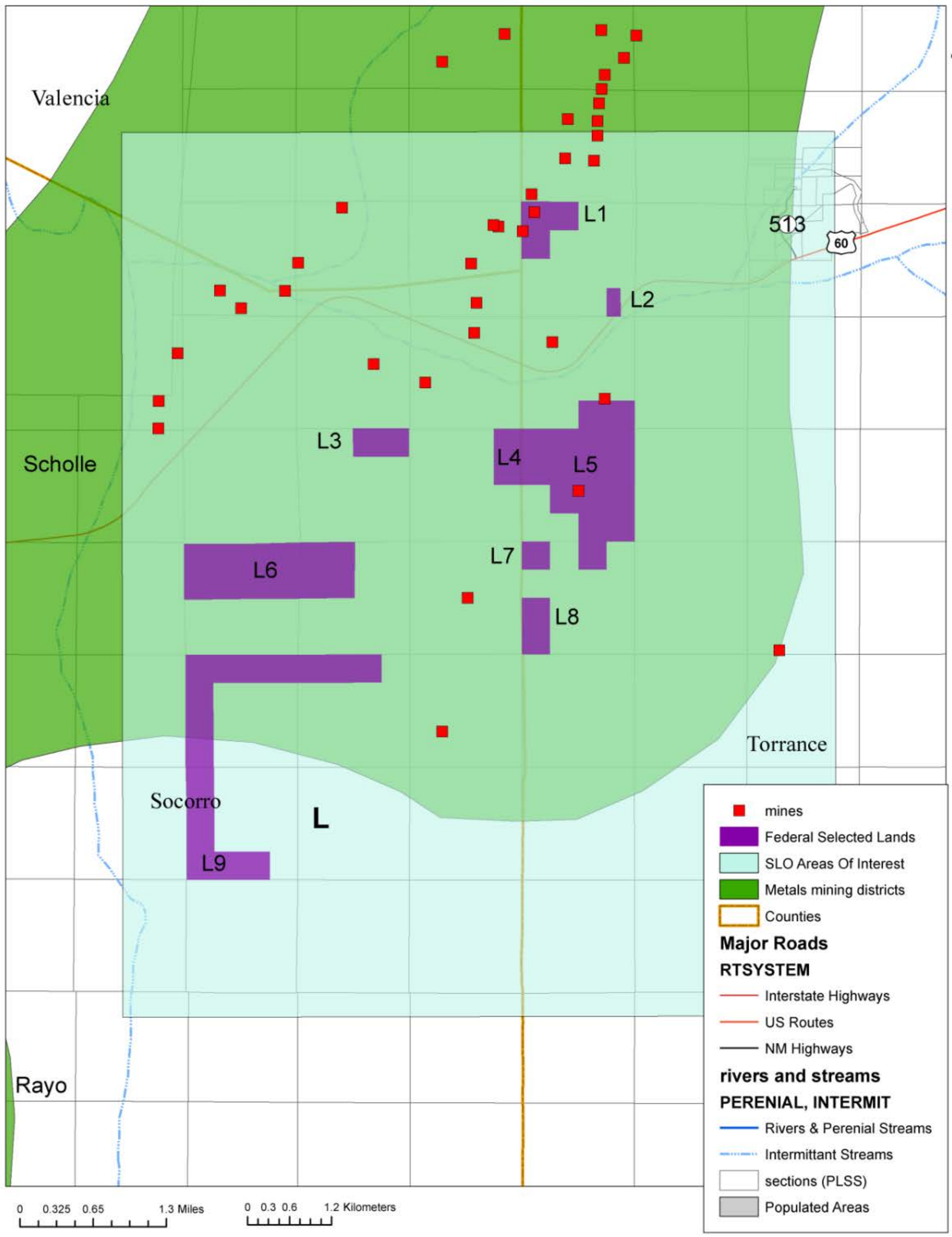


FIGURE 26. Mines and mining districts in Area L. See Figure 1 for location of Area L. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

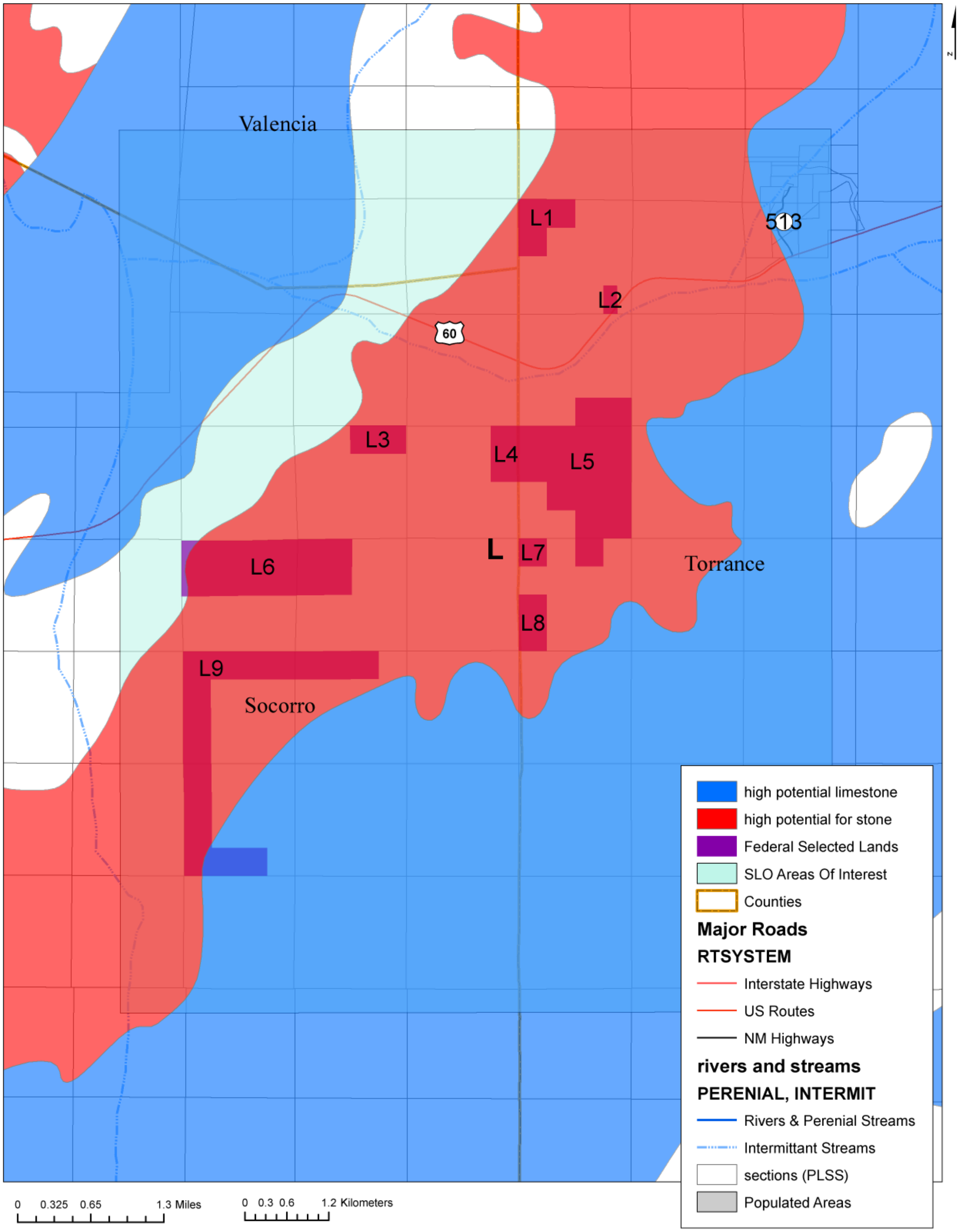


FIGURE 27. Mineral-resource potential for limestone and stone in Area L. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

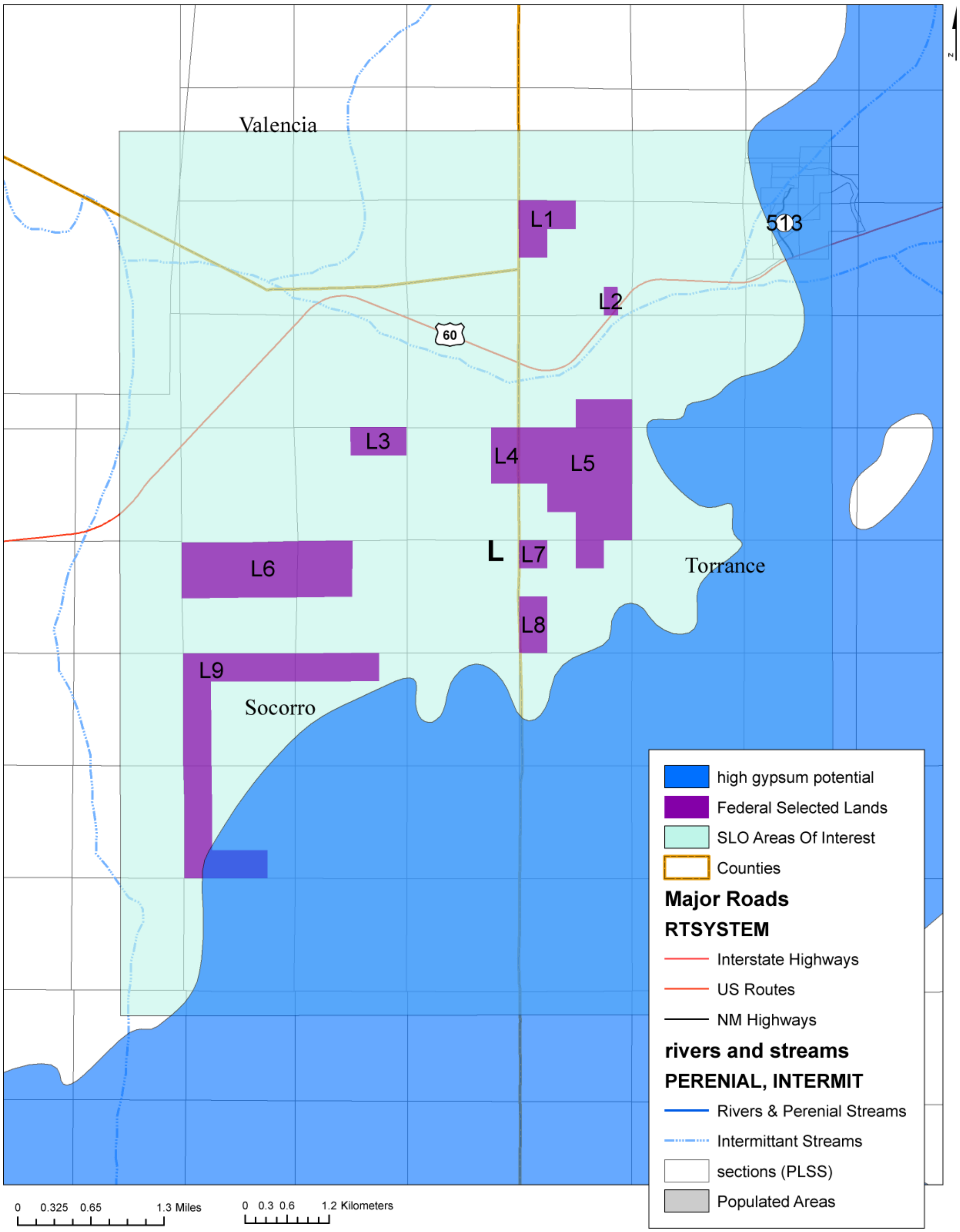


FIGURE 28. Mineral-resource potential for gypsum in Area L. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

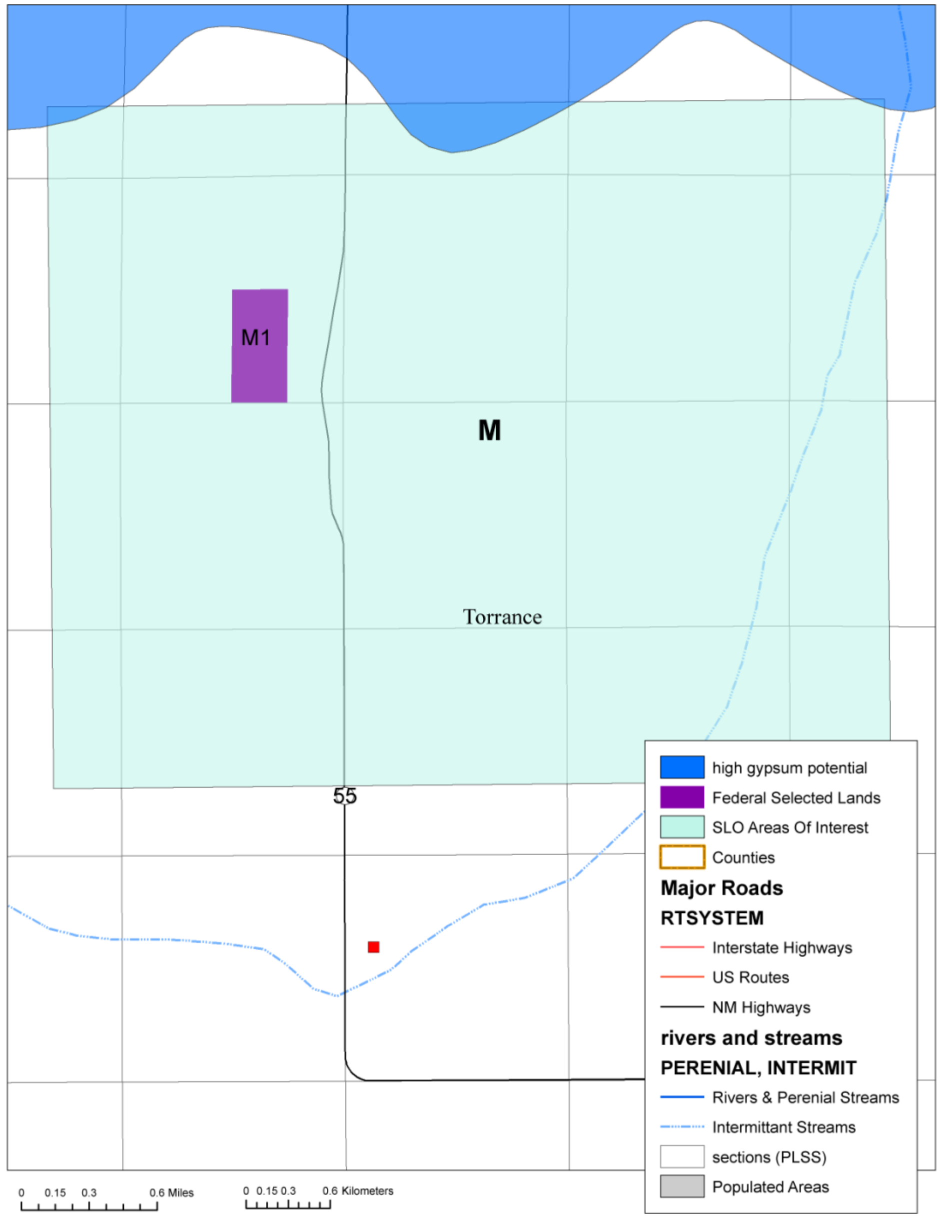


FIGURE 29. Mineral-resource potential for gypsum in Area M. See Figure 1 for location of Area M. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

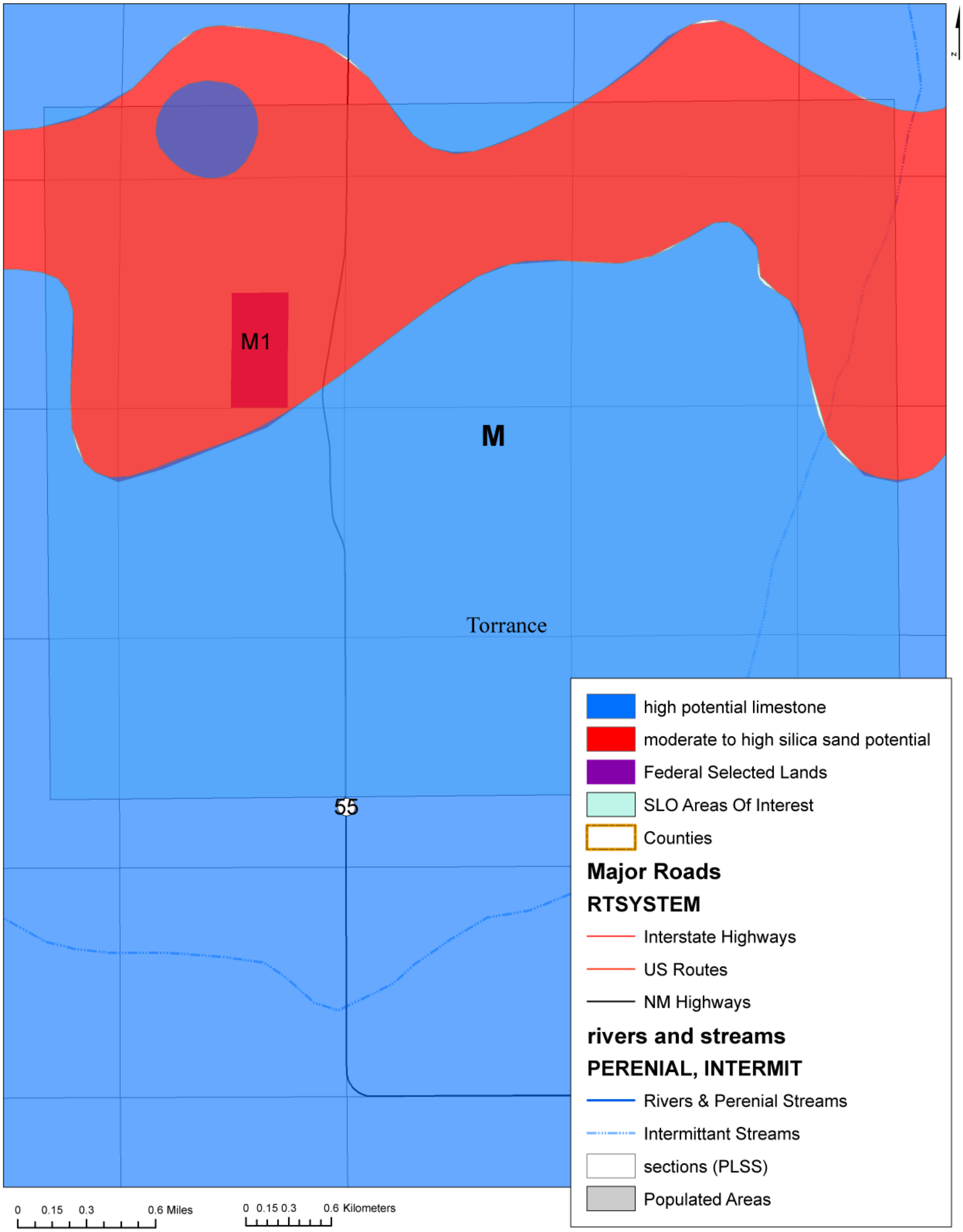


FIGURE 30. Mineral-resource potential for limestone and silica sand in Area M. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area N

Area N is in T1S, R5E, south of Scholle in Torrance and Socorro Counties. Although a small portion of the Chupadera Mesa mining district (DIS241) is in the northeastern corner of Area N (Fig. 31; McLemore, 1984), there are no active or inactive mines or occurrences in Area N. There are mining claims staked in the northern portion of Area N.

The Chupadera Mesa mining district has a low potential with a low level of certainty for iron skarns and replacements in carbonate rocks (Kelley, 1949; McLemore, 1984). The mineral-resource potential for sand and gravel is high with a high level of certainty in portions of Area N. The mineral-resource potential for silica sand is moderate to high with a high level of certainty in the north-central portion of Area N and unknown with a low level of certainty in the southeastern portion of Area N (Fig. 31). The mineral-resource potential for gypsum is high with a high level of certainty (Fig. 31), and for limestone is high with a high level of certainty in portions of Area N (Fig. 32).

## Area O

Area O is in T1N, R8-9E in the northern Chupadera Mesa, southwestern Torrance County (Fig. 33; McLemore, 1984). There are no active or inactive mines, occurrences, mining districts, or mining claims in Area O. The mineral-resource potential for limestone in Area O is high with a high level of certainty in the San Andres Limestone.

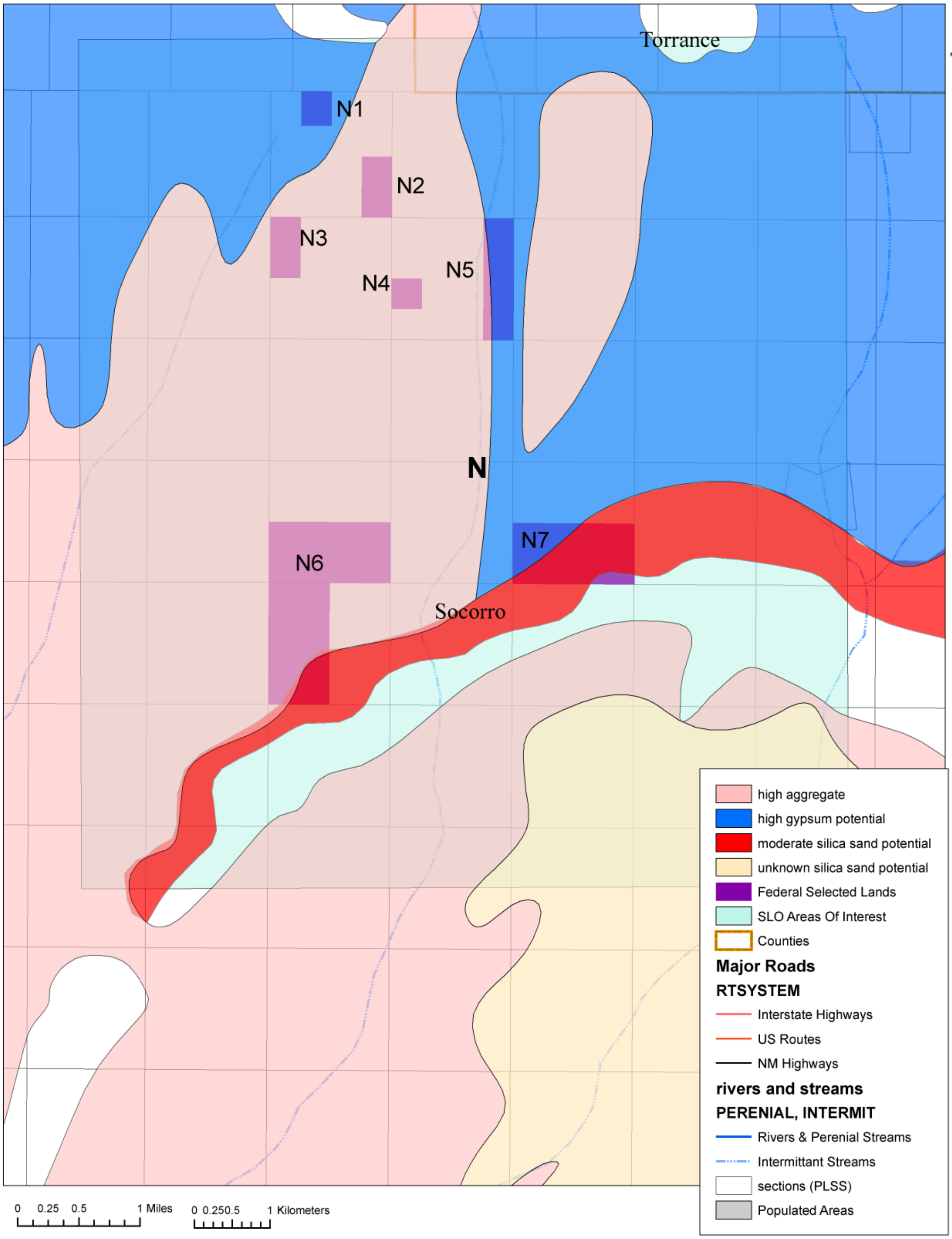


FIGURE 31. Mineral-resource potential for aggregate, gypsum and silica sand in Area N. See Figure 1 for location of Area N. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

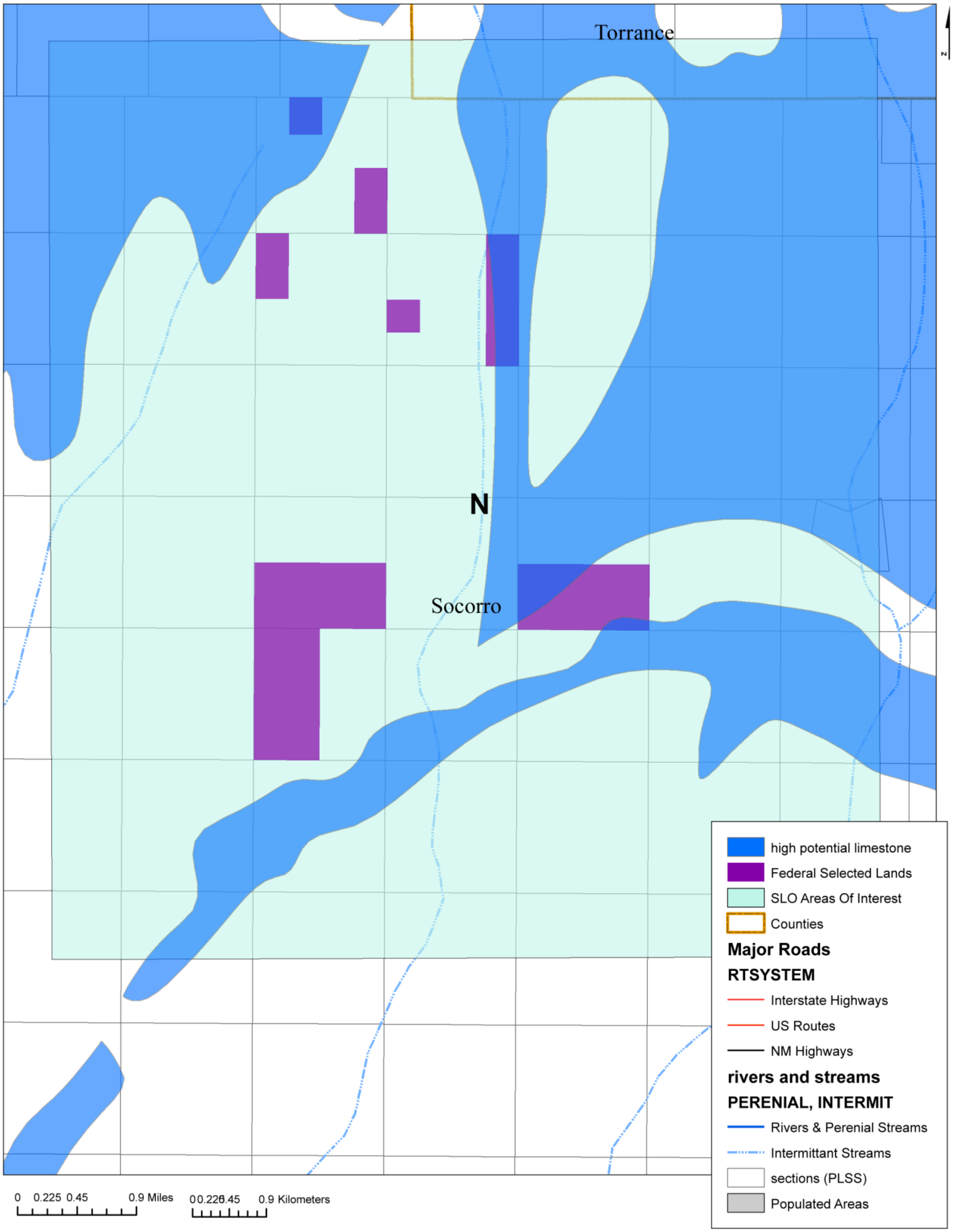


FIGURE 32. Mineral-resource potential for limestone in Area N. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

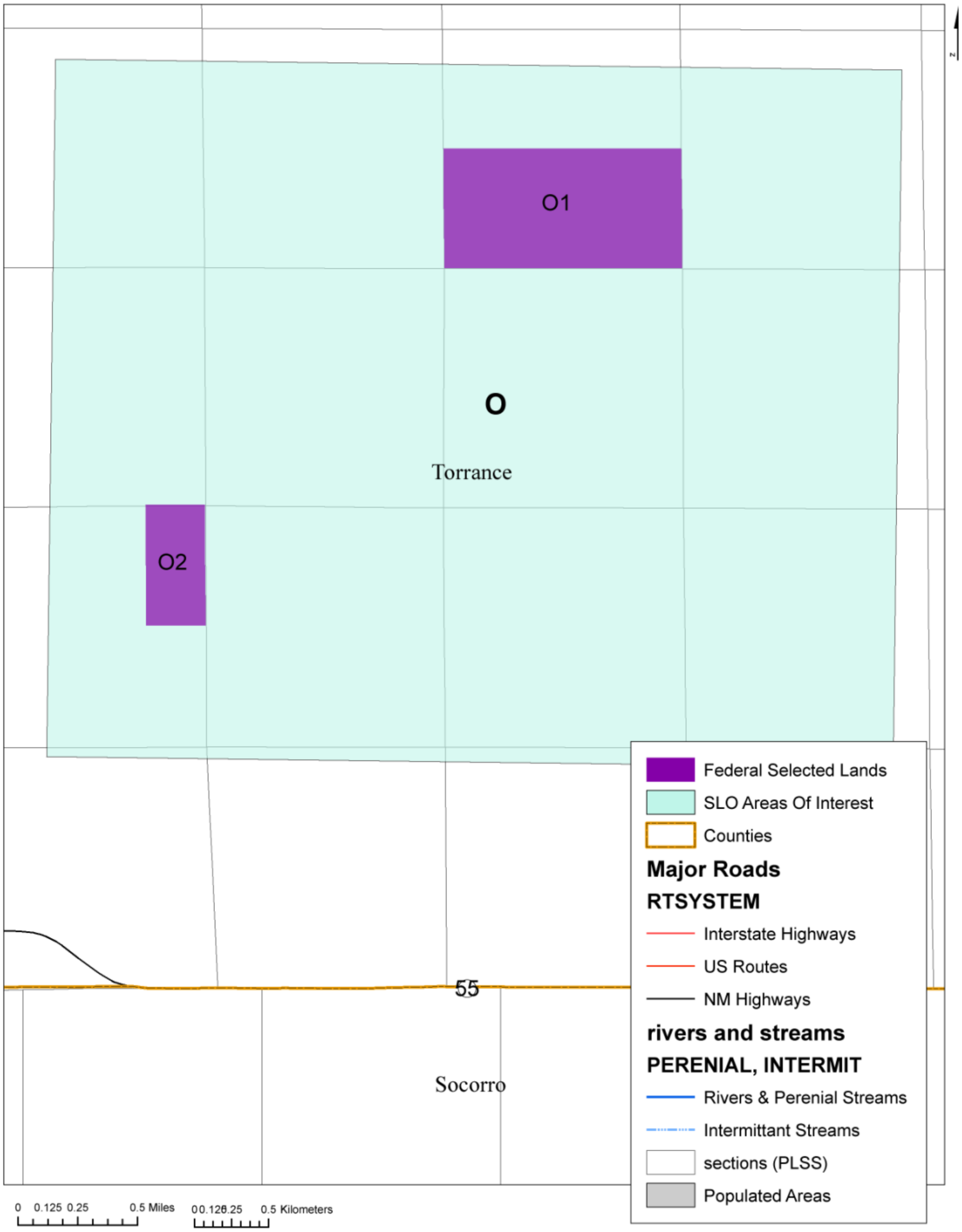


FIGURE 33. Area O in southwestern Torrance County. The mineral-resource potential for limestone in Area O is high with a high level of certainty. See Figure 1 for location of Area O. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area P

Area P is in T2-4S, R10-11E on Chupadera Mesa in eastern Socorro and western Lincoln Counties and is west of Area Q. Portions of the Gallinas Mountains (DIS092), Tecolote (DIS098), and Ancho (DIS089) mining districts are in Area P, and mines and mining claims are found in portions of Area P (Fig. 34; Kelley, 1949; McLemore, 1991, 2010b, 2015b, 2016a, 2018b; Korzeb and Kness, 1992; Schreiner, 1993; Bartsch-Winkler and Donatich, 1995). There are no active mines in Area P (Fig. 5). Although there are no reported active mines in Area P, some additional sand and gravel mines may be active to supply raw material for current road construction in the area. Fire clay, mostly made into bricks, structural tile, and firebrick, was produced from the Ancho district from about 1902 to 1922 and Korzeb and Kness (1992) report an inferred resource of fire clay for structural materials in the Dakota and Chinle Formations in the Ancho district.

The mineral-resource potential is high with a moderate level of certainty for REE; moderate with a moderate level of certainty for gold, silver, and iron; and low with a moderate level of certainty for copper, molybdenum, uranium, and tellurium in the Gallinas Mountains district. The mineral-resource potential is low with a low level of certainty for iron in the Tecolote district. The mineral-resource potential is high with a moderate level of certainty for clay in the Ancho district. The mineral-resource potential is high with a high level of certainty for limestone (Fig. 35), gypsum, and sand and gravel (aggregates; Fig. 36) in portions of Area P.

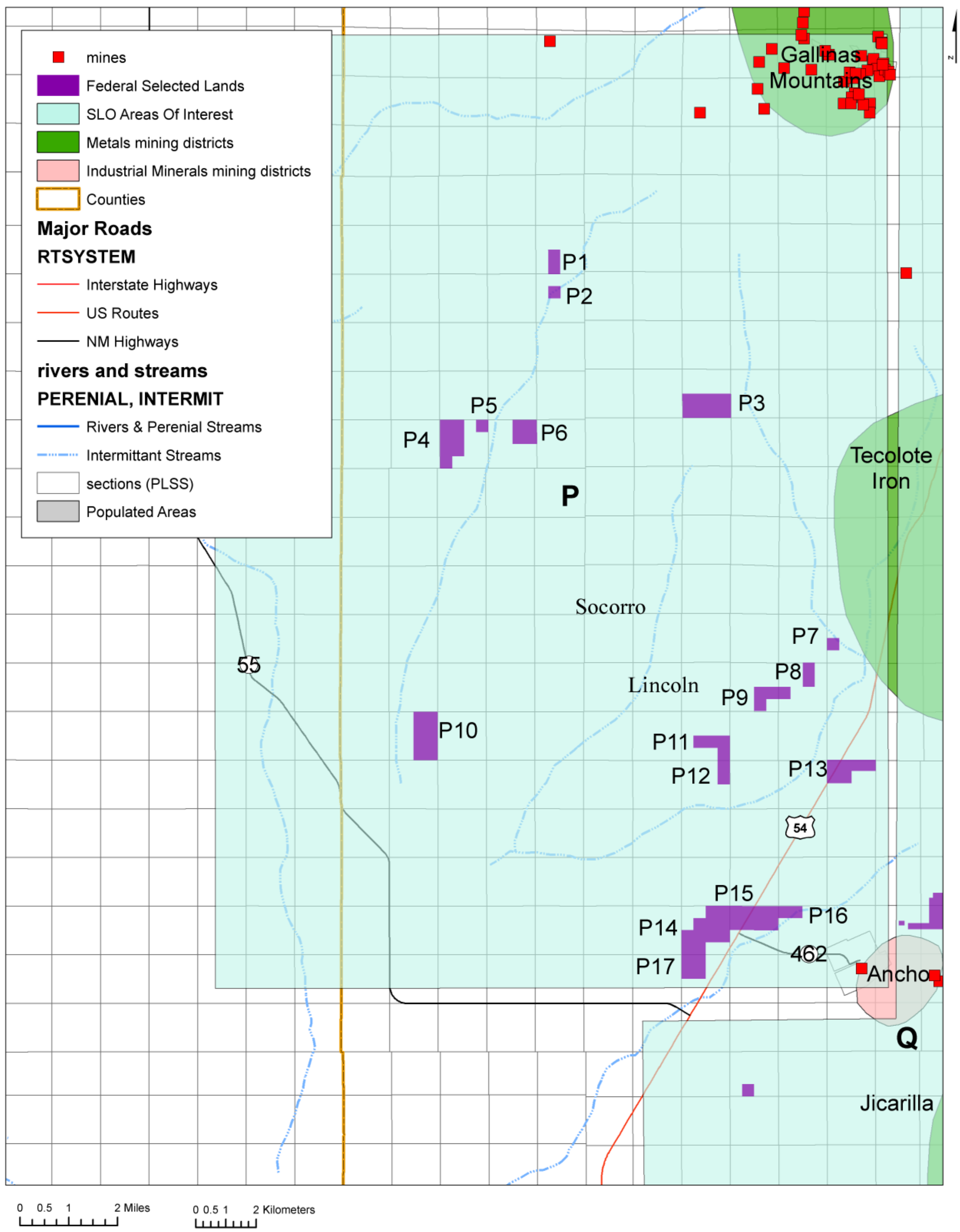


FIGURE 34. Mines and mining districts in Area P. See Figure 1 for location of Area P. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

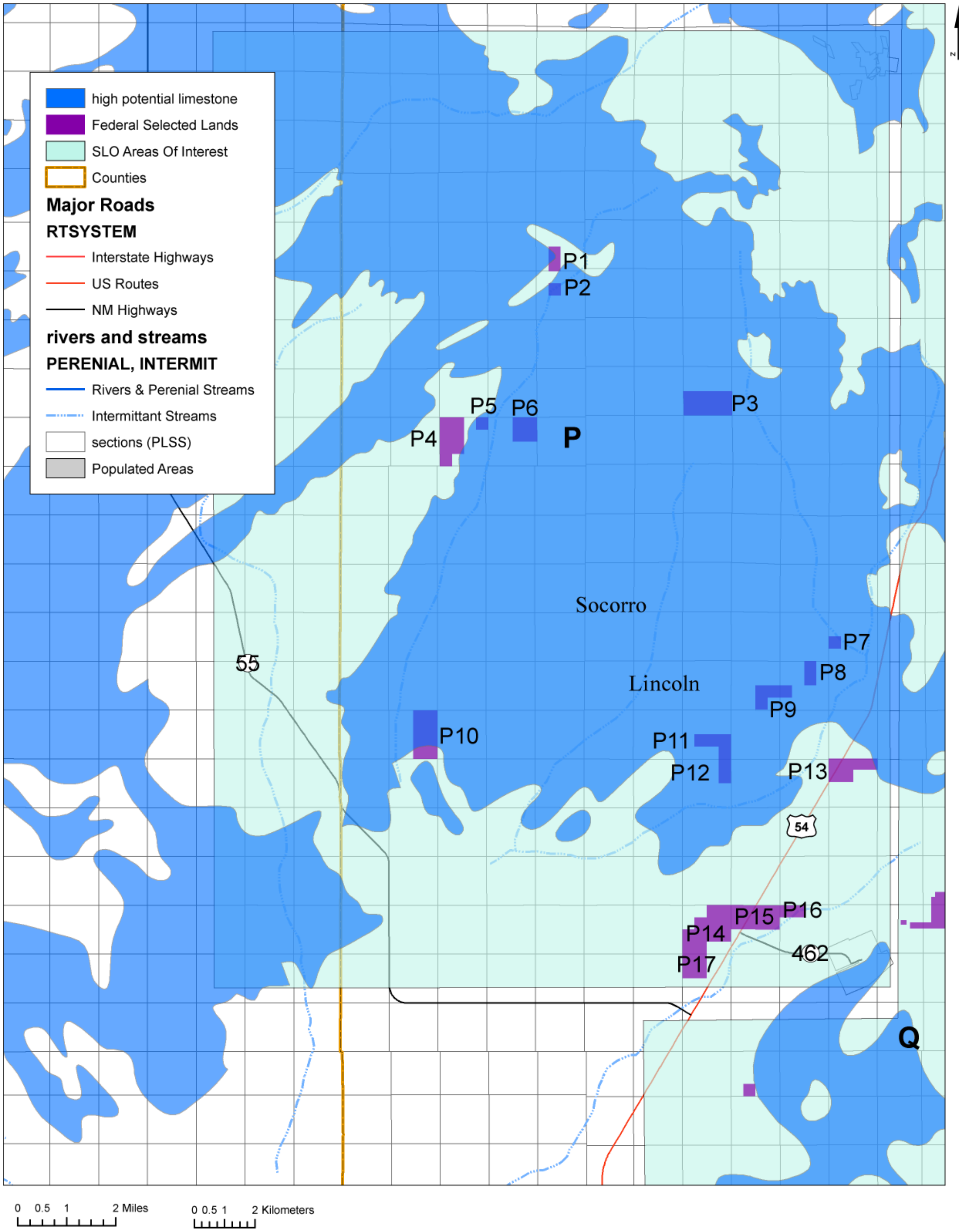


FIGURE 35. Mineral-resource potential for limestone in Area P. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

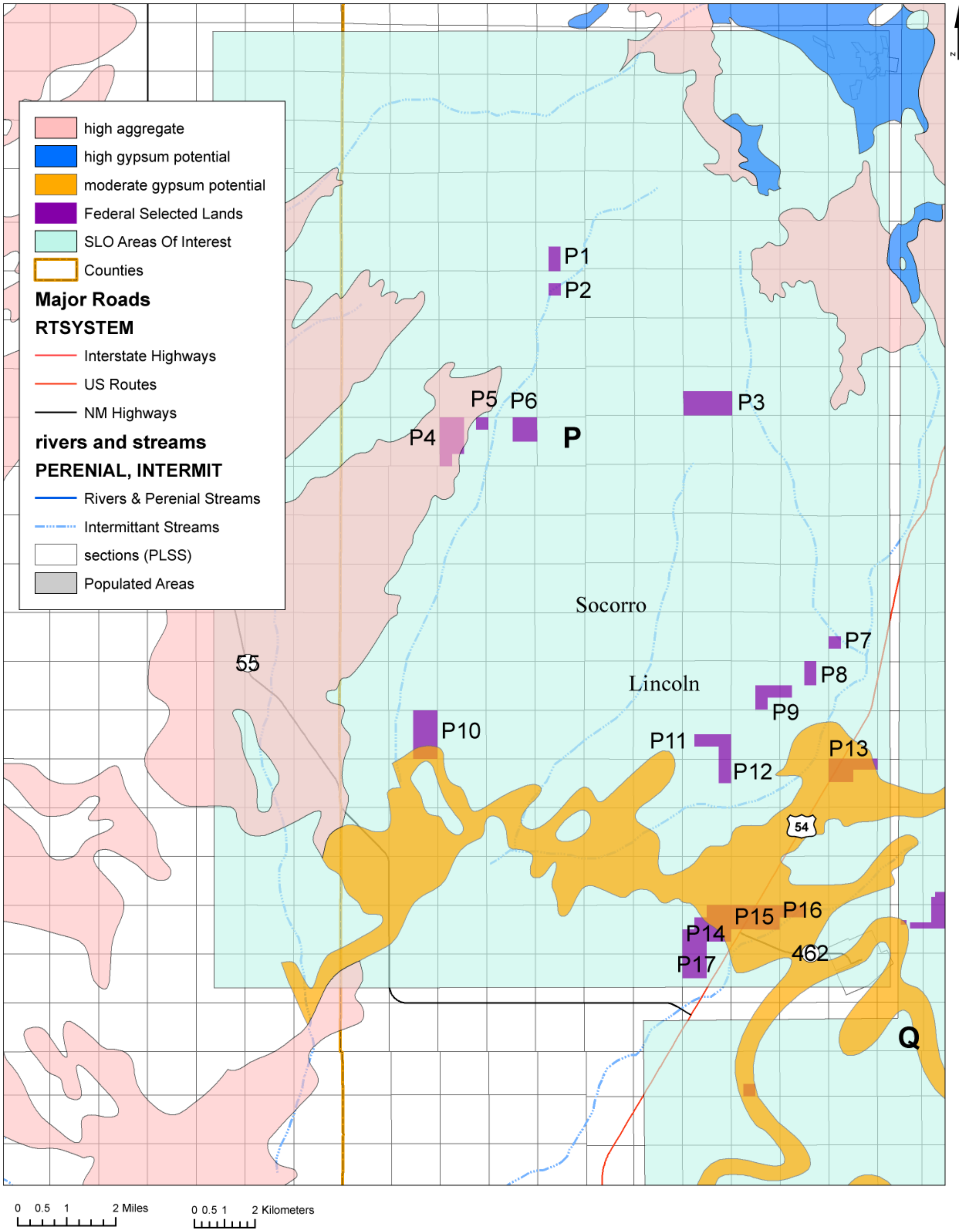


FIGURE 36. Mineral-resource potential for gypsum and aggregates in area P. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area Q

Area Q is in T5S, R12-18E on the Pedernal Uplift east of White Oaks, Jicarilla, and Corona in Lincoln County, north of Area R and east of Area P. The Ancho (DIS089), Jicarilla (DIS093), Tecolote (DIS098), and Macho (DIS094) mining districts and northern Sierra Blanca coal field (DIS097) are in Area Q (Fig. 37; Kelley, 1949; Johnson, 1972; Segerstrom and Ryberg, 1974; McLemore, 1991,1994, 2016a; McLemore et al., 1991; Korzeb and Kness, 1992; Bartsch-Winkler and Donatich, 1995; Hoffman, 2002), and mines, occurrences and mining claims are found in portions of Area Q (Fig. 38). The only active mines in Area Q are placer gold mines in the Jicarilla mining district, although some additional sand and gravel mines may be active to supply raw material for current road construction in the area (Fig. 5).

The mineral-resource potential is high with a moderate level of certainty for clay in the Ancho district. The mineral-resource potential is very high with a high level of certainty for placer gold and high with a moderate level of certainty for lode gold in the Jicarilla district. The mineral-resource potential is moderate with a high level of certainty for iron and low with a low level of certainty for molybdenum and tellurium in the Jicarilla district. The mineral-resource potential is low with a low level of certainty for iron in the Tecolote and Macho districts. The mineral-resource potential is high with a high level of certainty for limestone (Fig. 39), gypsum, stone (crushed and dimension; Fig. 40), and sand and gravel (aggregates; Fig. 41) in portions of Area P. The mineral-resource potential is moderate with a moderate level of certainty for gypsum in portions of Area P (Fig. 40). The mineral-resource potential is low to low-moderate with a moderate level of certainty for coal in the Sierra Blanca coal field in the southern portion of Area P (Fig. 40). The mineral-resource potential is unknown with a low level of certainty silica sand in the northern portion of Area P (Fig. 40).

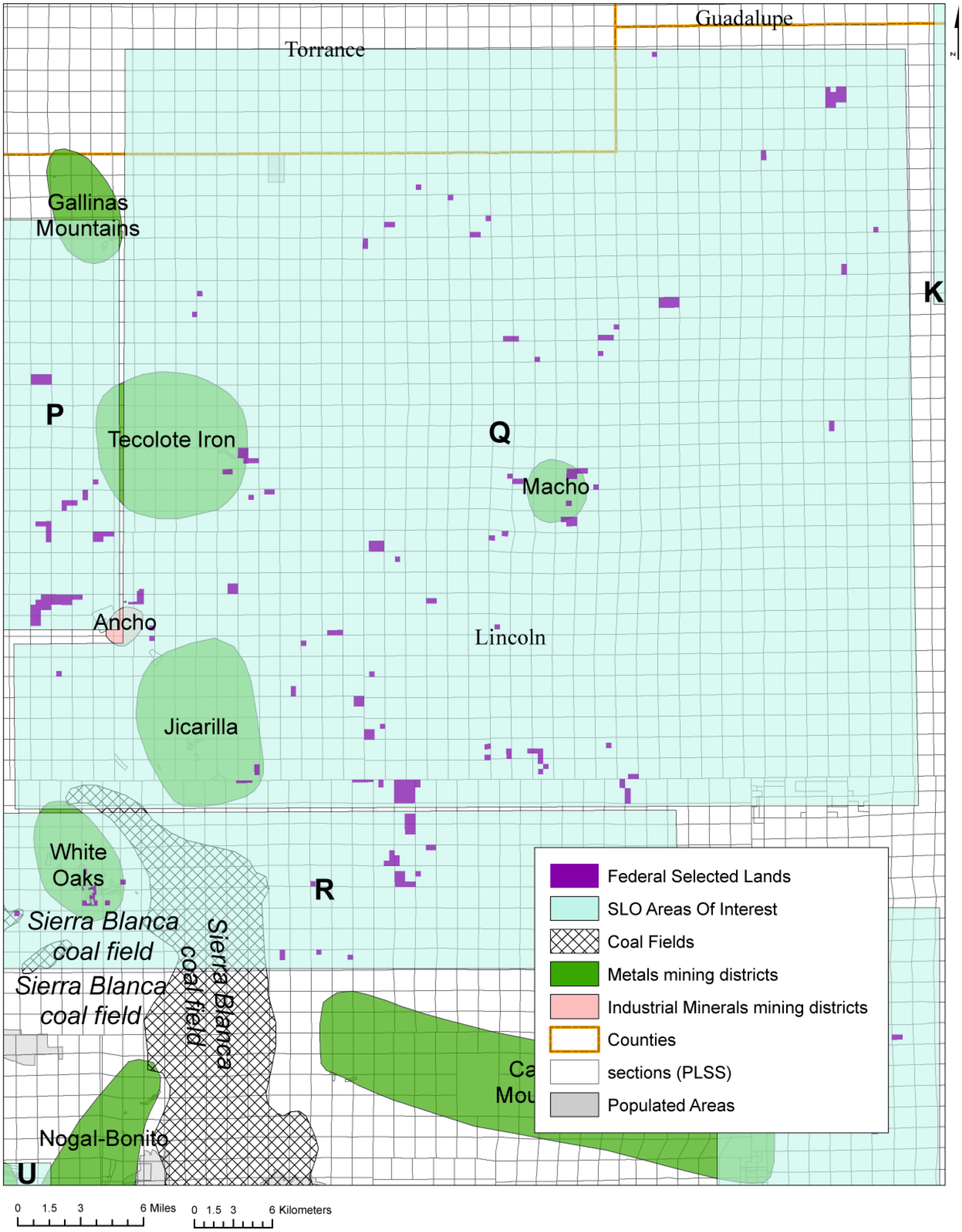


FIGURE 37. Mining districts in Area Q. See Figure 1 for location of Area Q. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

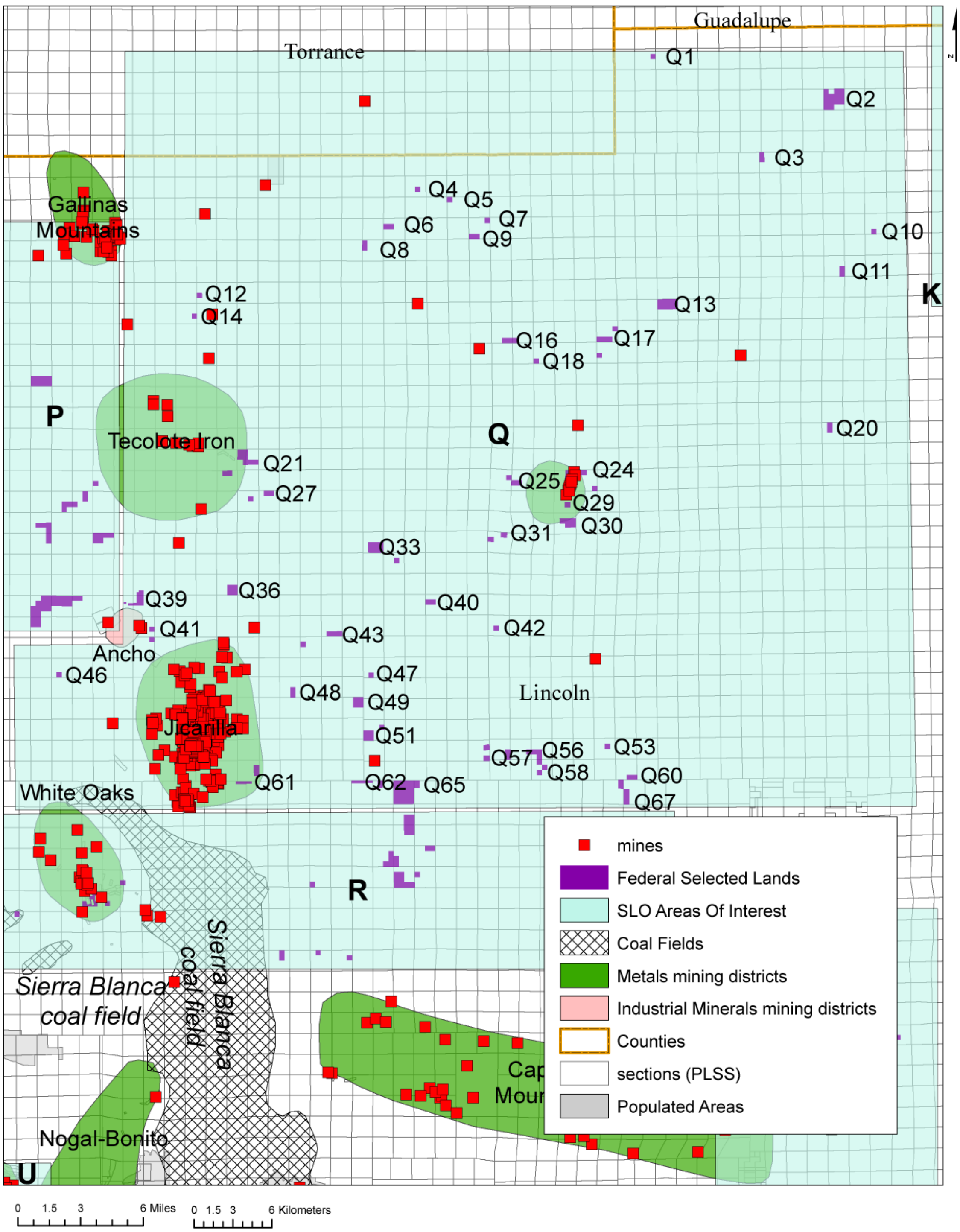


FIGURE 38. Mining districts and mines in Area Q. See Figure 1 for location of Area Q. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

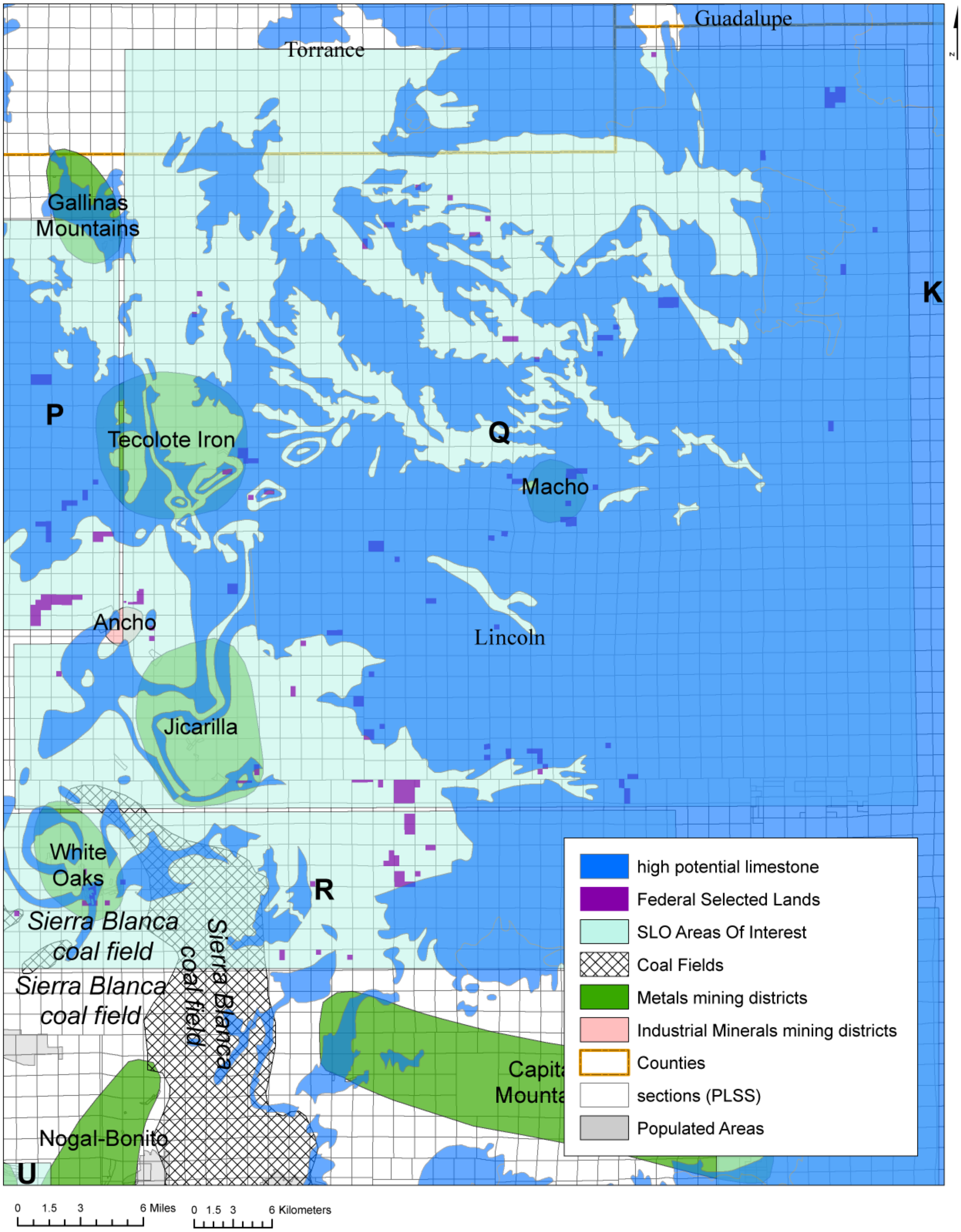


FIGURE 39. Mineral-resource potential for limestone in Area Q. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

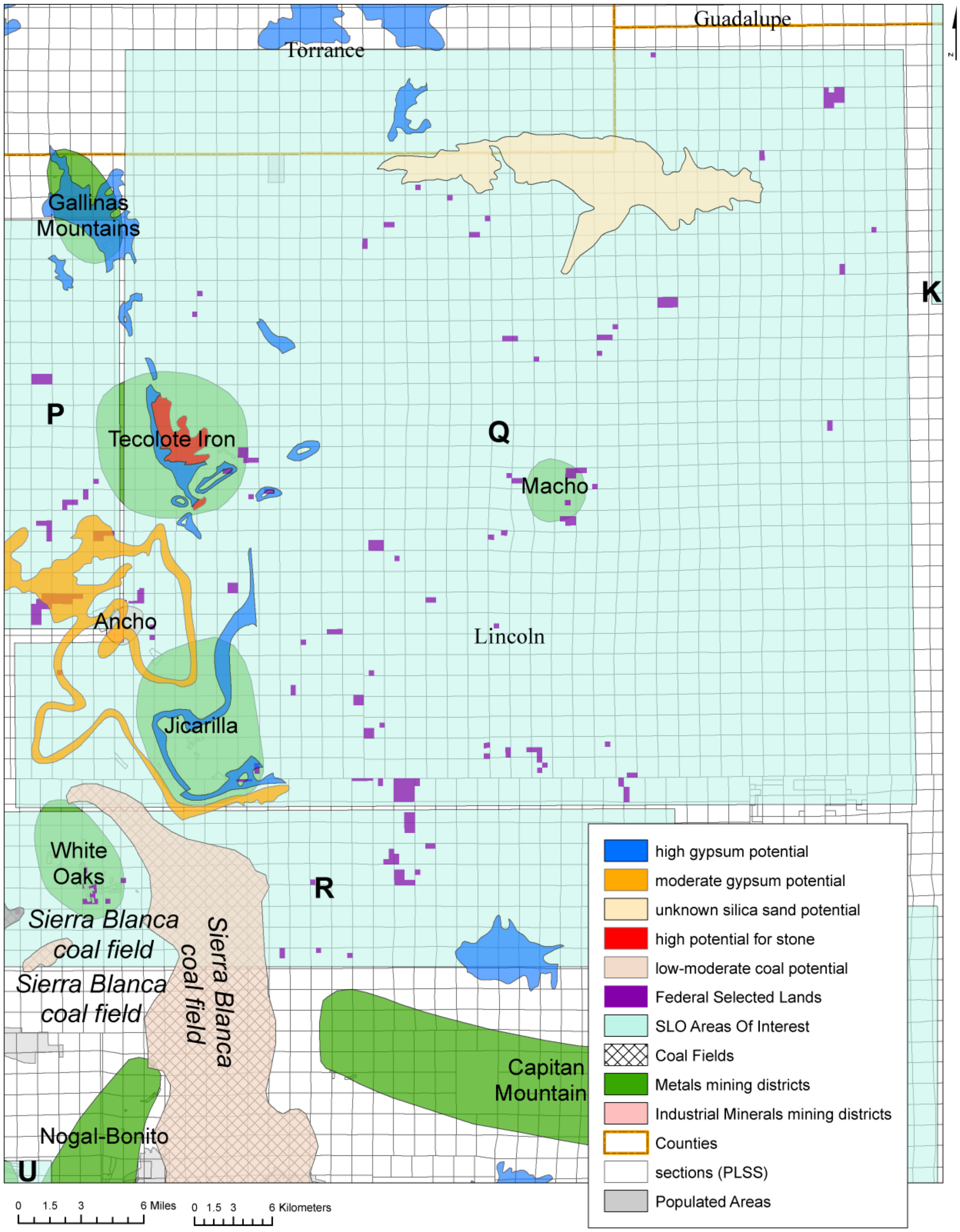


FIGURE 40. Mineral-resource potential for gypsum, silica sand, stone and coal in Area Q. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

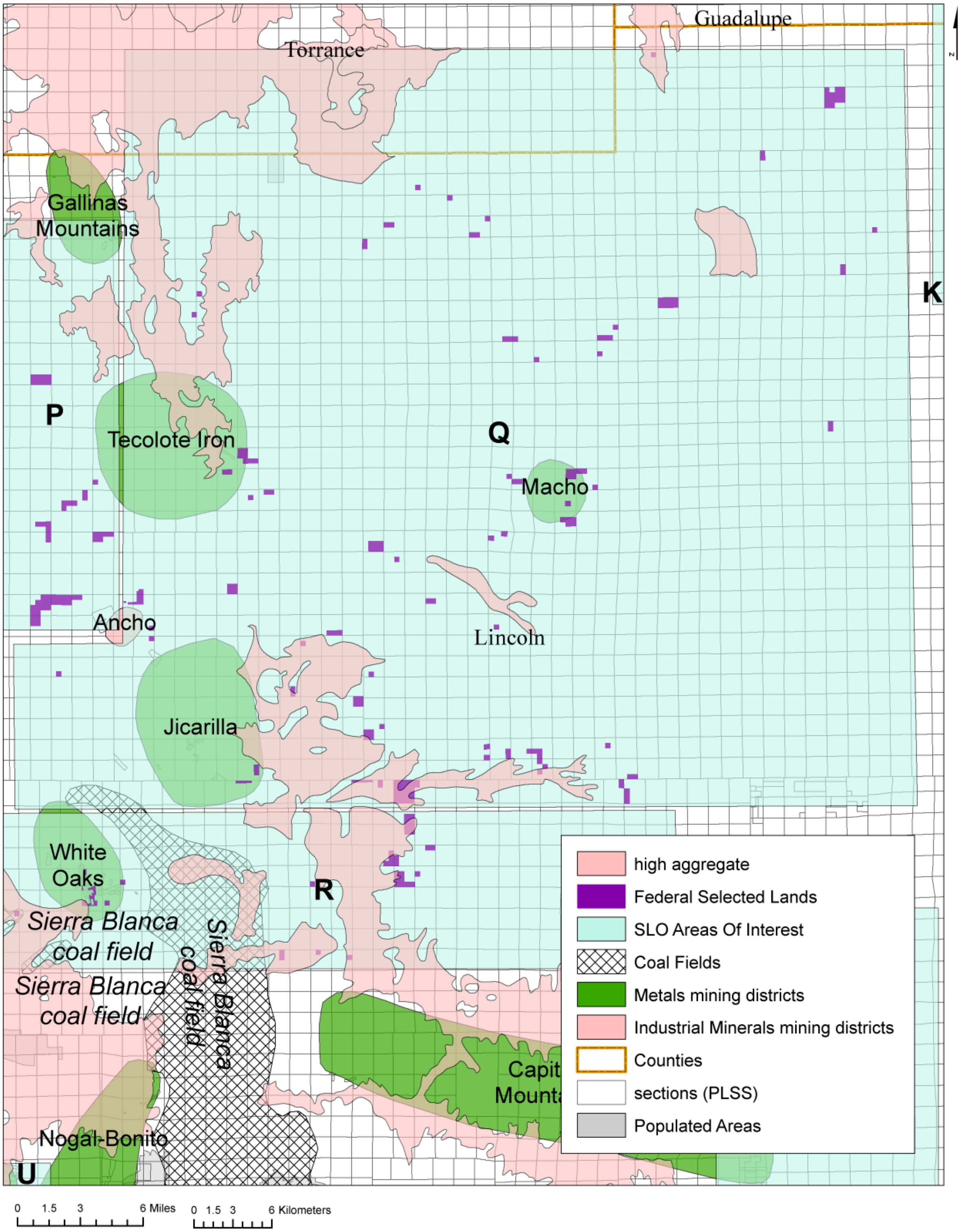


FIGURE 41. Mineral-resource potential for aggregates in Area Q. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area R

Area R is T3-4S, R9-15E on the Pedernal Uplift south of Area Q and includes White Oaks, Lincoln County. Although there are no active mines in Area R, there is an active exploration occurrence for gallium south of the area (Ortega, NMLI0407). The White Oaks mining district (DIS099) and Sierra Blanca coal field (DIS097) are in Area R, and mines, occurrences, and mining claims are found in portions of Area R (Fig. 42; Kelley, 1949; Johnson, 1972; McLemore, 1991, 1994, 2016a; Korzeb and Kness, 1992; Bartsch-Winkler and Donatich, 1995; Hoffman, 2002). Basalt was mined from the Carrizozo Malpais, a basalt lava flow, from 1964 to 1972 for ornamental, building, decorative, and crushed stone (Custer, 1975; Stoeser et al., 1989; Korzeb and Kness, 1992). Scoria for decorative stone and road material was mined from 1948 to 2012 from pits in Broken Back Crater and the unnamed crater to the south.

The mineral-resource potential is high with a high level of certainty for placer gold, lode gold, silver, and tungsten in the White Oaks district. The mineral-resource potential is moderate with a moderate level of certainty for iron and low with a low level of certainty for tellurium in the White Oaks district. The mineral-resource potential is low to low-moderate with a moderate level of certainty for coal in the Sierra Blanca coal field. The mineral-resource potential is high with a high level of certainty for basalt, scoria, sand and gravel (aggregates), and limestone in portions of Area R (Fig. 44, 45, 46). The mineral-resource potential is unknown with a low level of certainty for gallium in the Carrizo Mountain area (Fig. 46).

## Area S

Area S is in T5-6S, R19-20E on the Pecos Slope in Lincoln and Chaves Counties. Although there are no active mines in Area S, there are two inactive sand and gravel (aggregates) mines in the area (NMLI0498, NMCH0053). There are no mining claims or mining districts in Area S. The mineral-resource potential is high with a high level of certainty for limestone in Area S (Fig. 46).

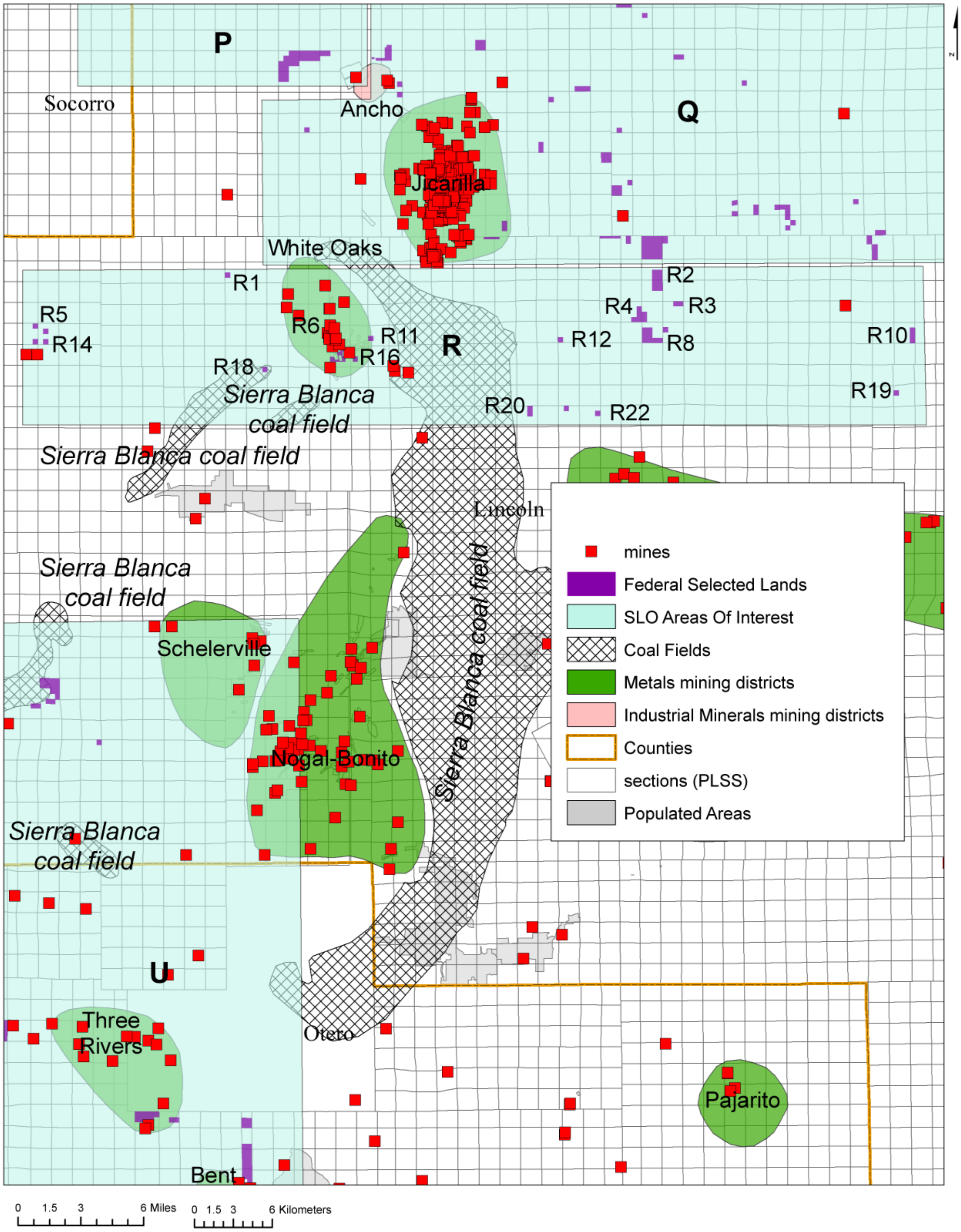


FIGURE 42. Mines and mining districts in Area R in Lincoln and Chaves Counties. See Figure 1 for location of Area R. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

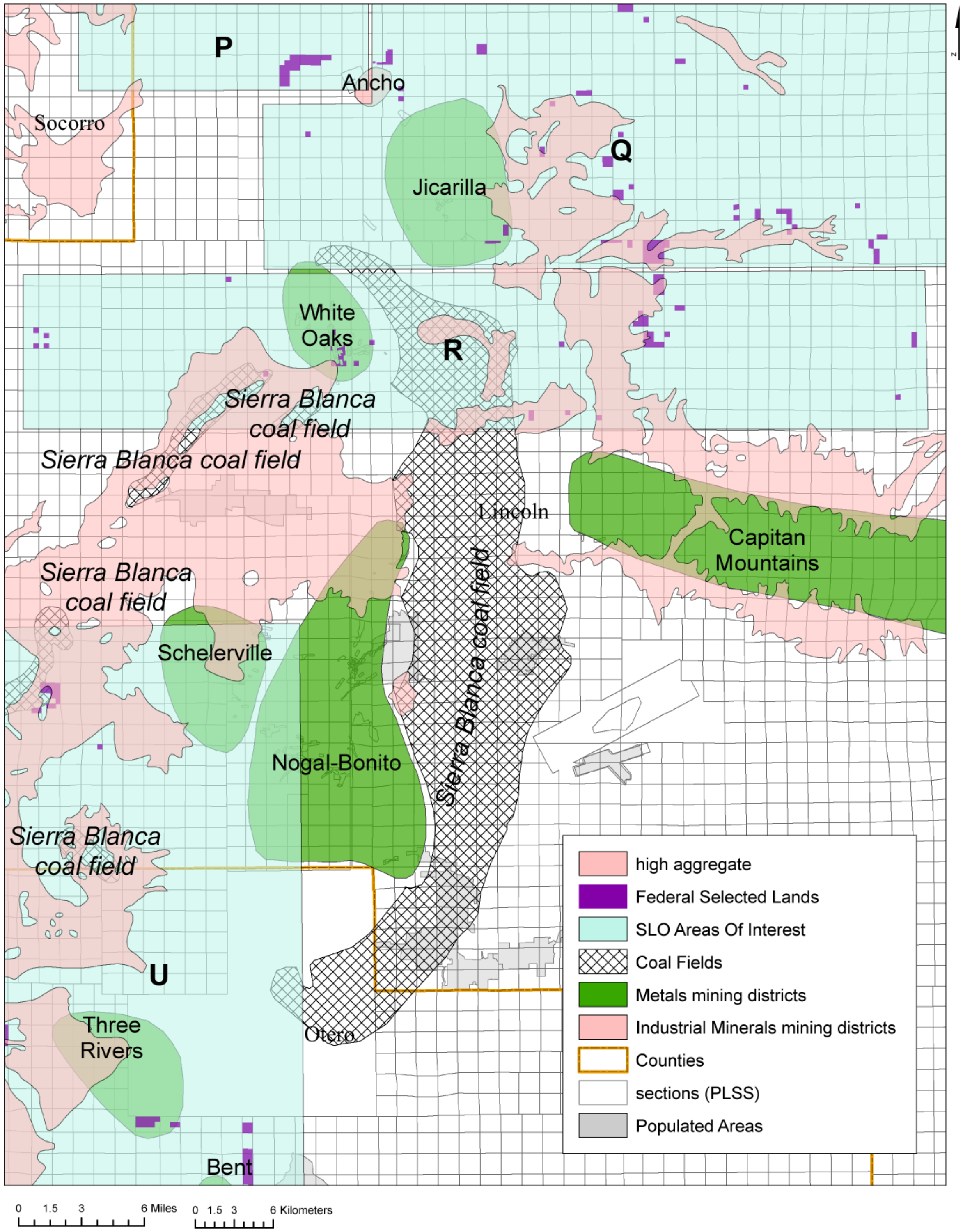


FIGURE 43. Mineral-resource potential for aggregates in Area R in Lincoln and Chaves Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

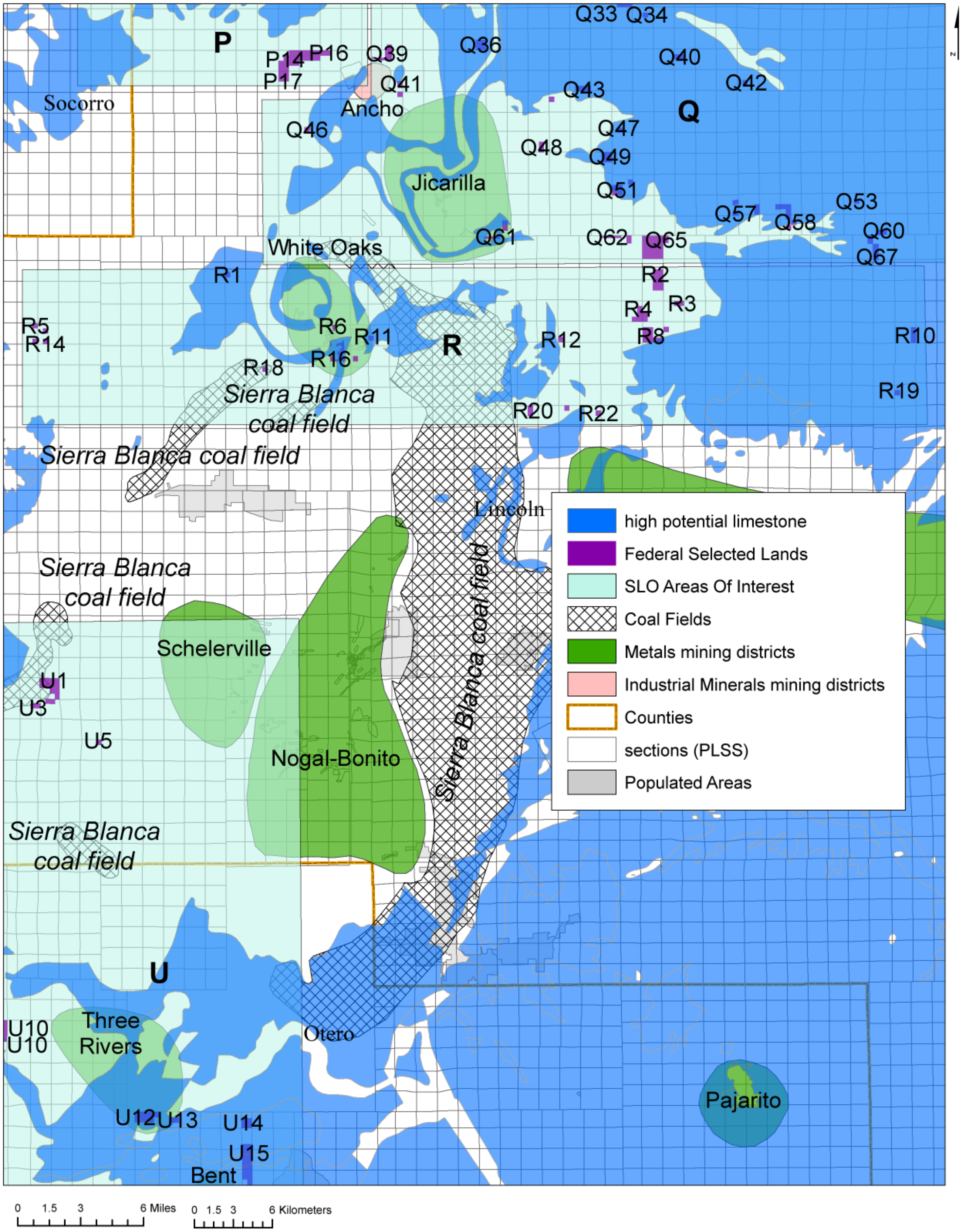


FIGURE 44. Mineral-resource potential for limestone in Area R in Lincoln and Chaves Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

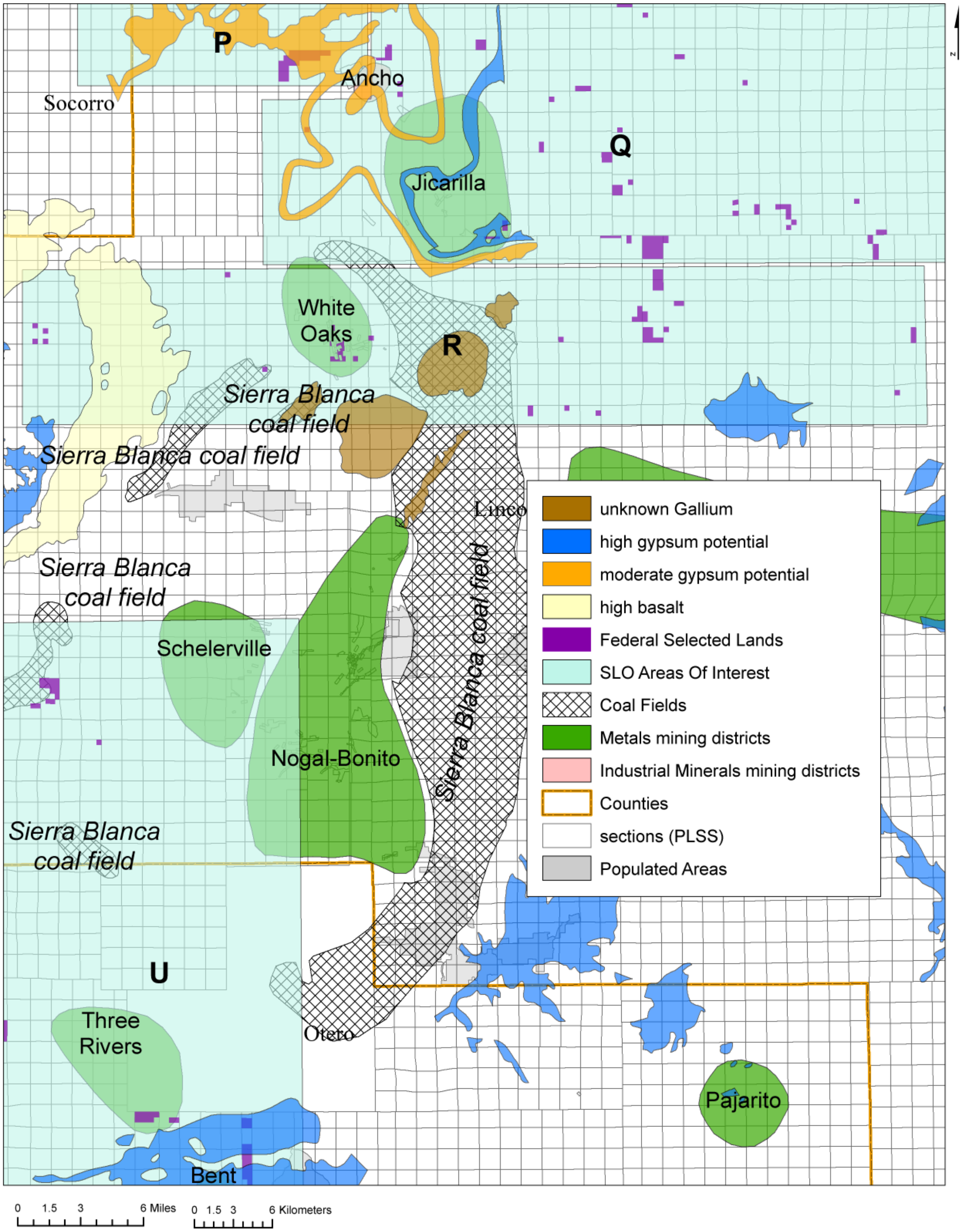


FIGURE 45. Mineral-resource potential for gallium, gypsum, and basalt in Area R in Lincoln and Chaves Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.


FIGURE 46. Area S in Lincoln and Chaves Counties. The mineral-resource potential for limestone in Area S is high with a high level of certainty. See Figure 1 for location of Area S. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area T

Area T is in T4-7S, R23-30E on the Pecos Slope in Chaves County. Although there are no mining districts or active mines in Area T, there are inactive mines, occurrences and mining claims in Area T (Fig. 47).

The mineral-resource potential is high with a high level of certainty for limestone and sand and gravel (aggregates) in portions of Area T (Fig. 47). The mineral-resource potential is moderate with a moderate level of certainty for salt, potash, and uranium in the Ogallala Formation in portions of Area T (Fig. 48, 49; McLemore, 1983; McLemore and Chenoweth, 1989, 2017; McLemore and Austin, 2017; Hall et al., 2017). The mineral-resource potential is high with a high level of certainty for mineral collecting of Pecos diamonds in the central portion of Area T (Fig. 48). The mineral-resource potential is unknown with a low level of certainty for silica sand in portions of Area T.

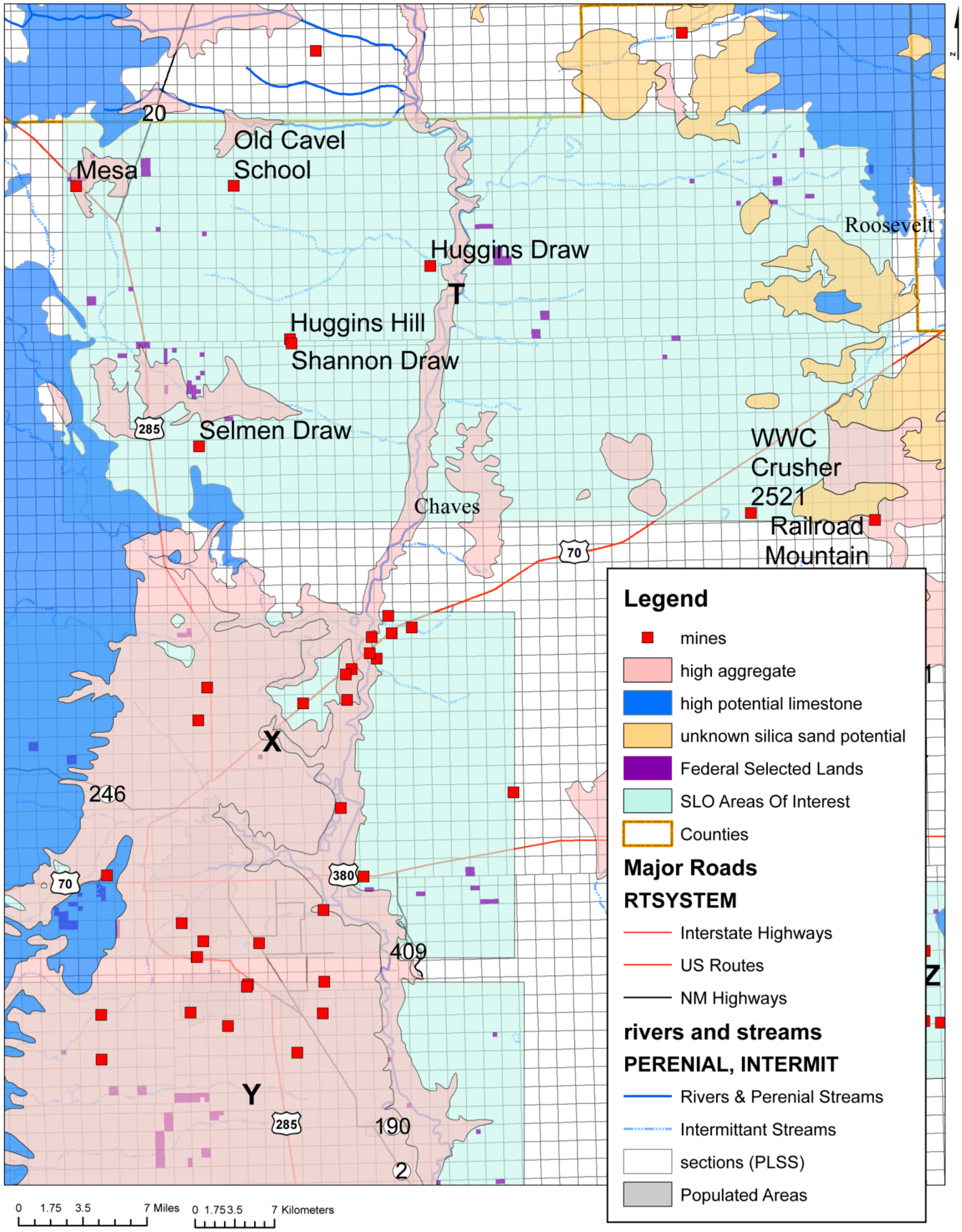


FIGURE 47. Mines and mineral-resource potential for aggregates, limestone, and silica sand in Area T in Chaves County. See Figure 1 for location of Area T. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

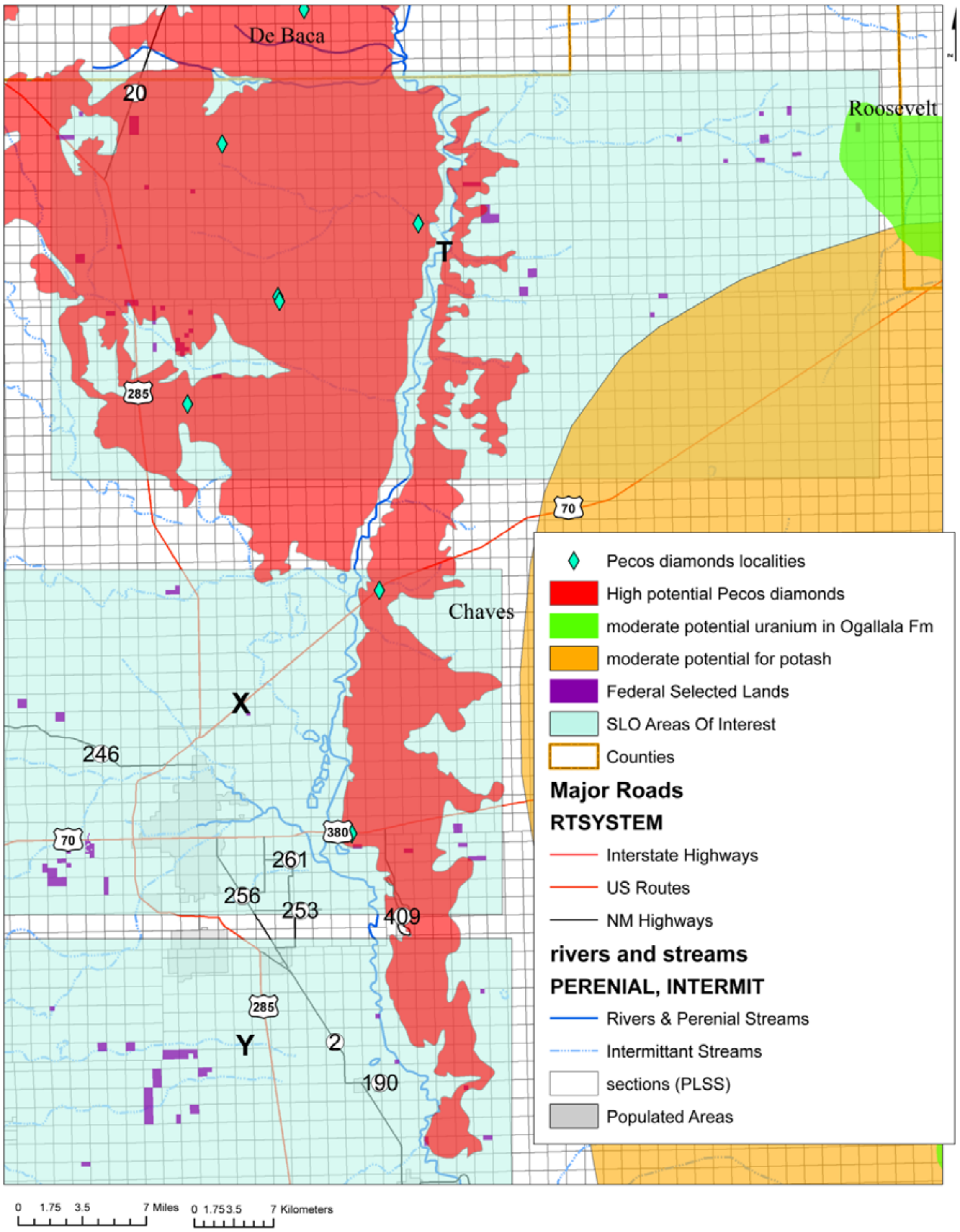


FIGURE 48. Mineral-resource potential for Pecos diamonds, uranium, and potash in Area T in Chaves County. See Figure 1 for location of Area T. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

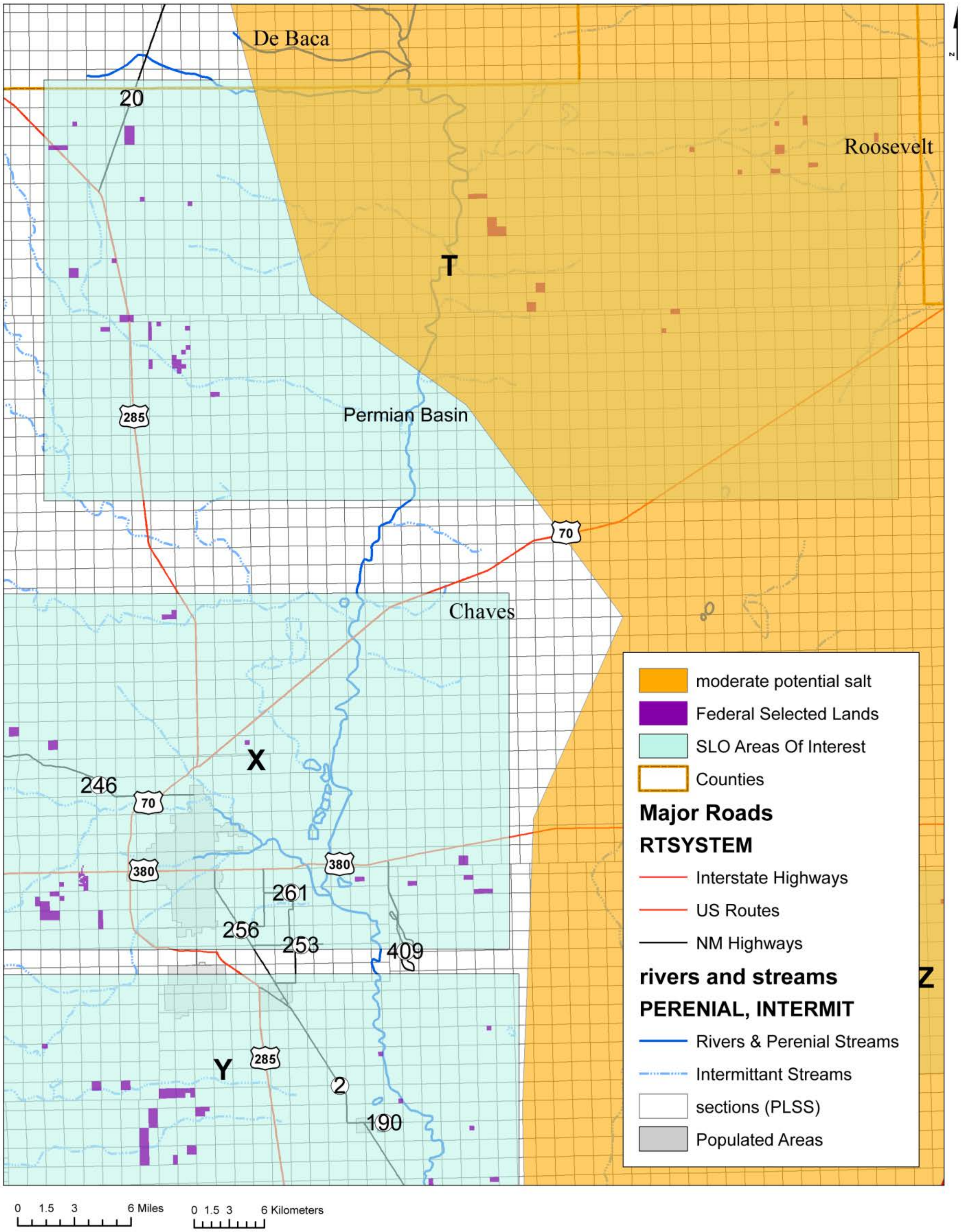


FIGURE 49. Mineral-resource potential for salt in Area T in Chaves County. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area U

Area U is in T9-18S, R9-1E in a geologically diverse area in Lincoln and Otero Counties that includes the eastern Tularosa Basin, the northern Sacramento Mountains, the Sierra Blanca Basin, and Sierra Blanca. The Schelerville (DIS096), Nogal-Bonito (DIS095), Three Rivers (DIS132), Tularosa (DIS133), Bent (DIS127) and Scaramento (DIS131) mining districts and the Sierra Blanca coal field (DIS097) (Fig. 50; Wegemann, 1914; Kelley, 1949; Johnson, 1972; Segerstrom et al., 1979; Arkell, 1983; Briggs, 1983; McLemore, 1991, 1994, 2016a; Korzeb and Kness, 1992; Bartsch-Winkler and Donatich, 1995; Green and O'Neill, 1998; Hoffman, 2002; McLemore et al., 2014) are in Area U; numerous mines and occurrences and mining claims are found in Area U (Fig. 50). There are active sand and gravel (aggregates) mines in Area U.

The mineral-resource potential is high with a high level of certainty for placer gold, lode gold, and molybdenum in the Nogal-Bonito district. The mineral-resource potential is moderate with a moderate level of certainty for copper, and low with a low level of certainty for tellurium in the Nogal-Bonito district. The mineral-resource potential is moderate with a moderate level of certainty for gold in the Schelerville district. The mineral-resource potential is moderate with a moderate level of certainty for copper and low with a low level of certainty for molybdenum in the Bent district. The mineral-resource potential is low with a low level of certainty for copper and gold in the Sacramento district. The mineral-resource potential is low with a low level of certainty for copper and molybdenum in Tularosa district. The mineral-resource potential is moderate with a moderate level of certainty for iron and low with a low level of certainty for REE in the Three Rivers district.

The mineral-resource potential is high with a high level of certainty for sand and gravel (aggregates) in western portion of Area U (Fig. 51). The mineral-resource potential is high with a high level of certainty for gypsum in eastern and northwestern portions of Area U and moderate with a moderate level of certainty for gypsum in southwestern portion of Area U (Fig. 52). The mineral-resource potential is high with a high level of certainty for limestone in the northwestern and eastern portions of Area U (Fig. 51). The mineral-resource potential is unknown with a low level of certainty for silica sand in western portions of Area U (Fig. 53). The mineral-resource potential is high with a high level of certainty for stone (crushed and dimension) in the Abo Formation in the Sacramento Mountains and for basalt in the eastern portion of Area U (Fig. 53). Note that the area designated for basalt potential is in the BLM Valley of Fires Recreation Area and withdrawn from mineral entry. The mineral-resource potential is low to low-moderate with a moderate level of certainty for coal in the Sierra Blanca coal field (Wegemann, 1914; Arkell, 1983; Hoffman, 2002) in the northern portions of Area U.

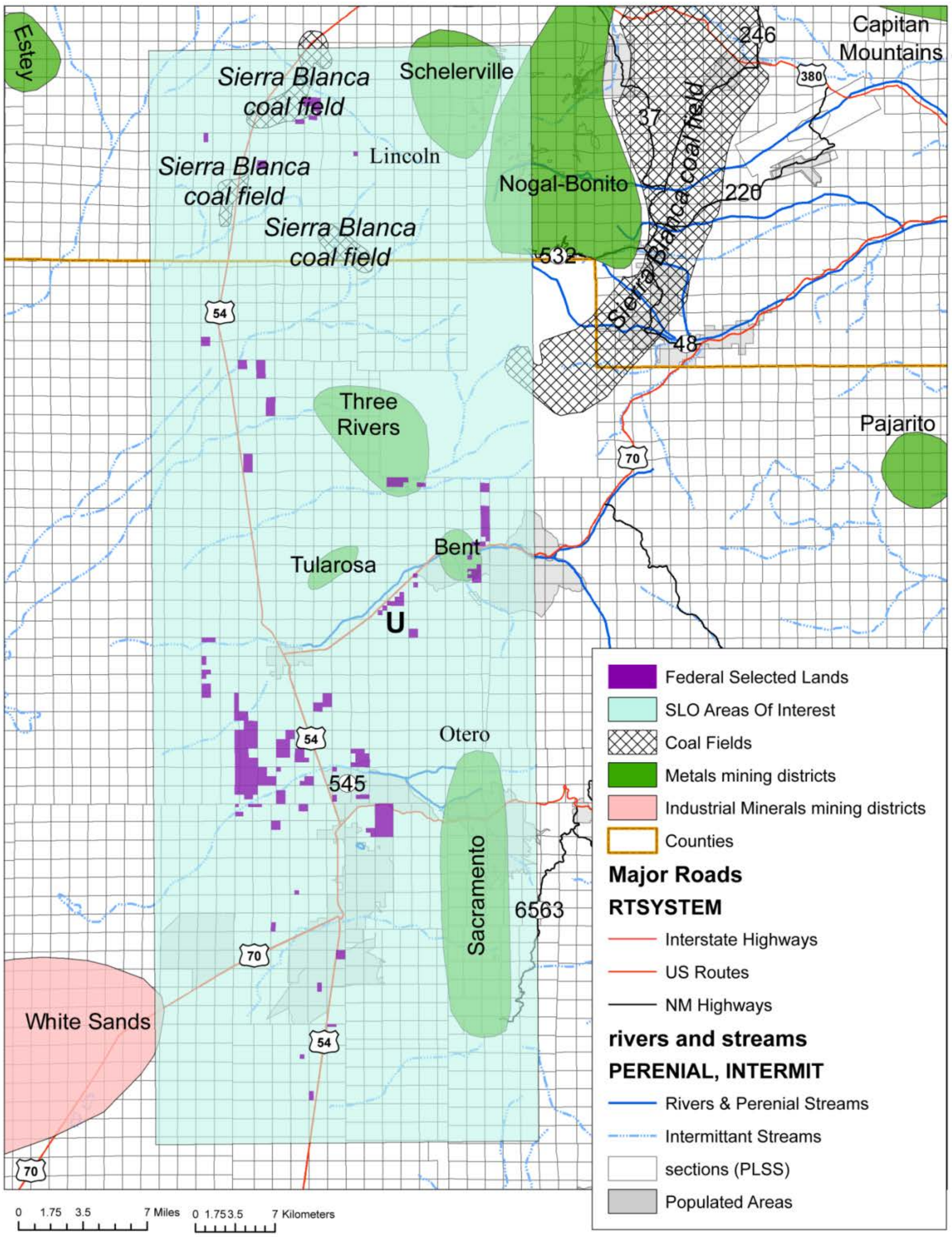


FIGURE 50. Mining districts in Area U in Lincoln and Otero Counties. See Figure 1 for location of Area U. The mineral-resource potential is high with a high level of certainty for placer gold, lode gold, and molybdenum in the Nogal-Bonito district. The mineral-resource potential is

moderate with a moderate level of certainty for copper, and low with a low level of certainty for tellurium in the Nogal-Bonito district. The mineral-resource potential is moderate with a moderate level of certainty for gold in the Schelerville district. The mineral-resource potential is moderate with a moderate level of certainty for copper and low with a low level of certainty for molybdenum in the Bent district. The mineral-resource potential is low with a low level of certainty for copper and gold in the Sacramento district. The mineral-resource potential is low with a low level of certainty for copper and molybdenum in Tularosa district. The mineral-resource potential is moderate with a moderate level of certainty for iron and low with a low level of certainty for REE in the Three Rivers district. The mineral-resource potential is low to moderate and low with a moderate level of certainty for coal in the Sierra Blanca coal field. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

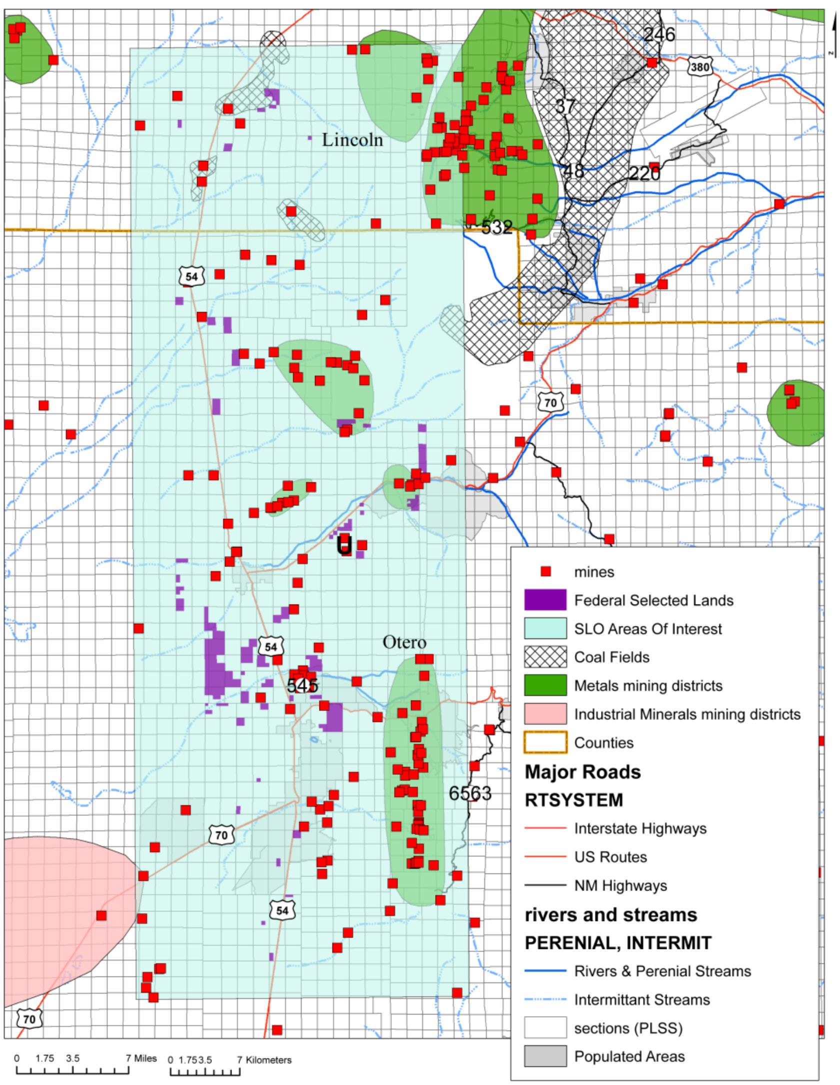


FIGURE 51. Mines in Area U in Lincoln and Otero Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

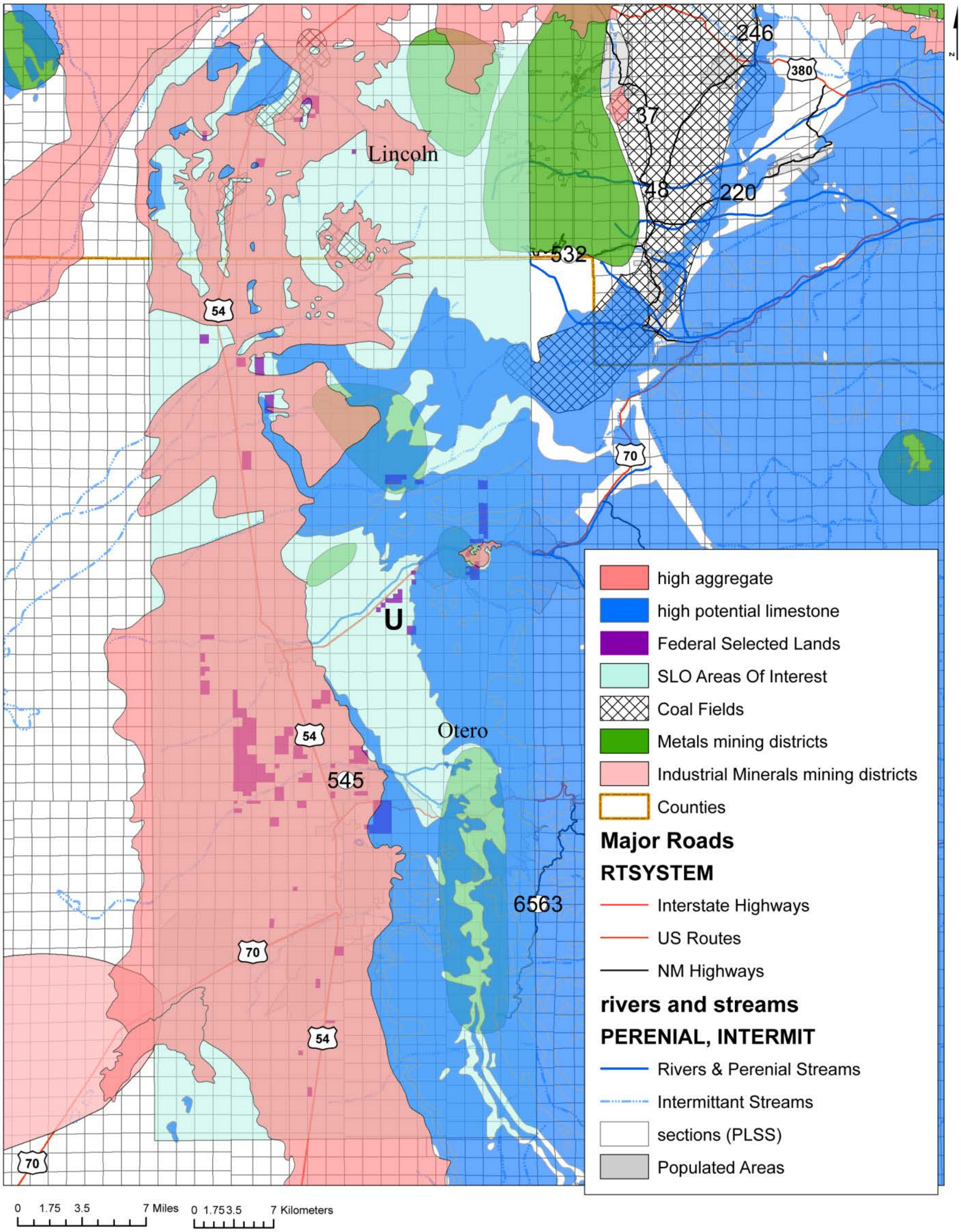


FIGURE 52. Mineral-resource potential for sand and gravel (aggregates) and limestone in Area U in Lincoln and Otero Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

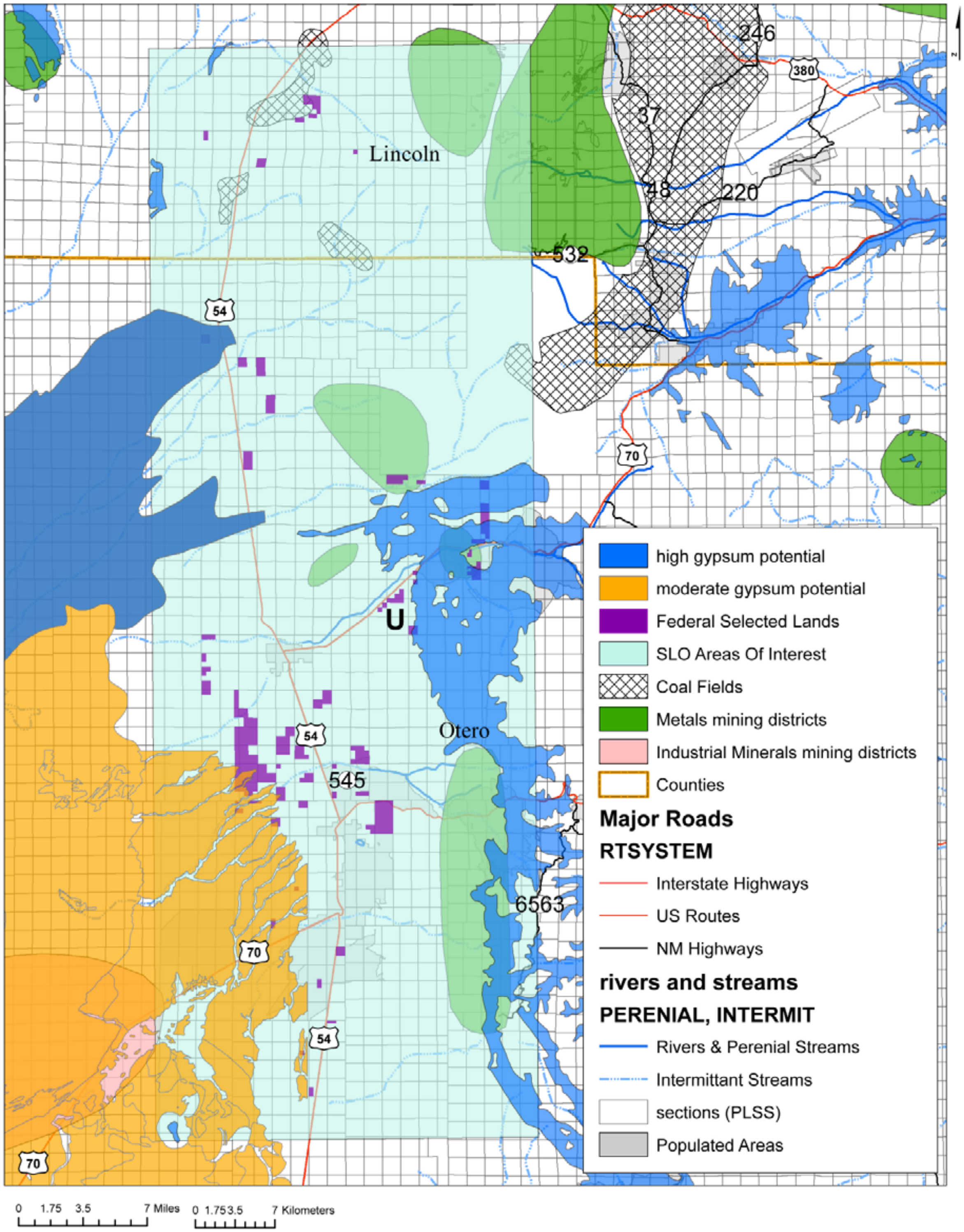


FIGURE 53. Mineral-resource potential for gypsum in Area U in Lincoln and Otero Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

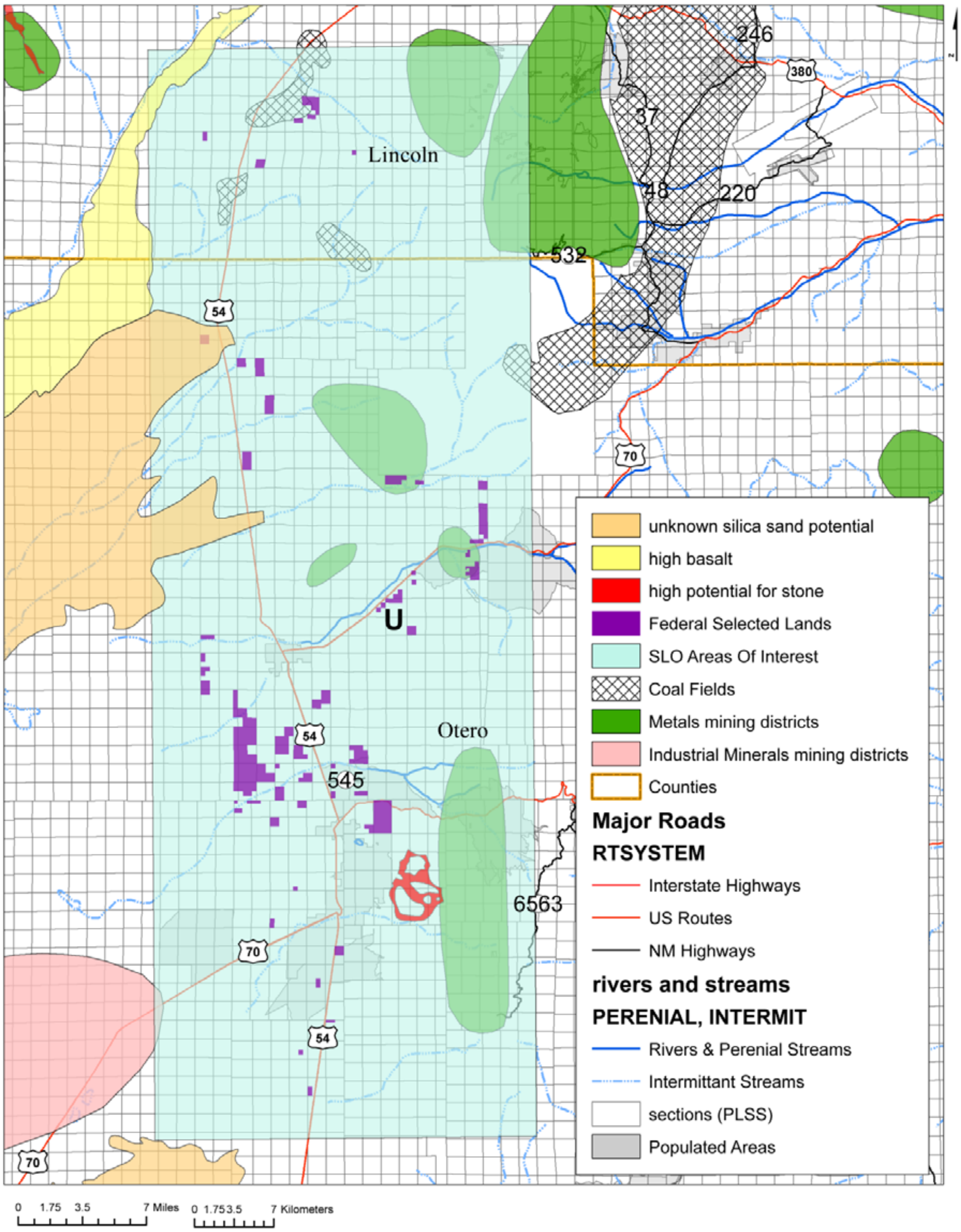


FIGURE 54. Mineral-resource potential for stone and silica sand in Area U in Lincoln and Otero Counties. Note that the area designated for basalt potential is in the BLM Valley of Fires Recreation Area and withdrawn from mineral entry. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area V

Area V is in T7-10S, R17-19E on the Pecos Slope in southeastern Lincoln County. Part of the Capitan Mountains mining district (DIS091) is in the western portion of Area V (Fig. 55; Kelley, 1949; Tuftin, 1984; McLemore and Phillips, 1991; McLemore, 2018b). Although there are no active mines in Area V (Fig. 5), there are mines, occurrences and mining claims in the western portion of Area V (Fig. 55).

The mineral-resource potential is high with a moderate level of certainty for iron and REE-Th-U in the Capitan Mountains district. The mineral-resource potential is low with a moderate level of certainty for gold, manganese, and uranium in the Capitan Mountains district. The mineral-resource potential is high with a high level of certainty for gypsum in the western portion of Area V and for limestone in all of Area V (Fig. 56).

## Area W

Area W is in T7-10S, R20-21E on the Pecos Slope in Lincoln and Chaves Counties. There are no mining districts or mining claims in Area W. Although there are no active mines in Area W (Fig. 5), there are mines and occurrences in the area (Fig. 57). The mineral-resource potential is high with a high level of certainty for sand and gravel (aggregates) in southeastern portion of Area W and high with a high level of certainty for limestone in the rest of Area W (Fig. 57).

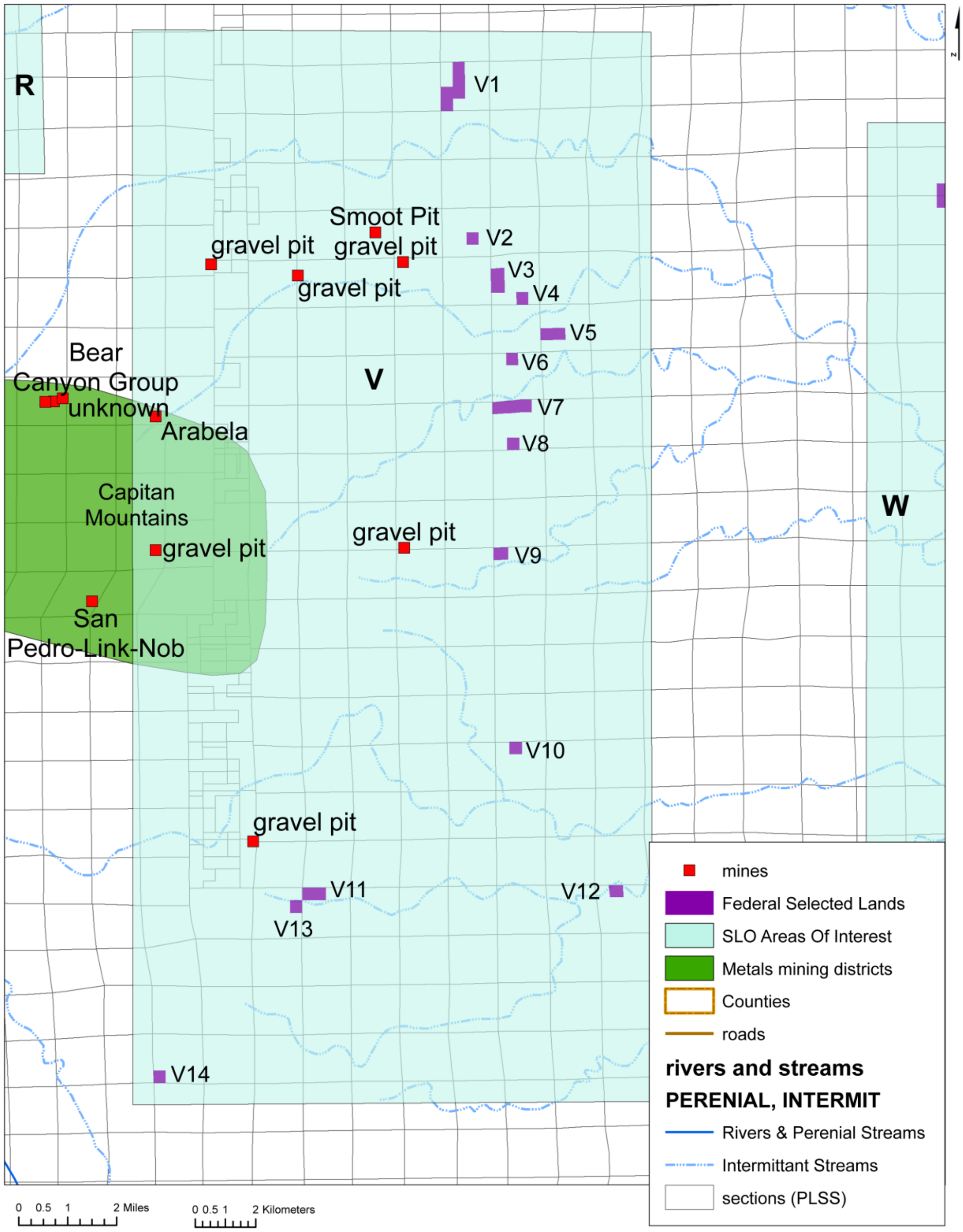


FIGURE 55. Mines and mining districts in Area V in Lincoln County. See Figure 1 for location of Area V. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

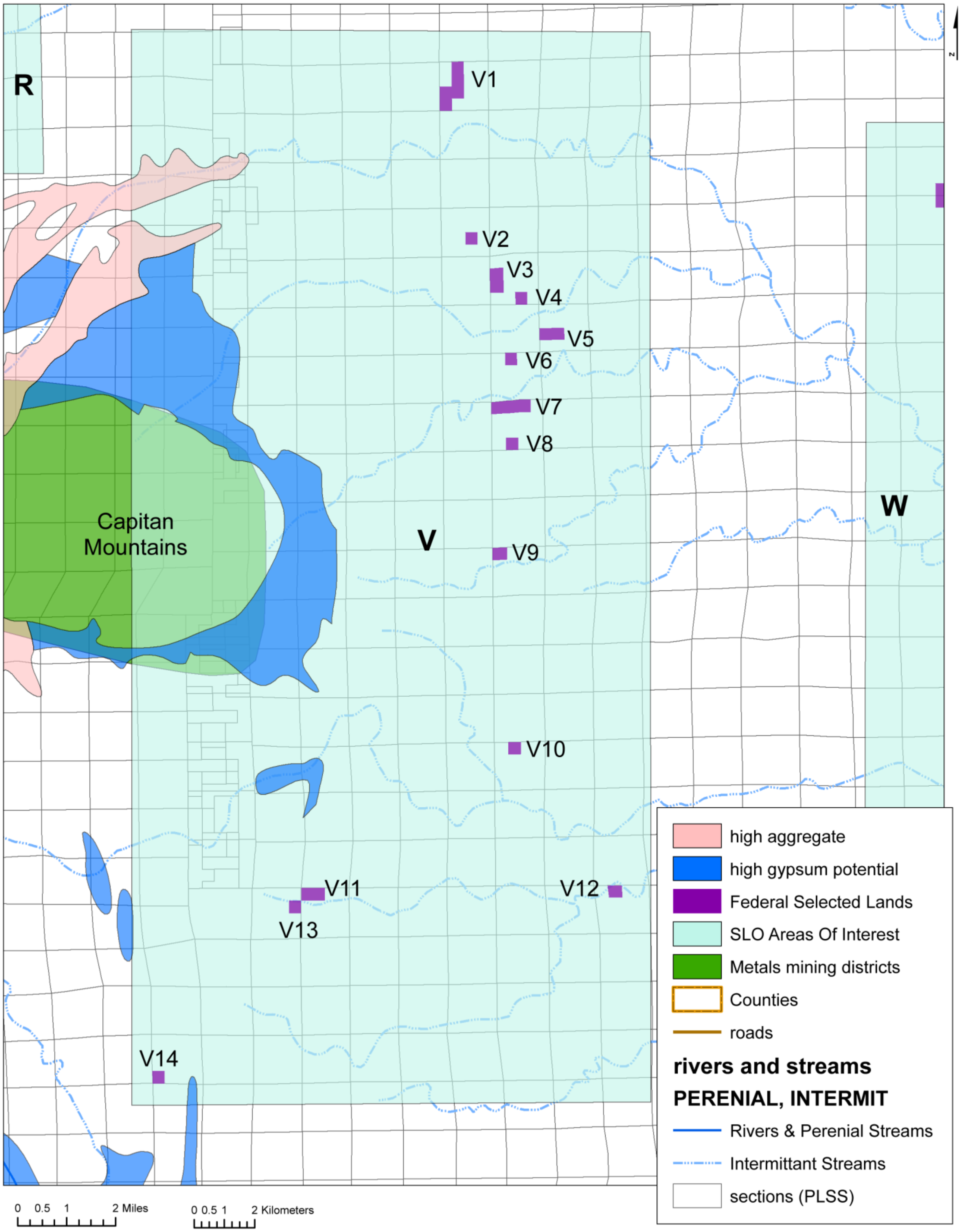


FIGURE 56. Mineral-resource potential for gypsum and sand and gravel (aggregates) in Area V in Lincoln County. See Figure 1 for location of Area V. Note that all of Area V has a mineral-

resource potential of high with a high level of certainty for limestone. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

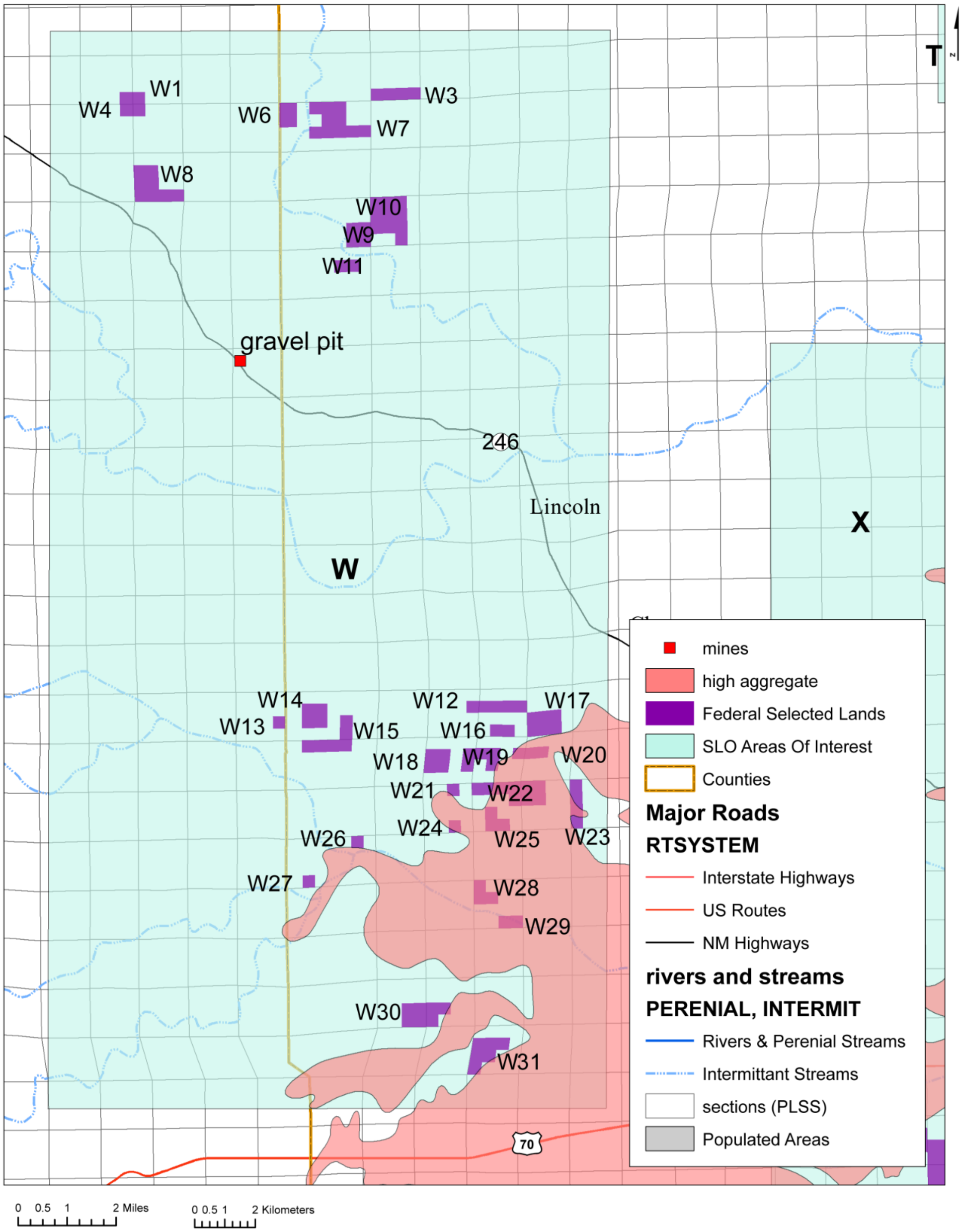


FIGURE 57. Mines and mineral-resource potential for sand and gravel (aggregates) in Area W in Lincoln and Chaves Counties. See Figure 1 for location of Area W. Note that the rest of Area W has a mineral-resource potential of high with a high level of certainty for limestone. Note that

some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area X

Area X is in T8-11S, R22-27E on the Pecos Slope in west-central Chaves County. There are no mining districts in Area X, but there are active and inactive mines and occurrences and mining claims in the area (Fig. 58).

The mineral-resource potential is high with a high level of certainty for sand and gravel (aggregates) in the central portion of Area X (Fig. 59). The mineral-resource potential is high with a high level of certainty for diatomite in the central portion of Area X (Fig. 59) and for limestone in the western portion of Area X (Fig. 60). The mineral-resource potential is high with a high level of certainty for mineral collecting of Pecos diamonds in the eastern portion of Area X (Fig. 60).

## Area Y

Area Y is in T12-15S, R19-27E on the Pecos Slope in southern Chaves and southeastern Lincoln Counties. There are no mining districts, active mines, or mining claims in Area Y, but there are inactive mines and occurrences in Area Y (Fig. 61).

The mineral-resource potential is high with a high level of certainty for sand and gravel (aggregates) in the eastern portion of Area Y (Fig. 62) and for limestone in the western portion of Area Y (Fig. 62). The mineral-resource potential is high with a high level of certainty for mineral collecting of Pecos diamonds in the eastern portion of Area Y (Fig. 48). The mineral-resource potential is unknown with a low level of certainty for silica sand in a small portion of eastern Area Y (Fig. 62).

## Area Z

Area Z is in T11-12S, R31E on the Northwest Shelf of the Permian Basin in southeastern Chaves County. There are no mining districts, active mines, or mining claims in Area Z, but there are inactive sand and gravel mines in Area Z (some are caliche pits) (Fig. 63).

The mineral-resource potential is high with a high level of certainty for caliche (i.e., limestone) (Fig. 63) and moderate with a moderate level of certainty for uranium in the Ogallala Formation in the eastern part of Area Z (Fig. 64; McLemore, 1983; McLemore and Chenoweth, 1989, 2017; McLemore and Austin, 2017; Hall et al., 2017). The mineral-resource potential is moderate with a moderate level of certainty for potash in the entire Area Z. The mineral-resource potential is high with a high level of certainty for salt in the southeastern corner of Area Z and moderate with a moderate level of certainty for salt in the rest of Area Z (Fig. 65).

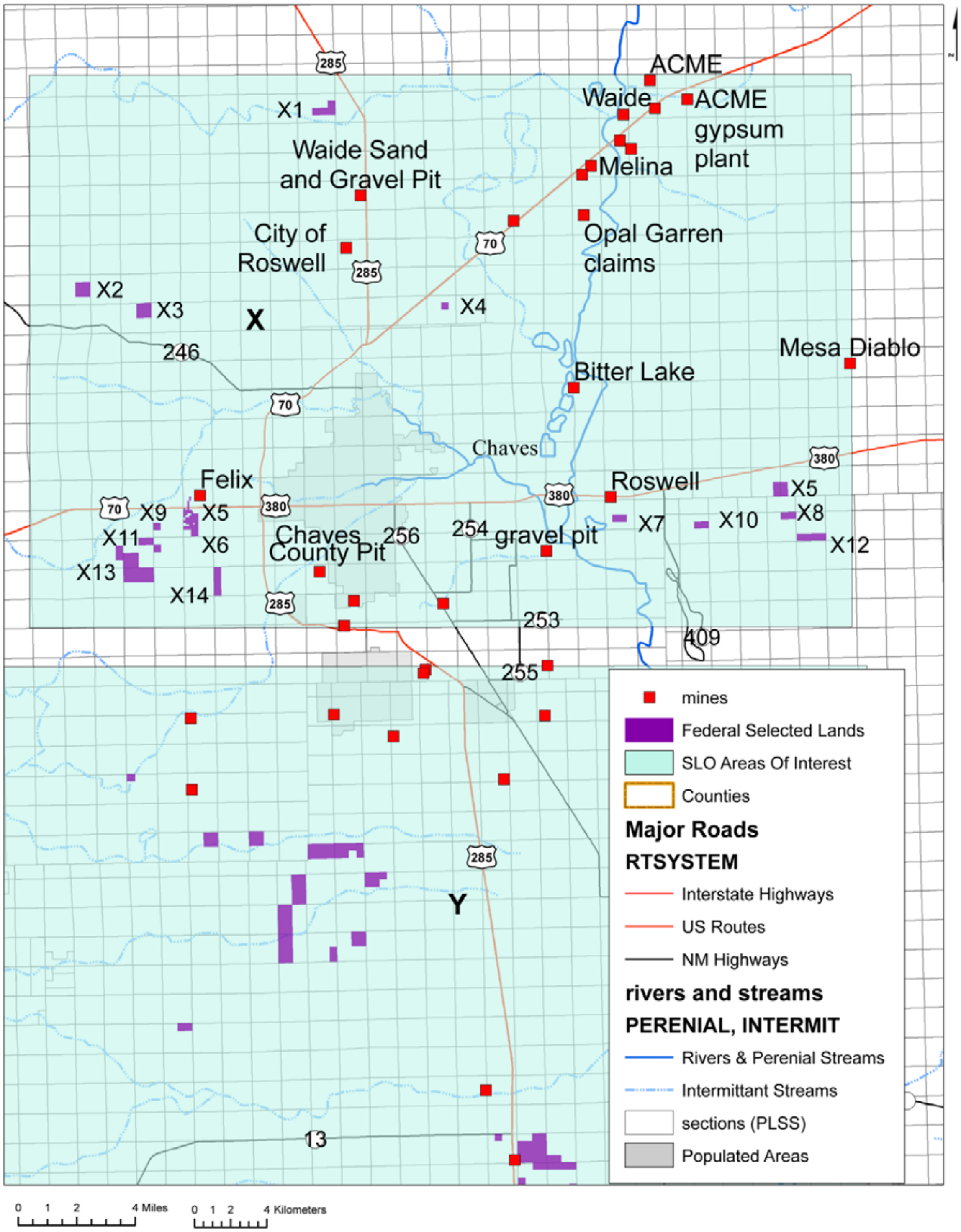


FIGURE 58. Mines in Area X in Chaves County. See Figure 1 for location of Area X. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

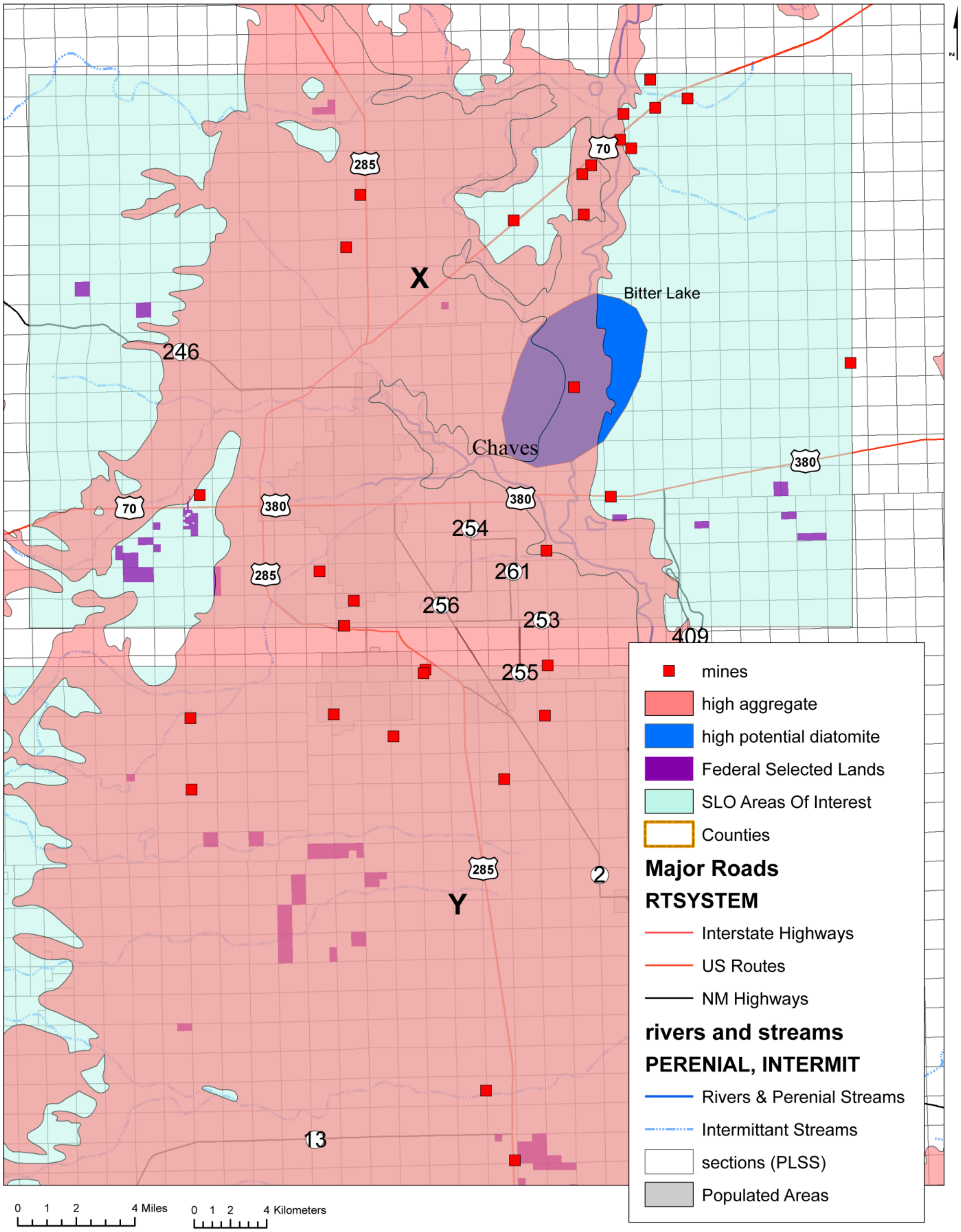


FIGURE 59. Mineral-resource potential for sand and gravel (aggregates) and diatomite in Area X in Chaves County. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

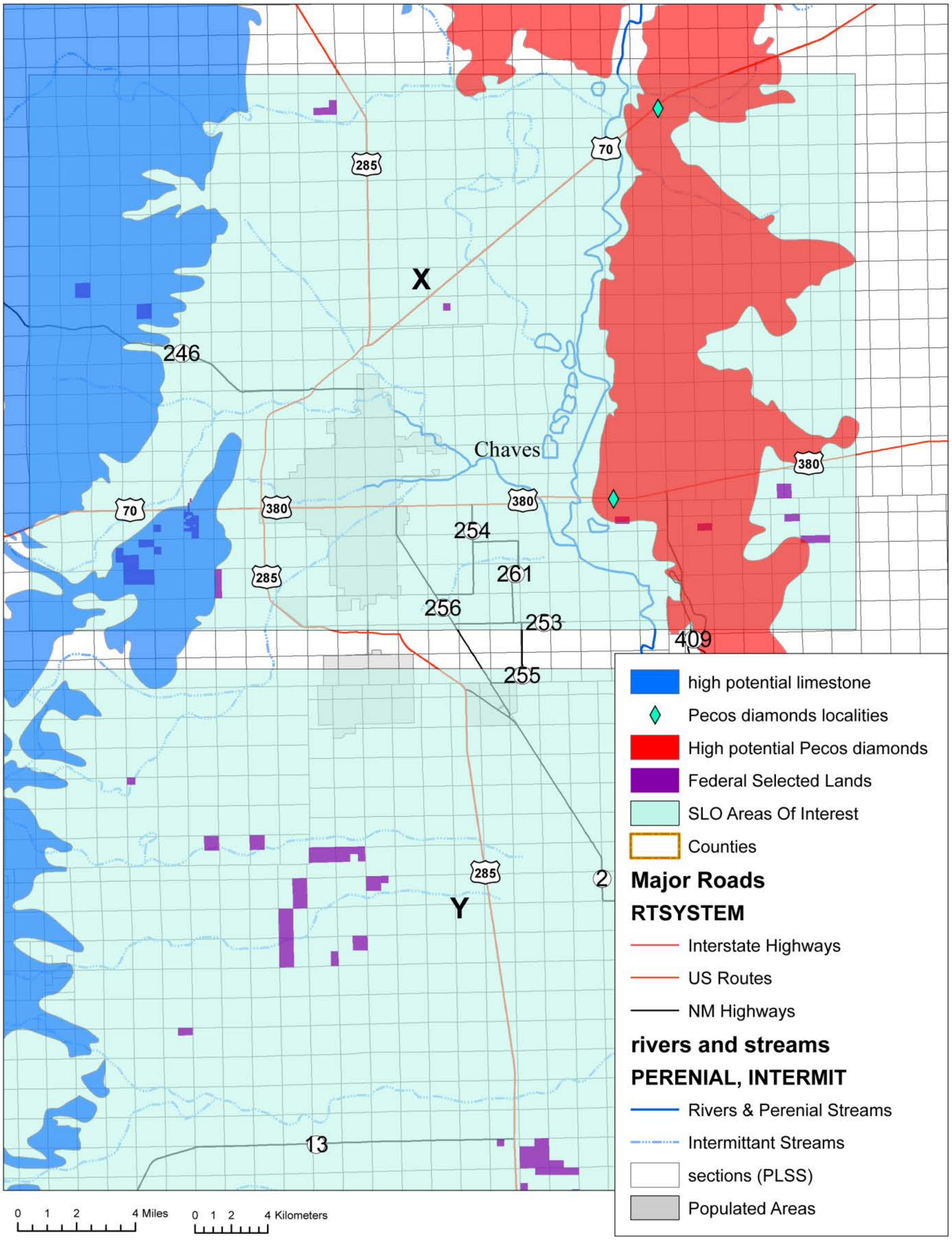


FIGURE 60. Mineral-resource potential for limestone and Pecos diamonds in Area X in Chaves County. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

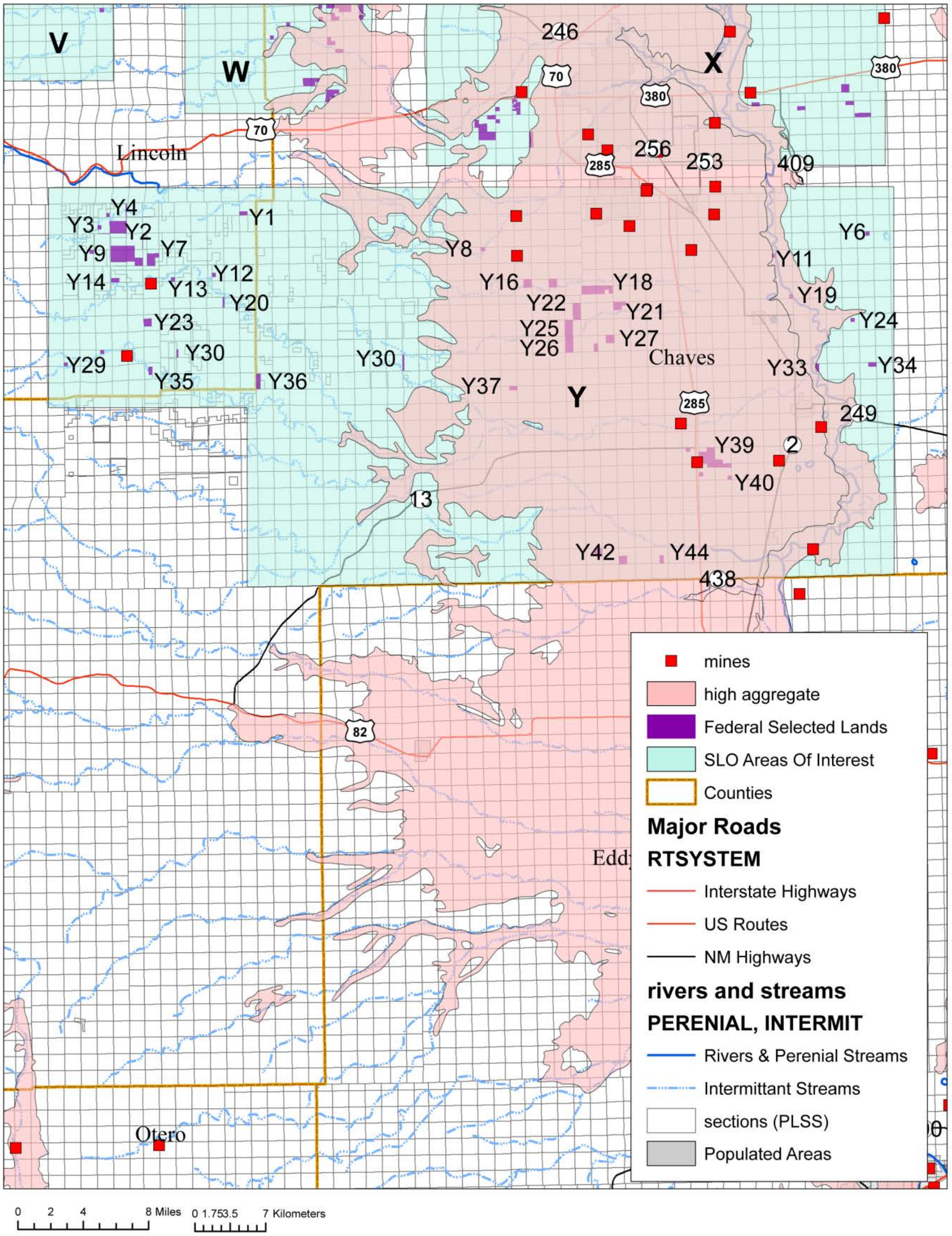


FIGURE 61. Mines and mineral-resource potential for sand and gravel (aggregates) in Area Y in Chaves and Lincoln Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

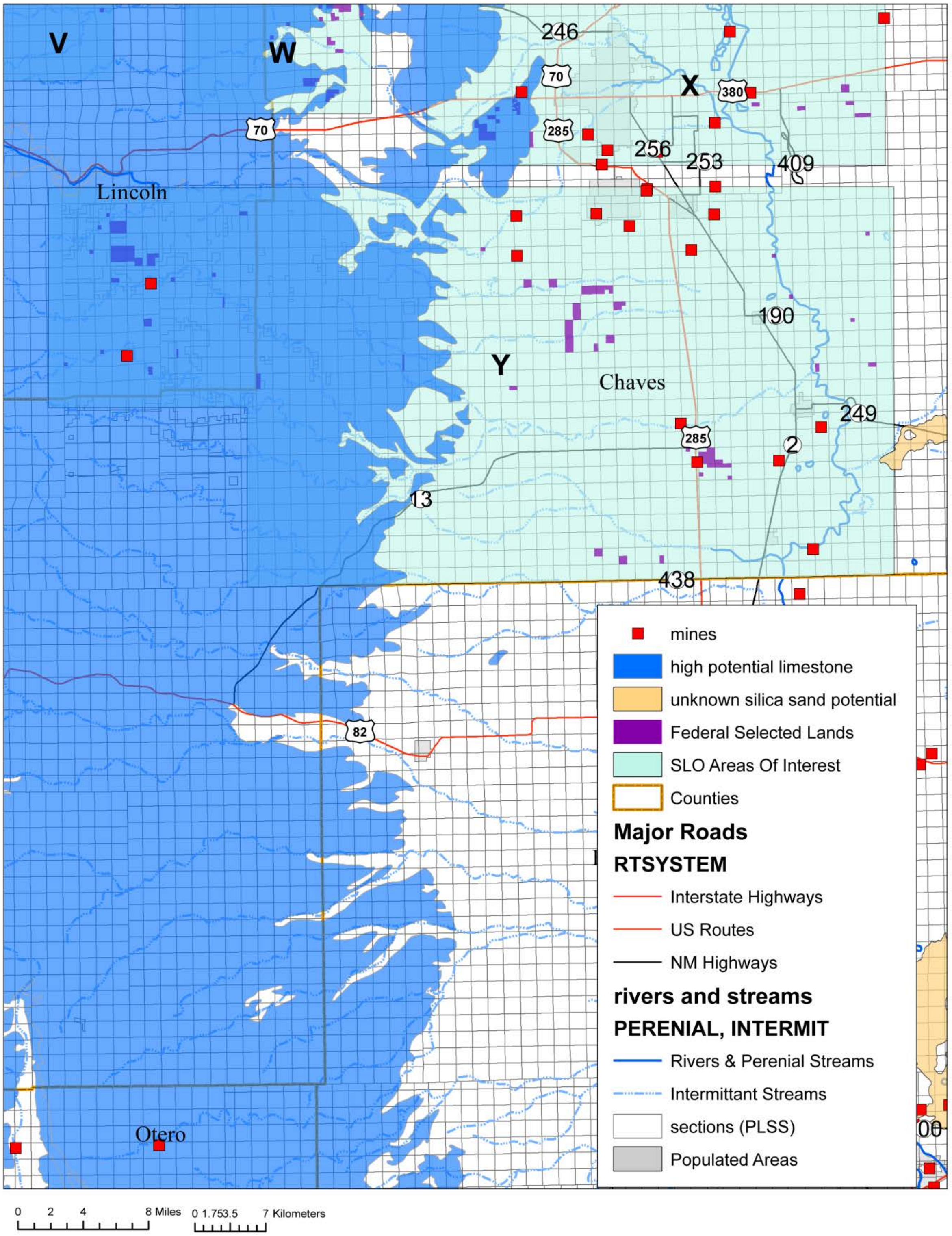


FIGURE 62. Mineral-resource potential for limestone and silica sand in Area Y in Chaves and Lincoln Counties. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

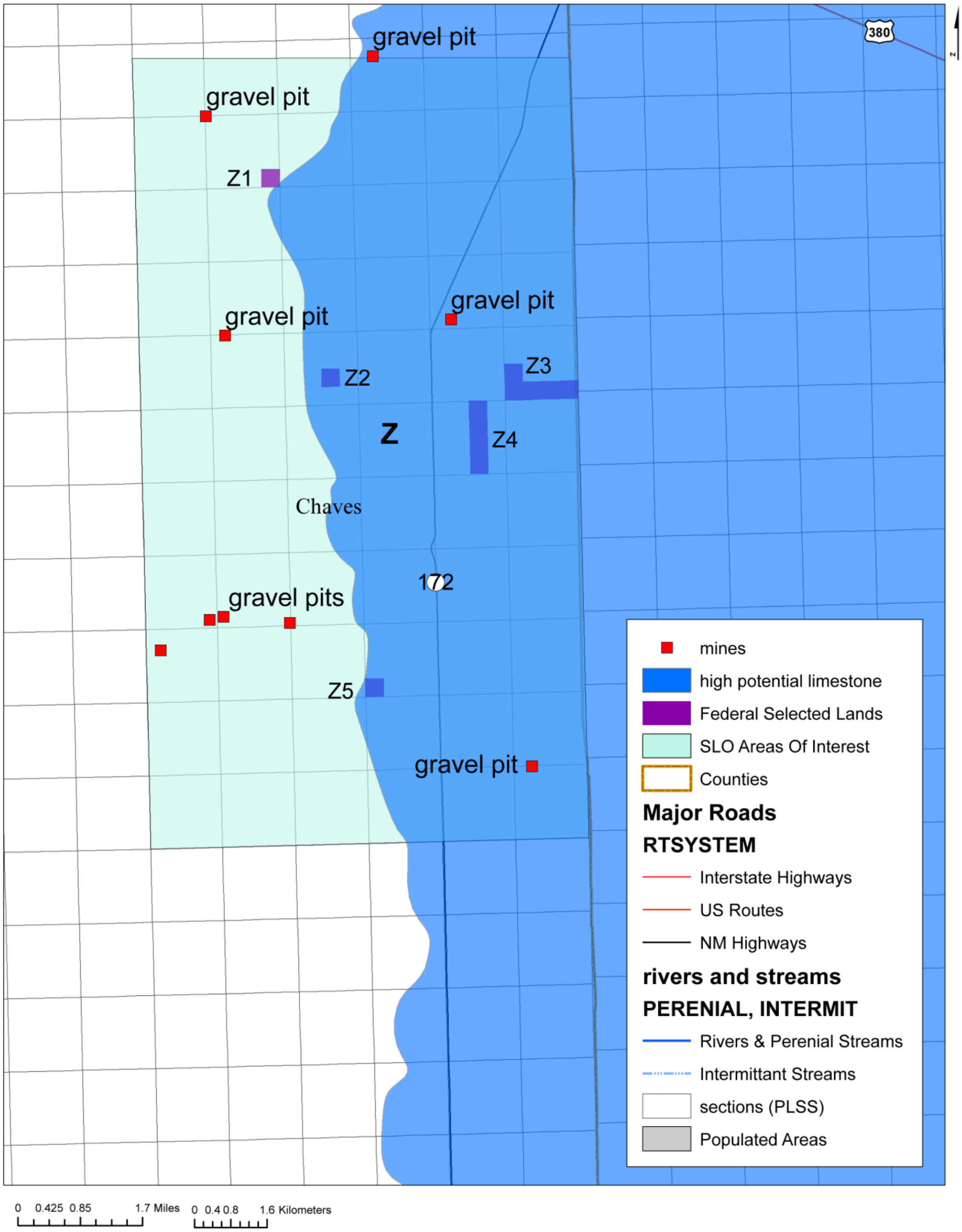


FIGURE 63. Mines and mineral-resource potential for limestone in Area Z in Chaves County. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

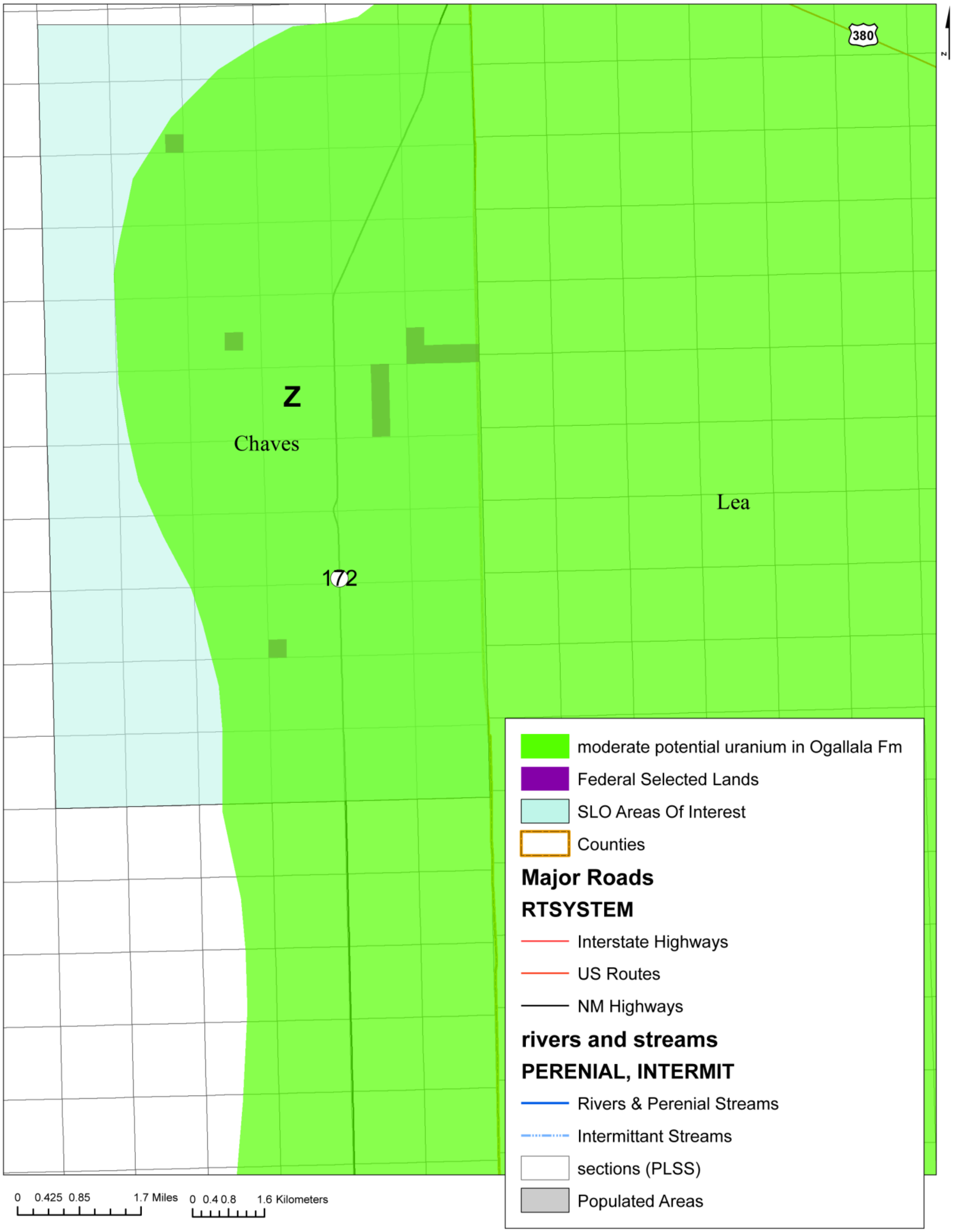


FIGURE 64. Mineral-resource potential for uranium in Area Z in Chaves County. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

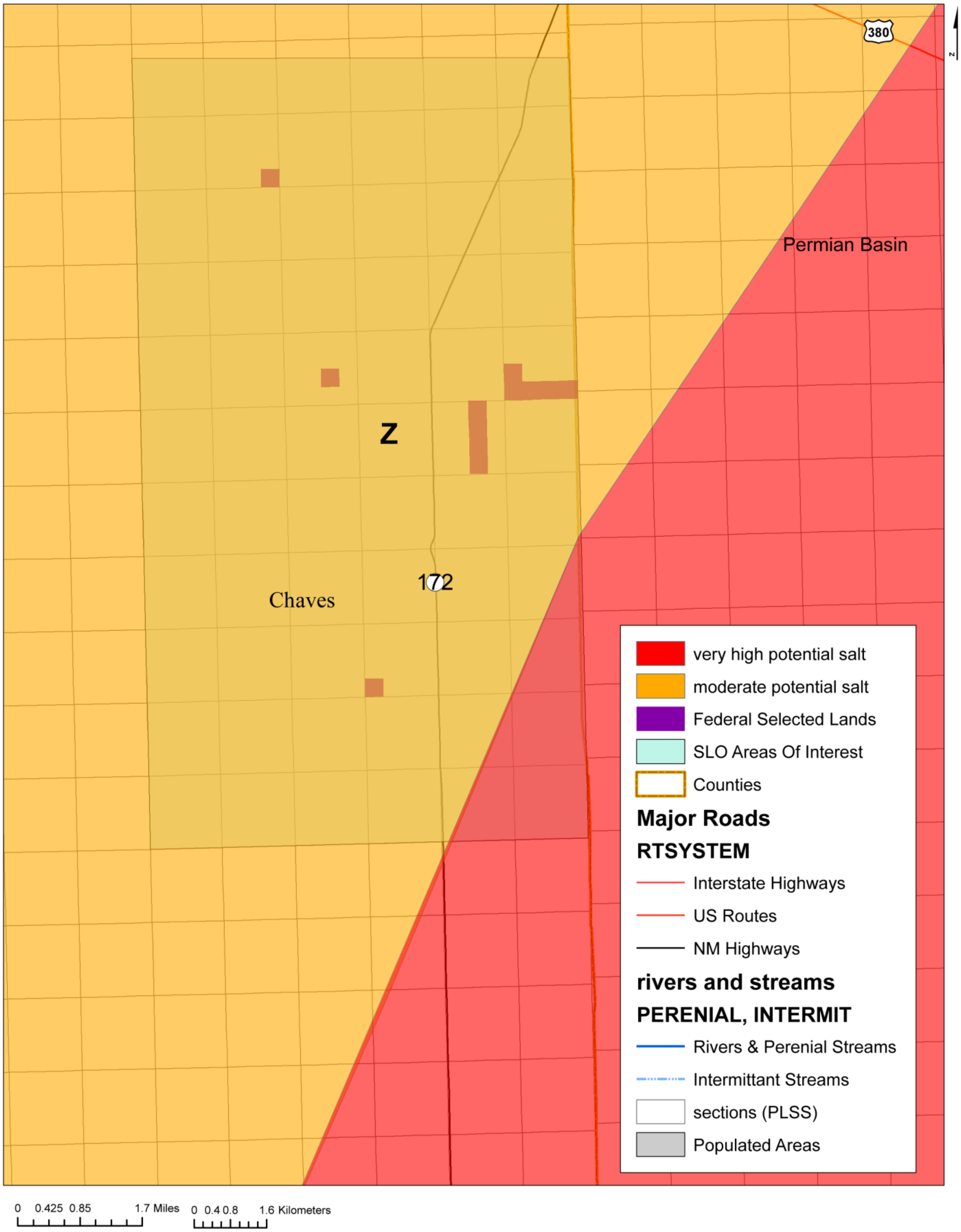


FIGURE 65. Mineral-resource potential for salt in Area Z in Chaves County. The mineral-resource potential is moderate with a moderate level of certainty for potash in the entire Area Z.

Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## Area AA

Area AA is in T26S, R16-17E and includes portions of the Cornudas Mountains and the eastern part of the Otero Platform in southern Otero County along the border with Texas. The Cornudas Mountains mining district (DIS128) is in the eastern portion of Area AA, although none of the parcels are actually within the mining district (Fig. 66; Schreiner, 1994; McLemore et al., 1996b, c; McLemore and Guilinger, 1996; Nutt et al., 1997; McLemore, 2010c, 2015a, b, 2018b). Although there are no active mines in Area AA (Fig. 5), there are inactive mines, occurrences and mining claims found in the area. The Wind Mountain nepheline syenite mine (NMOt0013) in the Cornudas Mountains mining district, is considered an active exploration site. A test shipment of nepheline syenite was shipped from the Wind Mountain nepheline syenite mine for potential ceramic and other industrial applications (McLemore et al., 1996b, c).

The mineral-resource potential is high with a high level of certainty for stone (nepheline syenite) in the alkaline igneous intrusions in the Cornudas Mountains mining district. The mineral-resource potential is high with a moderate level of certainty for REE and beryllium and low with a low level of certainty for gold in the Cornudas Mountains mining district (Fig. 66). The mineral-resource potential for limestone is high with a high level of certainty in most of Area AA, including the parcels (Fig. 67). The mineral-resource potential for gypsum is high with a high level of certainty in the eastern portion of Area AA (Fig. 68). The mineral-resource potential is for high with a high level of certainty for sand and gravel (aggregates) along drainages in Area AA (Fig. 68).

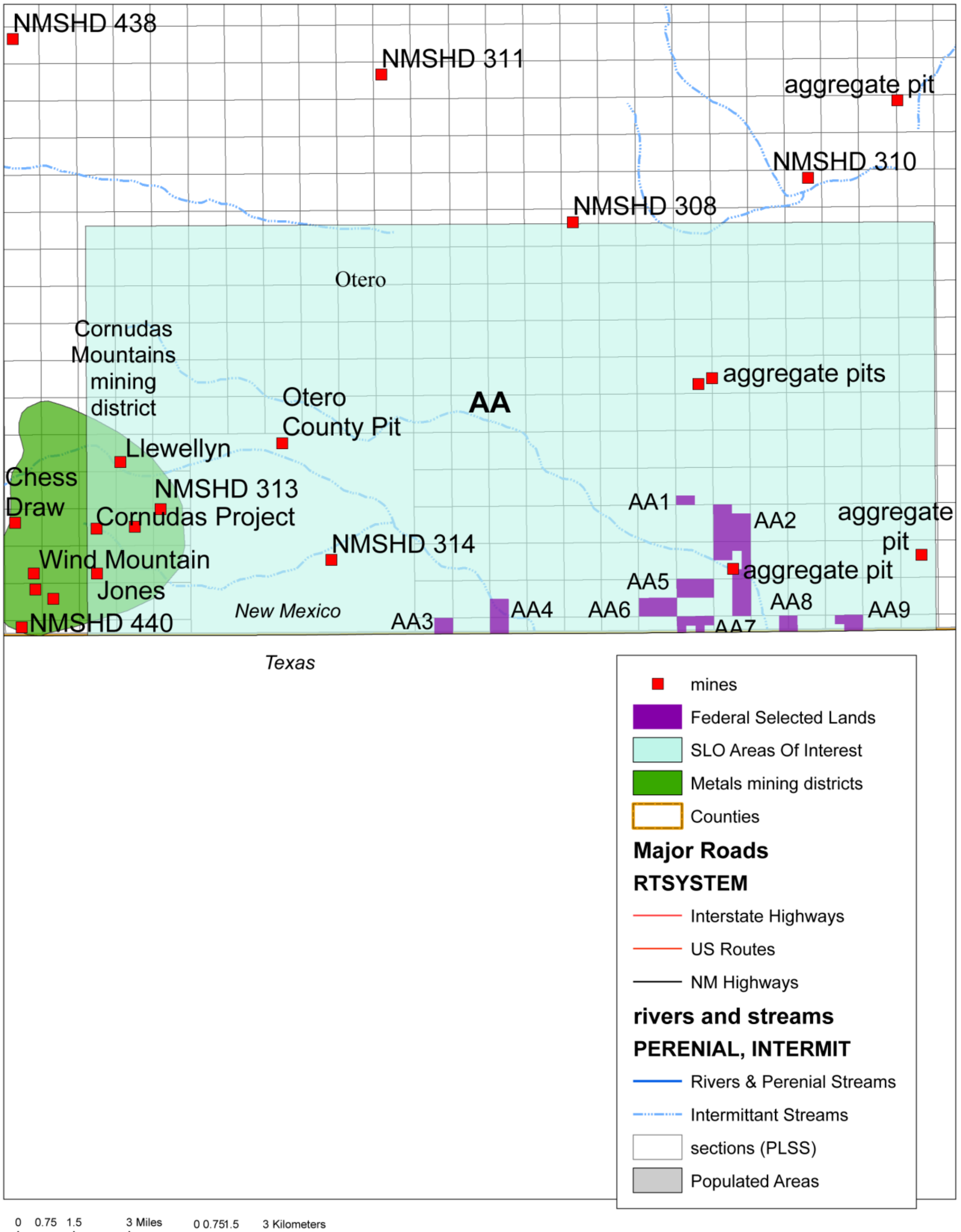


FIGURE 66. Mines and mining district in Area AA in Otero County. See Figure 1 for location of Area AA. The mineral-resource potential is high with a high level of certainty for stone (nepheline syenite) in the alkaline igneous intrusions in the Cornudas Mountains mining district. The mineral-resource potential is high with a moderate level of certainty for REE and beryllium and low with a low level of certainty for gold in the Cornudas Mountains mining district. Note

that some of the colors are different from the legend because of the transparency function in ARCMAP.

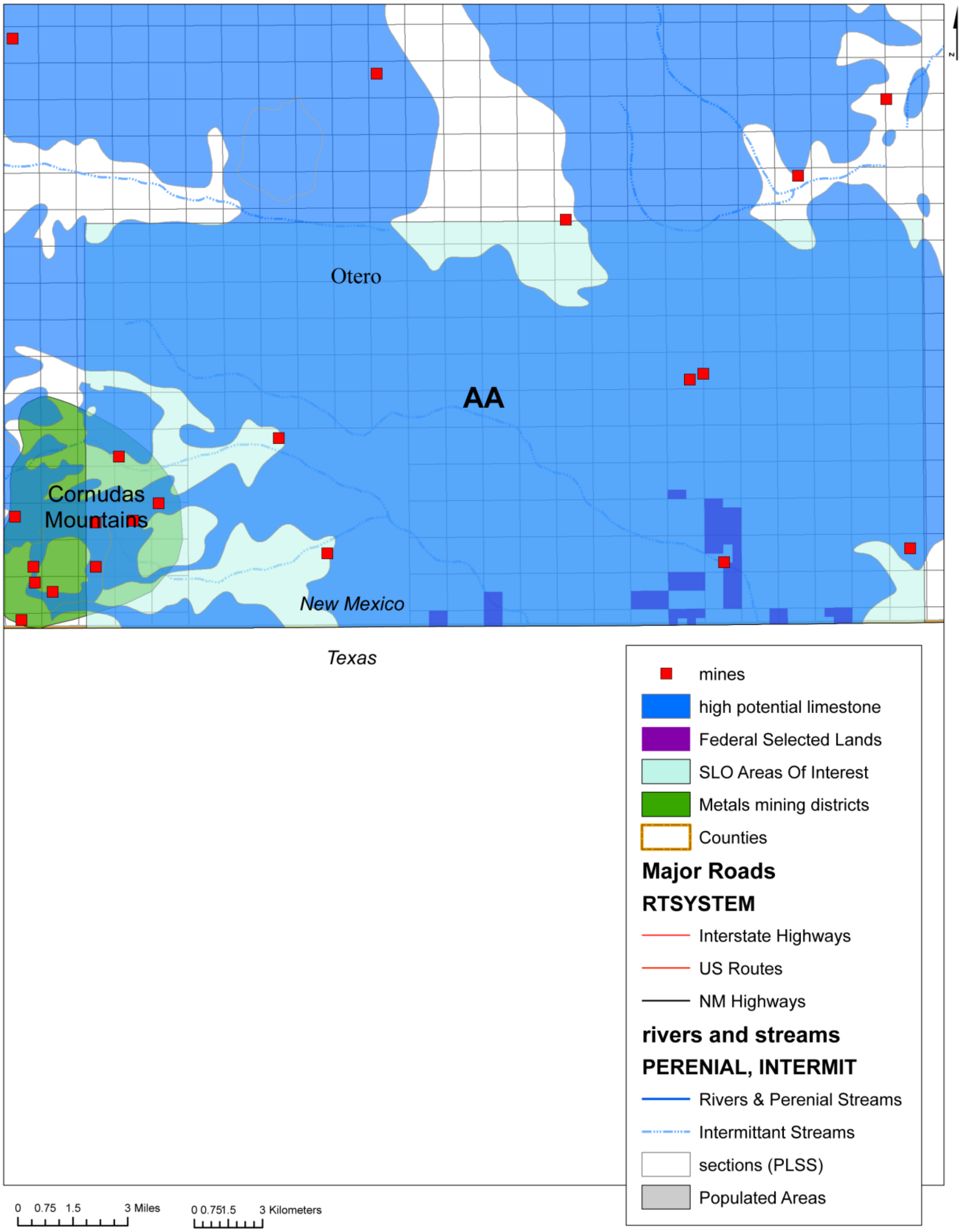


FIGURE 67. Mineral-resource potential for limestone in Area AA in Otero County. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

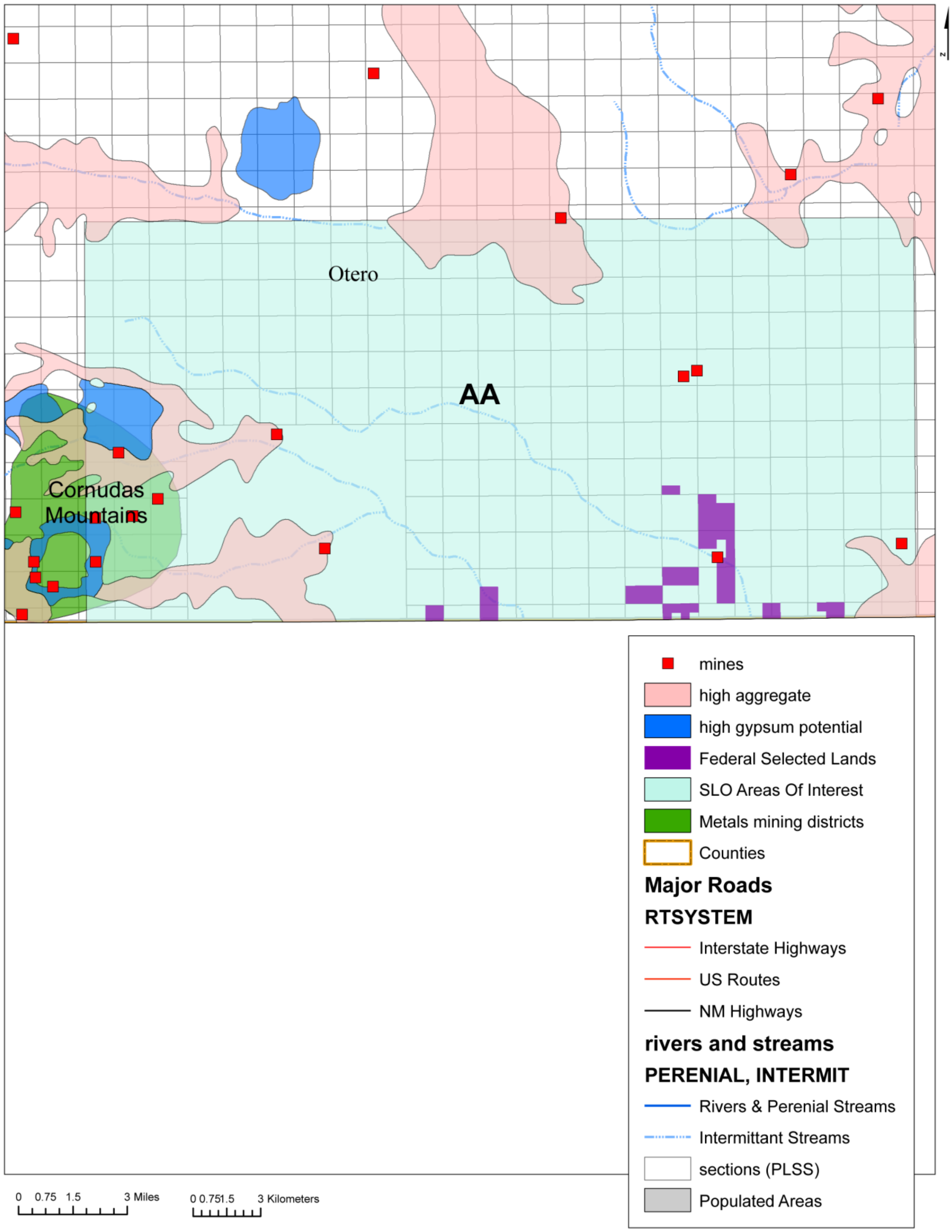


FIGURE 68. Mineral-resource potential for sand and gravel (aggregates) and gypsum in Area AA in Otero County. Note that some of the colors are different from the legend because of the transparency function in ARCMAP.

## REASONABLY FORESEEABLE DEVELOPMENT

Reasonably foreseeable development (RFD) is defined as the potential for the occurrence and likelihood for future development (i.e. mining) of mineral resources. The evaluation of RFD involves the evaluation of the potential of the occurrence of the resource based on geologic factors (i.e. mineral resource classification described above) and the evaluation of the potential for future exploitation of that resource based upon economic factors. Economic factors include future supply and demand, future prices, costs of production and processing, and changes due to new technologies. The best approach is to assess past production, supply, demand, and prices and predict changes in the future. Local economic factors also have a role in determination of RFD. McLemore (2017) and McLemore et al. (2017) include production tables and graphs showing the production of numerous commodities produced from New Mexico, which are used in the evaluation of the RFD.

In this report the RFD has been designated as high, low, unknown, and none. High RFD refers to areas where future production is likely. Low RFD refers to areas where production is not as likely because of economic factors. Unknown refers to areas where not enough data are available to properly asses the RFD. None refers to areas where there are no known resources in the area.

The near-term future mineral production of many commodities, especially metals, in New Mexico is uncertain at best because of many complex, interrelated issues, including permitting issues, bonding, land access, available water, environmental concerns, and negative perceptions of mining within the state. It typically takes 10-15 years to permit a mine in the U.S. The Copper Flat mine in Hillsboro, Sierra County has been in the permitting process for about 15 years and a record of decision from the BLM is pending (https://www.blm.gov/programs/planning-and-nepa/plans-in-development/new-mexico/copper-flat-eis) and, if permitted, would be the first new major metal mine to be permitted under the New Mexico Mining Act of 1993 (http://www.emnrd.state.nm.us/MMD/MARP/documents/MiningAct.PDF). Some communities view mining as unfavorable and are against any mining, even of sand and gravel or other aggregates. Without community support, obtaining permits to mine are difficult and take years of negotiating and ultimately are resolved by the courts. Areas adjacent to (or even near) wilderness areas, wilderness study areas, national and state parks and monuments, and wildlife refuges typically face similar opposition to mining. Some land owners depend upon other uses of their land (such as grazing, farming, hunting) and are fearful mining is high risk and could negatively impact those other more reliable income sources. The environmental issues are addressed in that most mines today must have approved closure plans before final permits are issued (see Fig. 3 for the typical mine life cycle). Mining companies are reluctant to invest in exploration and potential development in New Mexico because these issues add to the high risk of return of investment in a reasonable time period. Some additional specifics of economic factors for each commodity or commodity group are explained below.

TABLE 3. Commodities found in New Mexico selected for evaluation in this report. Critical minerals are designated by Schulz et al. (2017). ? not evaluated

| COMMODITY CLASS | COMMODITY | IS IT A CRITICAL MINERAL? | AREA COMMODITY IS PRESENT | REASONABLY FORESEEABLE DEVELOPMENT |
|---|---|---|---|---|
| Metals | Copper (Cu) | | L, P, U | Low |
| | Lode gold and silver (Au, Ag) | | C, L, P, Q, R, U, V | Low |
| | Placer gold (Au, recreational miners) | | C, Q | High |
| | Molybdenum (Mo) | | B, P, Q, U | Low |
| | Platinum group elements (PGE: Pd, Pt, Os, Ir, Rh) | Yes | None | None |
| | Antimony (Sb) | Yes | ? | ? |
| | Chromium | Yes | None | None |
| | Cobalt (Co) | Yes | None | None |
| Industrial minerals | Sand and gravel (aggregates) | | B, C, D, E, F, G, H, I, K, N, P, Q, R, T, U, W, Y, AA | High |
| | Arsenic | Yes | ? | ? |
| | Barium (barite) (Ba) | Yes | H | Low |
| | Beryllium (Be) | Yes | AA | Unknown |
| | Bismuth | Yes | ? | ? |
| | Cesium and rubidium | Yes | ? | ? |
| | Clay | | A, P, Q | High |
| | Diatomite | | X | High |
| | Fluorine (fluorite)(F) | Yes | H | Low |
| | Gallium (Ga) | Yes | R | Unknown |
| | Garnet | | ? | ? |
| | Germanium (Ge) | Yes | ? | ? |
| | Graphite (carbon) | Yes | None | None |
| | Gypsum | | G, H, J, N, P | High |
| | Hafnium (Hf) | Yes | None | None |
| | Humate | | A, B | High |
| | Indium (In) | Yes | none | None |
| | Iron (Fe), iron oxide and magnetite (Fe) | | N, P, Q, R, U, V | High |
| | Limestone and dolomite | | B, G, H, K, L, M, N, O, P, Q, R, S, T, U, V, | High |

| COMMODITY CLASS | COMMODITY | IS IT A CRITICAL MINERAL? | AREA COMMODITY IS PRESENT | REASONABLY FORESEEABLE DEVELOPMENT |
|---|---|---|---|---|
| | | | W, X, Y, Z | |
| | Lithium (Li), strontium (Sr), bromine (Br), boron (B) | Yes | J | Unknown |
| | Manganese (Mn) | Yes | V | Low |
| | Mica | | none | None |
| | Niobium, tantalum (Nb, Ta) | Yes | | Unknown |
| | Perlite | | none | None |
| | Potash (K) | Yes | T, Z | High |
| | Pumice | | F | High |
| | Rare earth elements (REE), including yttrium (Y) and thorium (Th) | Yes | B, I, P, U, V, AA | Unknown |
| | Rhenium (Re) | Yes | none | None |
| | Salt | | J, T, Z | High |
| | Scandium (Sc) | Yes | none | None |
| | Selenium (Se) | Yes | A, B | Unknown |
| | Silica sand | | G, H, J, M, N, Q, T, U, Y | Unknown |
| | Stone | | A, C, D, G, H, K, L, Q, U, AA | High |
| | Tellurium (Te) | Yes | Q, R, U | Low |
| | Tin (Sn) | Yes | none | None |
| | Titanium (Ti) | Yes | B | Low |
| | Tungsten (W) | Yes | R | Low |
| | Vanadium (V) | Yes | A, B | Unknown |
| | Zeolites | | AA | High |
| | Zirconium (Zr) | Yes | B | Low |
| Gemstones | Gemstones (including mineral collecting) | | C, T, X, Y | High |
| Uranium | Uranium (U) | Yes | A, B, D, E, I, J, T, Z | High to low |
| Coal | Coal | | A, B, Q, R, U | Low |

## Copper and molybdenum

New Mexico has been a significant producer for copper and molybdenum, primarily from the Silver City and Questa areas (McLemore, 1996c, 2017; McLemore and Lueth, 2017). The reasonably foreseeable development for copper and molybdenum in the 27 areas is low because of the small size of known deposits, access issues, environmental regulations, and permitting delays. Most commodities have normal fluctuations in prices, which results in fluctuations in production.

## Gold and silver

The reasonably foreseeable development for placer gold in the Jicarilla, White Oaks, and Nogal-Bonito districts is high for recreational gold miners (McLemore, 2001, 2017; McLemore and Lueth, 2017). The reasonably foreseeable development for commercial development of placer and lode gold and silver is low to high because of the small size of known deposits, access issues, environmental regulations, available water, and permitting delays.

## Potash

The reasonably foreseeable development for potash is high (McLemore and Austin, 2017).

## Sand and Gravel (Aggregates)

The reasonably foreseeable development for sand and gravel (aggregates) near highway construction and larger cities is high.

## Uranium

Although New Mexico was once a significant producer of uranium, uranium has not been produced from the state since 2002. New Mexico has significant remaining resources that could be developed in the future if the price increases, number of nuclear generating plants increases, and environmental regulations allows for easier permitting uranium mines in the state (McLemore and Chenoweth, 1989, 2017). However, most of the uranium in the Grants district will require a mill for processing and only one mill is operating in the United States at Blanding, Utah, which would require expensive transportation costs. Therefore, the reasonably foreseeable development for uranium in the near future is low (<10 yrs), but is high in the long term as demand and price increases (>10 yrs).

## Coal

New Mexico has been a significant producer of coal, especially from the San Juan Basin. In 2017, the EIA estimates that New Mexico contains approximately 3% of the coal reserves in the U.S. (https://www.eia.gov/state/analysis.php?sid=NM). However, coal production in New Mexico is expected to decrease in the future as the electricity-generating plants in the Four

Corners area close or are replaced by gas-fired generators (Fig. 69; Hoffman, 2017). Coal-fired electricity generation in New Mexico is declining in response to tougher air quality regulations, more competitively priced natural gas supplies, and California's decision in 2014 to stop purchasing electricity generated from coal (https://www.eia.gov/state/analysis.php?sid=NM). Therefore, it is unlikely that any new coal mines will come into production in the near future, unless China decides to import New Mexico coal.

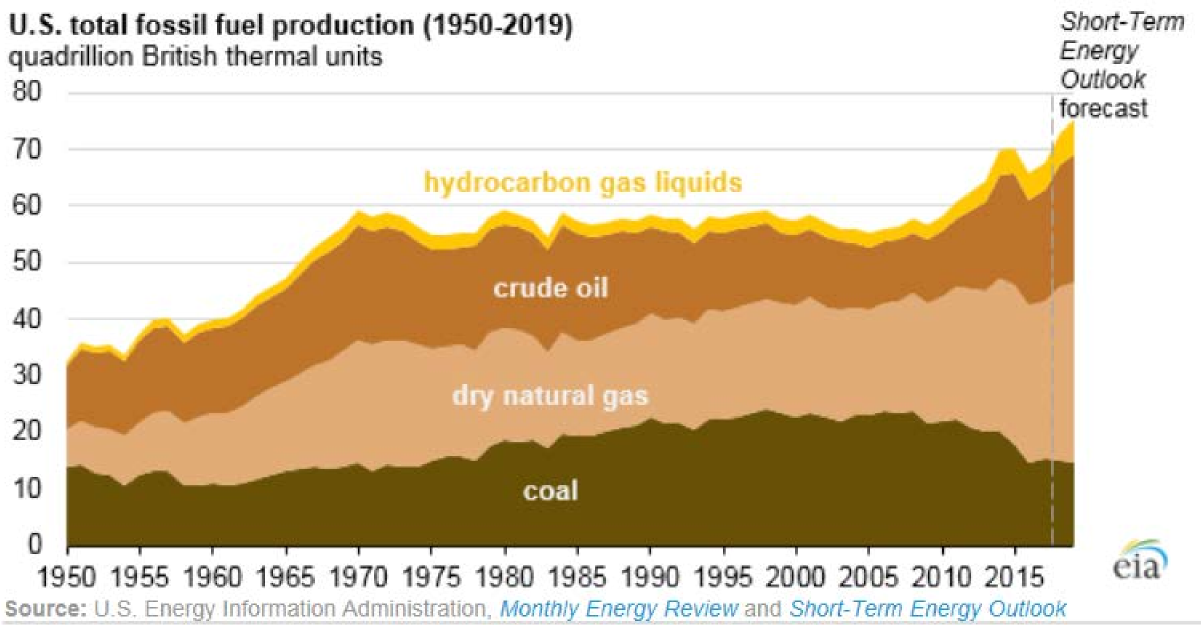


FIGURE 69. Although the EIA expects record levels of total energy production from the U.S. in 2018-2019, the production of coal is expected to continue to decrease (https://www.eia.gov/todayinenergy/detail.php?id=34572).

## Critical Minerals

The reasonably foreseeable development for critical minerals in New Mexico is unknown. If economic deposits are delineated, their production potential is high. For example, the EIA projects an increase in wind and solar power (Fig. 70) over the next few years, which would increase the demand for those critical elements that go into the manufacture of wind turbines, solar panels, and batteries.

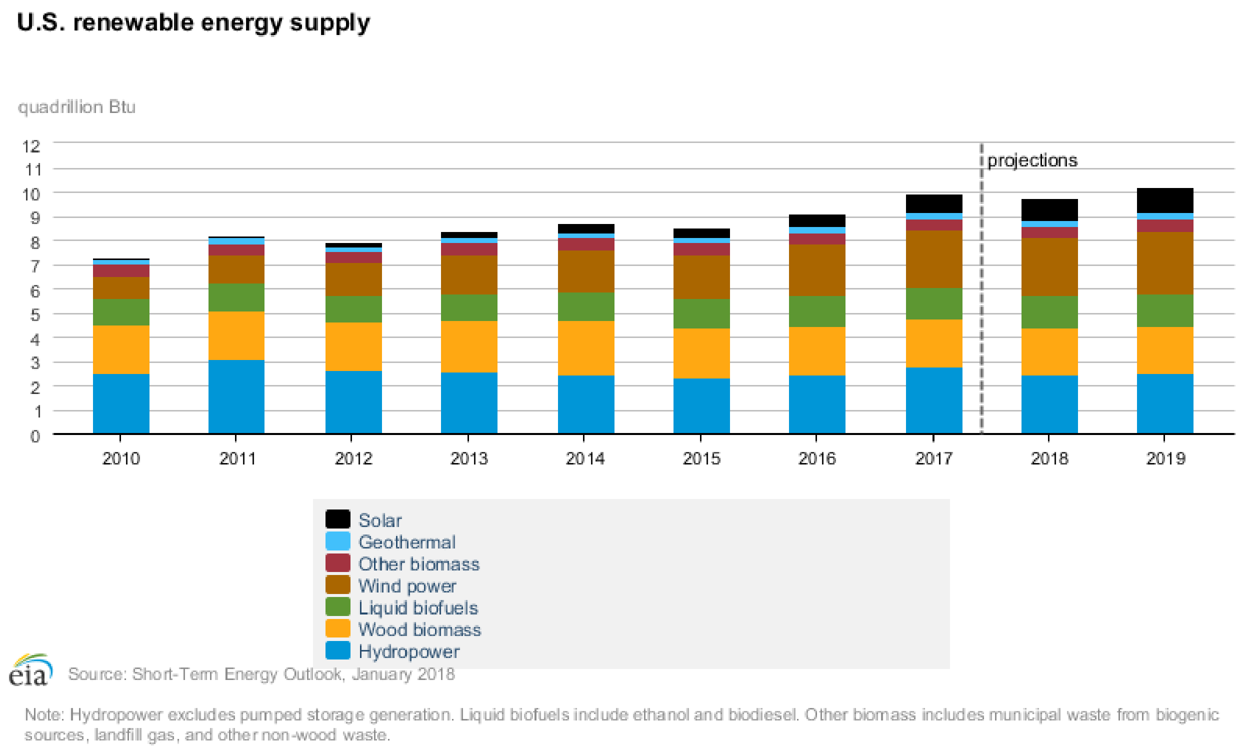


FIGURE 70. Short-term renewable energy outlook in the U.S. (https://www.eia.gov/outlooks/steo/data.php?type=figures).

## CONCLUSIONS

Energy (coal, uranium), metal, and industrial minerals resources are broadly distributed throughout New Mexico and are found in many mining districts that are scattered throughout the state (Table 3; Fig. 2). Distribution of mineral deposits is highly dependent on the geological conditions and processes necessary for concentration of the commodity in question. The BLM grouped the 423 individual parcels into 27 areas, designated A through AA. The assessment for each area is summarized in Appendix 1 and for each individual parcel is in Appendix 2. As geologic mapping progresses at more detailed scales (e.g., 1:24,000), the mineral-resource potential in most areas of New Mexico will need to be updated. Furthermore, this assessment is based upon a literature search and experience of the author, but still requires field verification.

## RECOMMENDATIONS

- Much of New Mexico has not been mapped at 1:24,000 scale, which is needed to fully understand the geology, structure, hydrology, and mineral-resource potential of the area.

- The jasperoids throughout the state need to be sampled and analyzed for metals to assess the potential for sedimentary-hosted gold (Carlin-type) deposits.
- A complete inventory of mineral deposits, historic and inactive mines, occurrences, and prospects is needed.
- Areas with active claims should be field checked.
- Areas indicated for silica sand and dimension stone require additional mapping, sampling, and other analyses to properly determine the mineral-resource potential.
- Regional geophysical data should be better incorporated into this assessment in order to identify areas in the subsurface that could have potential mineral resources.
- Refine this assessment to a more detailed scale (at least 1:12,000).
- Compare this assessment with older mineral-resource assessments of specific areas, especially Wilderness Study Areas reports and BLM and USFS assessments.

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# APPENDIX 1

## MINERAL-RESOURCE POTENTIAL OF 27 BLM AREAS

| Area | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Comments |
|---|---|---|---|---|---|---|---|
| A | Rio Arriba | coal | DIS146 | low | low | K | |
| | | humate | | moderate | high | K | |
| | | uranium | | moderate | high | J | |
| | | V, Se, Mo | | unknown | low | J | |
| | | crushed stone-andesite (aggregates) | | high | high | Tim | |
| | | clay | | unknown | low | K | |
| B | Sandoval | coal | DIS150 | low-moderate | moderate | Kkf | |
| | | coal | DIS158 | moderate | moderate | | |
| | | humate | DIS158 | high | high | Kkf | |
| | | limestone | | high | high | | |
| | | uranium | DIS116 | high | high | J | |
| | | uranium | | moderate | moderate | J | |
| | | V, Se, Mo | | unknown | low | J | |
| | | REE-Zr-Ti | | unknown | low | K | |
| | | sand, gravel | | high | high | Qal | |
| C | Rio Arriba | placer Au | DIS149 | moderate | moderate | Qa | |
| | | basalt, andesite, scoria | | high | high | Tpb | |
| | | sand, gravel | | high | high | Q | along stream channels |
| | | mineral collecting chert | | unknown | low | | |
| D | Mora | basalt, andesite, scoria | | high | high | Tpb | |
| | | crushed stone | | high | high | | |
| | | sand, gravel | | high | high | Q | southern along stream |
| | | uranium | | low | low | | eastern part |
| E | Colfax, Mora | sand and gravel (aggregates) | | high | high | | |
| | | uranium | | low | moderate | | |
| F | Santa Fe | sand and gravel | | high | high | QTs | eastern part |
| | | basalt, andesite, scoria | | high | high | Tbp | western part |
| | | pumice | | high | high | | northwestern corner |
| G | Santa Fe | sand and gravel | | moderate | moderate | Qp | |
| | | gypsum | | high | high | San Rafel Group | |

| Area | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Comments |
|---|---|---|---|---|---|---|---|
| | | limestone | | high | high | San Rafel Group | |
| | | silica sand | | moderate | moderate | San Rafel Group | |
| | | stone | | high | high | | northeastern portion |
| H | Santa Fe | barite, fluorite, galena | DIS182 | moderate | high | Pa | |
| | | sand and gravel | | moderate | moderate | Qp, Psa | |
| | | limestone | | high | high | Pg, Py | |
| | | gypsum | | high | high | Py | |
| | | silica sand | | moderate | moderate | Pg | |
| | | stone | | high | high | Pa | |
| I | Torrance | sand and gravel | | high | high | Qpl | |
| | | uranium | | unknown | low | Y, episyenites | |
| | | REE-Th | | unknown | low | Y, episyenites | |
| J | Torrance | salt | DIS243 | high | high | Qe, Qpl | |
| | | sodium | DIS243 | moderate | moderate | | |
| | | Li, Sr, Br, B | DIS243 | unknown | low | Qe, Qpl | |
| | | silica sand | | moderate | moderate | Pg | |
| | | gypsum | | moderate | moderate | Qe, Qpl | |
| | | uranium | | unknown | low | Qe, Qpl | |
| K | Guadalupe | limestone (caliche) | | high | high | Trs | |
| | | sand and gravel | | high | high | Qa | |
| | | gypsum | | moderate | moderate | | |
| | | stone | | high | high | Trs | |
| L | Torrance | Cu, Ag, Au | DIS246 | low | moderate | Pa | |
| | | stone | | high | high | Pa | central portion |
| | | gypsum | | high | high | Py | southeastern portion |
| | | limestone | | high | high | Psa | western and southeastern portion |
| M | Torrance | gypsum | | high | high | Py | |
| | | limestone | | high | high | Psa | |
| | | silica sand | | moderate to high | moderate | Pg | |
| N | Torrance | iron | DIS241 | low | low | Psa, Py | |
| | | sand and gravel | | high | high | | |
| | | silica sand | | moderate to high | high | | north-central portion |
| | | silica sand | | unknown | low | | southeastern portion |
| | | gypsum | | high | high | | |
| | | limestone | | high | high | | |
| O | Torrance | limestone | | high | high | Psa | |
| P | Lincoln | REE | DIS092 | high | moderate | | |

| Area | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Comments |
|---|---|---|---|---|---|---|---|
| | | Au, Ag, Fe | DIS092 | moderate | moderate | | |
| | | Cu, Mo, U, Te | DIS092 | low | moderate | | |
| | | Fe | DIS098 | low | low | | |
| | | clay | DIS089 | high | moderate | K | |
| | | limestone | | high | high | Psa, Pg | |
| | | gypsum | | high | high | Pat | |
| | | sand, gravel (aggregates) | | high | high | | |
| Q | Lincoln | clay | DIS089 | high | moderate | K | |
| | | placer Au | DIS093 | high | high | | |
| | | lode Au | DIS093 | high | moderate | | |
| | | Fe | DIS093 | moderate | high | | |
| | | Mo, Te | DIS093 | low | low | | |
| | | Fe | DIS098 | low | low | | |
| | | Fe | DIS094 | low | low | | |
| | | limestone | | high | high | | |
| | | gypsum | | high | high | | |
| | | gypsum | | moderate | moderate | | |
| | | stone | | high | high | | |
| | | sand and gravel (aggregates) | | high | high | | |
| | | coal | DIS097 | low to low-moderate | moderate | K | |
| | | silica sand | | unknown | low | | |
| R | Lincoln | Au, Ag, W | DIS099 | high | high | | |
| | | Fe | DIS099 | moderate | moderate | | |
| | | Te | DIS099 | low | low | | |
| | | coal | DIS097 | low to low-moderate | moderate | K | |
| | | basalt, scoria | | high | high | | |
| | | sand and gravel (aggregates) | | high | high | | |
| | | limestone | | high | high | | |
| | | gallium | | unknown | low | | Carrizo Mountain area |
| S | Lincoln, Chaves | limestone | | high | high | | |
| T | Chaves | limestone | | high | high | | |
| | | sand and gravel (aggregates) | | high | high | | |
| | | salt | | moderate | moderate | P | |
| | | potash | | moderate | moderate | P | |
| | | uranium | | moderate | moderate | Ogallala Formation | |
| | | mineral collecting Pecos diamonds | | high | high | Psr | |
| | | silica sand | | unknown | low | | |

| Area | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Comments |
|---|---|---|---|---|---|---|---|
| U | Lincoln, Otero | Au, Mo | DIS095 | high | high | | |
| | | Cu | DIS095 | moderate | moderate | | |
| | | Te | DIS095 | low | low | | |
| | | Au | DIS096 | moderate | moderate | | |
| | | Cu | DIS127 | moderate | moderate | | |
| | | Mo | DIS127 | low | low | | |
| | | Cu, Au | DIS131 | low | low | | |
| | | Cu, Mo | DIS133 | low | low | | |
| | | Fe | DIS132 | moderate | moderate | | |
| | | REE | DIS132 | low | low | | |
| | | sand and gravel (aggregates) | | high | high | | western portion |
| | | gypsum | | high | high | | eastern and northwestern portions |
| | | gypsum | | moderate | moderate | | southwestern portion |
| | | limestone | | high | high | | northwestern and eastern portions |
| | | silica sand | | unknown | low | | western portion |
| | | stone | | high | high | Abo Formation | Sacramento Mountains |
| | | basalt | | high | high | | eastern portion |
| | | coal | DIS097 | low to low-moderate | moderate | K | |
| V | Lincoln | REE-Th | DIS091 | high | moderate | | |
| | | Au, Mn, U | DIS091 | low | moderate | | |
| | | iron | DIS091 | high | moderate | | |
| | | gypsum | | high | high | | western portion |
| | | limestone | | high | high | | most of the area |
| W | Lincoln, Chaves | sand and gravel (aggregates) | | high | high | | southeastern portion |
| | | limestone | | high | high | | |
| X | Chaves | sand and gravel (aggregates) | | high | high | | central portion |
| | | diatomite | | high | high | | central portion |
| | | limestone | | high | high | | western portion |
| | | mineral collecting Pecos diamonds | | high | high | Psr | |
| Y | Lincoln, Chaves | sand and gravel (aggregates) | | high | high | | |
| | | limestone | | high | high | | |

| Area | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Comments |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | mineral collecting Pecos diamonds | | high | high | Psr | |
| | | silica sand | | unknown | low | | |
| Z | Chaves | limestone (caliche) | | high | high | | |
| | | uranium | | moderate | moderate | Ogallala Formation | |
| | | potash | | moderate | moderate | | |
| | | salt | | high | high | | southeastern corner |
| | | salt | | moderate | moderate | | rest of area |
| AA | Otero | stone (nepheline syenite) | DIS128 | high | high | | Wind Mountain |
| | | REE, Be | DIS128 | high | moderate | | |
| | | Au | DIS128 | low | low | | |
| | | limestone | | high | high | | |
| | | gypsum | | high | high | | eastern portion |
| | | sand and gravel (aggregates) | | high | high | | drainages |

# APPENDIX 2

# MINERAL-RESOURCE POTENTIAL OF 423 BLM PARCELS

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| A1 | Rio Arriba | coal | DIS146 | low | low | K | | north of Dulce |
| A1 | | humate | | moderate | high | K | | |
| A1 | | uranium | | moderate | high | J | | |
| A1 | | aggregates (crushed stone-andesite) | | high | high | Tim | NMRA0151 | no obvious Qa units, check other maps |
| A1 | Rio Arriba | clay | | unknown | low | K | | |
| B1 | Sandoval | REE-Zr-Ti | | unknown | low | K | | |
| B2 | Sandoval | REE-Zr-Ti | | unknown | low | K | | |
| B3 | Sandoval | REE-Zr-Ti | | unknown | low | K | | |
| B4 | Sandoval | REE-Zr-Ti | | unknown | low | K | | |
| B5 | Sandoval | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B5 | | humate | | very high | high | Kkf | | |
| B5 | | REE-Zr-Ti | | unknown | low | K | | |
| B6 | Sandoval | REE-Zr-Ti | | unknown | low | K | | |
| B7 | Sandoval | REE-Zr-Ti | | unknown | low | K | | |
| B8 | Sandoval | coal | DIS158 | low-moderate | low | Kkf | | |
| B8 | | humate | | very high | high | K | | |
| B8 | | REE-Zr-Ti | | unknown | low | K | | |
| B9 | San Juan | coal | DIS158 | low-moderate | low | Kkf | | |
| B9 | | humate | | very high | high | K | | |
| B9 | | REE-Zr-Ti | | unknown | low | K | | |
| B10 | Sandoval | REE-Zr-Ti | | unknown | low | K | | |
| B11 | San Juan | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B11 | | humate | | very high | high | K | | |
| B11 | | uranium | | moderate | low | J | | |
| B11 | | REE-Zr-Ti | | unknown | low | K | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| B12 | Sandoval | coal | DIS158 | low-moderate | low | Kkf | | southern part of tract in district, northern part less potential |
| B12 | | humate | | very high | high | K | | |
| B12 | | REE-Zr-Ti | | unknown | low | K | | |
| B13 | San Juan | coal | DIS158 | low-moderate | low | Kkf | | |
| B13 | | humate | | very high | high | K | | |
| B13 | | uranium | | moderate | moderate | J | | |
| B13 | | REE-Zr-Ti | | unknown | low | K | | |
| B14 | Sandoval | coal | DIS158 | low-moderate | low | Kkf | | |
| B14 | | humate | | very high | high | K | | |
| B14 | | uranium | | moderate | moderate | J | | |
| B14 | | REE-Zr-Ti | | unknown | low | K | | |
| B15 | Sandoval | coal | DIS158 | low-moderate | low | Kkf | | |
| B15 | | humate | | very high | high | K | | |
| B15 | | uranium | | moderate | moderate | J | | |
| B15 | | REE-Zr-Ti | | unknown | low | K | | |
| B16 | Sandoval | coal | DIS158 | low-moderate | low | Kkf | | southern part of tract in district, northern part less potential |
| B16 | | humate | | very high | moderate | K | | |
| B16 | | REE-Zr-Ti | | unknown | low | K | | |
| B17 | Sandoval | coal | DIS158 | low-moderate | low | Kkf | | southern part of tract in district, northern part less potential |
| B17 | | humate | | very high | high | K | | |
| B17 | | REE-Zr-Ti | | unknown | low | K | | |
| B18 | Sandoval | coal | DIS158 | low-moderate | low | Kkf | | |
| B18 | | humate | | very high | high | K | | |
| B18 | | REE-Zr-Ti | | unknown | low | K | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| B19 | Sandoval | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B19 | | humate | | very high | high | K | | |
| B19 | | REE-Zr-Ti | | unknown | low | K | | |
| B20 | Sandoval | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B20 | | humate | | very high | high | K | | |
| B20 | | REE-Zr-Ti | | unknown | low | K | | |
| B21 | Sandoval | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B21 | | humate | | very high | high | K | | |
| B21 | | REE-Zr-Ti | | unknown | low | K | | |
| B22 | Sandoval | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B22 | | humate | | very high | high | K | | |
| B22 | | REE-Zr-Ti | | unknown | low | K | | |
| B22 | | sand, gravel | | high | high | Qal | | |
| B23 | McKinley | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B23 | | humate | | very high | high | K | | |
| B23 | | uranium | | moderate | moderate | J | | |
| B23 | | REE-Zr-Ti | | unknown | low | K | | |
| B24 | McKinley | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B24 | | humate | | very high | high | K | NMMK0400 | mine just south of tract, claims |
| B24 | | uranium | | moderate | moderate | J | | |
| B24 | | REE-Zr-Ti | | unknown | low | K | | |
| B24 | | sand, gravel | | high | high | Qal | | |
| B25 | McKinley | coal | DIS158 | low-moderate | moderate | Kkf | | |
| B25 | | humate | | very high | high | K | | |
| B25 | | uranium | | moderate | moderate | J | | |
| B25 | | REE-Zr-Ti | | unknown | low | K | | |
| C1 | Rio Arriba | basalt, andesite, scoria | | high | high | Tpb | NMRA0018 | |
| C1 | | mineral collecting chert | | unknown | low | | NMRA0299 | mineral collecting for chert |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| D1 | Mora | | | | | PPbsc | | |
| D2 | Mora | basalt, andesite, scoria | | high | high | Tmb | | |
| D3 | Mora | basalt, andesite, scoria | | high | high | Tpb | | |
| D4 | Mora | basalt, andesite, scoria | | high | high | Tpb | | |
| D5 | Mora | basalt, andesite, scoria | | high | high | Tpb | | |
| E1 | Colfax | uranium | | low | moderate | Kpn | | |
| E2 | Mora | uranium | | low | moderate | Kpn | | |
| E3 | Mora | uranium | | low | moderate | Kpn | | |
| F1 | Santa Fe | sand and gravel | | high | high | QTs | | sand and gravel mines nearby, pumice potential to west, claims to SW |
| F2 | | basalt, andesite, scoria | | high | high | Tbp | | |
| G1 | Santa Fe | sand and gravel | | moderate | moderate | Qp | | |
| G1 | | gypsum | | very high | high | | | |
| G1 | | limestone | | high | high | | | |
| G1 | | silica sand | | high | high | | | |
| G2 | Santa Fe | sand and gravel | | moderate | moderate | Qp | | |
| H1 | Santa Fe | sand and gravel | | moderate | moderate | Qp, Psa | | |
| H1 | | limestone | | high | high | | | |
| H2 | Santa Fe | sand and gravel | | moderate | moderate | Qp | | |
| H2 | | barite, fluorite, galena | DIS182 | moderate | moderate | Pa | NMSF0110 | no economic market |
| H3 | Santa Fe | limestone | | high | high | Pg, Py | NMSF0110 | |
| H3 | | gypsum | | high | high | Py | | only part of tract |
| H3 | | stone | | high | high | | | to the NE |
| H3 | | silica sand | | moderate | moderate | Pg | | |
| I1 | Torrance | sand and gravel | | high | high | Qpl | | DIS256 to east, REE, Th potential in subsurface?, gravel pis to the east, claims |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| J1 | Torrance | silica sand | | moderate | moderate | Pg | | |
| J2 | Torrance | silica sand | | moderate | moderate | Pg | | |
| J3 | Torrance | gypsum | | moderate | moderate | Qe, Qpl | | no mines on topo |
| J3 | | salt | | high | high | Qe, Qpl | | |
| J3 | | uranium | | unknown | low | Qe, Qpl | | |
| J3 | | Li, Sr, B | | unknown | low | Qe, Qpl | | |
| J4 | Torrance | gypsum | DIS243 | moderate | moderate | Qe, Qpl | | |
| J4 | | salt | | high | high | Qe, Qpl | | |
| J4 | | uranium | | unknown | low | Qe, Qpl | | |
| J4 | | Li, Sr, B | | unknown | low | Qe, Qpl | | |
| J5 | Torrance | gypsum | DIS243 | moderate | moderate | Qe, Qpl | | |
| J5 | | salt | | high | high | | | |
| J5 | | uranium | | unknown | low | | | |
| J5 | | Li, Sr, B | | unknown | low | | | |
| J6 | Torrance | gypsum | | moderate | moderate | Qe, Qpl | | |
| J6 | | salt | | high | high | | | |
| J6 | | uranium | | unknown | low | | | |
| J6 | | Li, Sr, B | | unknown | low | | | |
| J7 | Torrance | silica sand | | moderate | moderate | Pg | | |
| J8 | Torrance | gypsum | DIS243 | moderate | moderate | Qe, Qpl | | district in eastern portion of tract |
| J8 | | salt | | high | high | | | unknown potential for Li, Mg, B, Sr |
| J8 | | uranium | | occurrence | low | | | |
| J8 | | Li, Sr, B | | unknown | low | | | |
| J9 | Torrance | gypsum | DIS243 | moderate | moderate | Qe, Qpl | | |
| J9 | | salt | | high | high | | | unknown potential for Li, Mg, B, Sr |
| J9 | | uranium | | occurrence | low | | | |
| J9 | | Li, Sr, B | | unknown | low | | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| J10 | Torrance | gypsum | DIS243 | moderate | moderate | Qe, Qpl | | |
| J10 | | salt | | high | high | | | unknown potential for Li, Mg, B, Sr |
| J10 | | uranium | | occurrence | low | | | |
| J10 | | Li, Sr, B | | unknown | low | | | |
| J11 | Torrance | | | | | Qe, Qpl | | |
| J12 | Torrance | gypsum | DIS243 | moderate | moderate | Qe, Qpl | | |
| J12 | | salt | | high | high | | | unknown potential for Li, Mg, B, Sr |
| J12 | | uranium | | occurrence | low | | | |
| J12 | | Li, Sr, B | | unknown | low | | | |
| J13 | Torrance | gypsum | DIS243 | moderate | moderate | Qe, Qpl | | |
| J13 | | salt | | high | high | | | unknown potential for Li, Mg, B, Sr |
| J13 | | uranium | | occurrence | low | | | |
| J13 | | Li, Sr, B | | unknown | low | | | |
| K1 | Guadalupe | limestone (caliche) | | high | high | Trs | | |
| K2 | Guadalupe | stone | | high | high | Trs | | |
| K3 | Guadalupe | limestone (caliche) | | high | high | To | | |
| K3 | | stone | | high | high | Trs | | |
| K4 | Guadalupe | limestone | | high | high | Psa | | |
| K5 | Guadalupe | limestone | | high | high | To | | |
| K6 | Guadalupe | limestone | | high | high | To | | |
| K7 | Guadalupe | limestone | | high | high | To | | |
| | | sand and gravel | | high | high | Qa | | |
| K8 | Guadalupe | limestone | | high | high | To, Psa | | |
| K9 | Guadalupe | sand and gravel | | high | high | Qa | | |
| K10 | Guadalupe | sand and gravel | | high | high | Qa | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| K11 | Guadalupe | limestone | | high | high | To | | |
| K12 | Guadalupe | limestone | | high | high | To | | |
| K13 | Guadalupe | sand and gravel | | high | high | Qa | | |
| K14 | Guadalupe | limestone | | high | high | To | | |
| K15 | Guadalupe | sand and gravel | | high | high | Qp | | |
| K16 | Guadalupe | sand and gravel | | high | high | Qp | | |
| K17 | Guadalupe | sand and gravel | | high | high | Qp | | |
| K18 | Lincoln | | | | | Pat | | |
| K19 | Lincoln | | | | | Pat | | |
| K20 | Lincoln | sand and gravel | | high | high | Qa | | |
| K21 | Lincoln | sand and gravel | | high | high | Qa, Qp | | |
| K22 | Lincoln | sand and gravel | | high | high | Qp | | |
| K23 | Lincoln | limestone | | high | high | Psa | | |
| K24 | Lincoln | | | | | Pat | | |
| K25 | Lincoln | sand and gravel | | high | high | Qp | | |
| K26 | Lincoln | limestone | | high | high | Psa | | |
| K27 | Lincoln | limestone | | high | high | Psa | | |
| K28 | Lincoln | limestone | | high | high | Psa | | |
| K29 | Lincoln | limestone | | high | high | Psa | | |
| K30 | Lincoln | limestone | | high | high | Psa | | |
| L1 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | NMTO0249, NMTO247 | |
| L1 | | stone | | high | high | Pa | | |
| L2 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | | |
| L2 | | stone | | high | high | Pa | | |
| L3 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | | |
| L3 | | stone | | high | high | Pa | | |
| L4 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | | |
| L4 | | stone | | high | high | Pa | | |
| L5 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | NMTO0020, NMTO0029 | |
| L5 | | stone | | high | high | Pa | | |
| L6 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | | |
| L6 | | stone | | high | high | Pa | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| L7 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | | |
| L7 | | stone | | high | high | Pa | | |
| L8 | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | | |
| L8 | | stone | | high | high | Pa | | |
| L9 (upper half) | Torrance | copper, gold, silver | DIS246 | low | moderate | Pa | | |
| L9 (upper half) | | stone | | high | high | Pa | | |
| L9 (lower half) | | gypsum | | high | high | Py | | |
| M1 | Torrance | silica sand | | moderate | moderate | Pg | | |
| N1 | Torrance | gypsum | | high | high | Py | | |
| N1 | | limestone | | high | high | | | |
| N2 | Torrance | | | | | Qp | | |
| N3 | Torrance | | | | | Qp | | |
| N4 | Torrance | | | | | Qp | | |
| N5 | Torrance | gypsum | | high | high | Py | | |
| N5 | | limestone | | high | high | Py | | |
| N6 | Torrance | | | | | Qp | | |
| N7 | Torrance | gypsum | | high | high | Py, Pg | | |
| N7 | | limestone | | high | high | | | |
| N7 | | silica sand | | moderate to high | high | | | |
| O1 | Torrance | limestone | | high | high | Psa | | |
| O2 | Torrance | limestone | | high | high | Psa | | |
| P1 | Lincoln | limestone | | high | high | Psa, Pg | | |
| P1 | | silica sand | | moderate to high | high | Pg | | |
| P2 | Lincoln | limestone | | high | high | Psa, Pg | | |
| P2 | | silica sand | | moderate to high | high | Pg | | |
| P3 | Lincoln | limestone | | high | high | Psa | | |
| P4 | Lincoln | | | | | Qa | | |
| P5 | Lincoln | limestone | | high | high | Psa | | |
| P6 | Lincoln | limestone | | high | high | Psa | | |
| P7 | Lincoln | limestone | | high | high | Psa | | |
| P8 | Lincoln | limestone | | high | high | Psa | | |
| P9 | Lincoln | limestone | | high | high | Psa | | |
| P10 | Lincoln | limestone | | high | high | Psa, Pat | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| P10 | | gypsum | | moderate | moderate | | | |
| P11 | Lincoln | limestone | | high | high | Psa | | |
| P12 | Lincoln | limestone | | high | high | Psa | | |
| P13 | Lincoln | gypsum | | moderate | moderate | Pat | | |
| P14 | Lincoln | | | | | Trc | | |
| P15 | Lincoln | gypsum | | moderate | moderate | Pat | | |
| P16 | Lincoln | gypsum | | moderate | moderate | Pat | | |
| P17 | Lincoln | | | | | Trc | | |
| Q1 | Lincoln | | | | | Qa | | |
| Q2 | Lincoln | limestone | | high | high | Psa | | |
| Q3 | Lincoln | limestone | | high | high | Psa | | |
| Q4 | Lincoln | limestone | | high | high | Psa | | |
| Q5 | Lincoln | limestone | | high | high | Pg, Psa | | |
| Q5 | | silica sand | | high | high | | | |
| Q6 | Lincoln | limestone | | high | high | Pg, Psa | | |
| Q6 | | silica sand | | high | high | | | |
| Q7 | Lincoln | silica sand | | high | high | Pg | | |
| Q8 | Lincoln | silica sand | | high | high | Pg | | |
| Q9 | Lincoln | limestone | | high | high | Pg, Psa | | |
| Q9 | | silica sand | | high | high | | | |
| Q10 | Lincoln | limestone | | high | high | Psa | | |
| Q11 | Lincoln | limestone | | high | high | Psa | | |
| Q12 | Lincoln | silica sand | | high | high | Pg | | |
| Q13 | Lincoln | limestone | | high | high | Psa | | |
| Q14 | Lincoln | silica sand | | high | high | Pg | | |
| Q15 | Lincoln | limestone | | high | high | Psa | | |
| Q16 | Lincoln | silica sand | | high | high | Pg | | |
| Q17 | Lincoln | limestone | | high | high | Psa | | |
| Q18 | Lincoln | limestone | | high | high | Psa | | |
| Q19 | Lincoln | limestone | | high | high | Psa | | |
| Q20 | Lincoln | limestone | | high | high | Psa | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| Q21 | Lincoln | limestone | DIS098 | high | high | Py, Psa | | |
| Q21 | | silica sand | | high | high | | | |
| Q22 | Lincoln | | DIS098 | | | Ti | | |
| Q23 | Lincoln | limestone | | high | high | Psa | | |
| Q24 | Lincoln | limestone | | high | high | Psa | | |
| Q25 | Lincoln | limestone | DIS094 | high | high | Psa | | |
| Q26 | Lincoln | limestone | | high | high | Psa | | |
| Q27 | Lincoln | | | | | Ti | | |
| Q28 | Lincoln | silica sand | | high | high | Pg | | |
| Q29 | Lincoln | limestone | | high | high | Psa | | |
| Q30 | Lincoln | limestone | | high | high | Psa | | |
| Q31 | Lincoln | limestone | | high | high | Psa | | |
| Q32 | Lincoln | limestone | | high | high | Psa | | DIS089 to south |
| Q33 | Lincoln | limestone | | high | high | Psa | | check for placer gold |
| Q34 | Lincoln | limestone | | high | high | Psa | | DIS089 to south |
| Q35 | Lincoln | | | | | Trc | | DIS089 to south |
| Q36 | Lincoln | limestone | | high | high | Psa | | DIS089 to south |
| Q37 | Lincoln | gypsum | | moderate | moderate | Trc, Pat | | |
| Q38 | Lincoln | | | | | Trc | | check for clay |
| Q39 | Lincoln | | | | | Trc | | |
| Q40 | Lincoln | limestone | | high | high | Psa | | |
| Q41 | Lincoln | limestone? | | | | Kdg, Km | | check for clay |
| Q42 | Lincoln | limestone | | high | high | Psa | | |
| Q43 | Lincoln | limestone | | high | high | Psa | | |
| Q44 | Lincoln | | | | | Trc | | |
| Q45 | Lincoln | | | | | Qa | | |
| Q46 | Lincoln | gypsum | | moderate | moderate | Pat | | |
| Q47 | Lincoln | limestone | | high | high | Psa | | |
| Q48 | Lincoln | | | | | Ti, Qa | | |
| Q49 | Lincoln | limestone | | high | high | Psa | | |
| Q50 | Lincoln | limestone | | high | high | Psa | | |
| Q51 | Lincoln | limestone | | high | high | Psa | | |
| Q52 | Lincoln | limestone | | high | high | Psa | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| Q53 | Lincoln | limestone | | high | high | Psa | | |
| Q54 | Lincoln | limestone | | high | high | Psa | | |
| Q55 | Lincoln | limestone | | high | high | Psa | | |
| Q56 | Lincoln | limestone | | high | high | Psa | | |
| Q57 | Lincoln | limestone | | high | high | Psa | | |
| Q58 | Lincoln | limestone | | high | high | Psa | | |
| Q59 | Lincoln | placer gold | DIS093 | high | high | Ti, Py | | |
| Q59 | | gypsum | | high | high | | | |
| Q59 | | limestone | | high | high | | | |
| Q59 | | iron | | | | | | |
| Q60 | Lincoln | limestone | | high | high | Psa | | |
| Q61 | Lincoln | placer gold | DIS093 | high | high | Ti, Py | | |
| Q61 | | gypsum | | high | high | | | |
| Q61 | | limestone | | high | high | | | |
| Q61 | | iron | | | | | | |
| Q62 | Lincoln | | | | | Qa, Trc | | |
| Q63 | Lincoln | | | | | Qa | | |
| Q64 | Lincoln | | | | | Qa, Trc | | |
| Q65 | Lincoln | | | | | Qa | | |
| Q66 | Lincoln | limestone | | high | high | Psa | | |
| Q67 | Lincoln | limestone | | high | high | Psa | | |
| R1 | Lincoln | | | | | Km | | |
| R2 | Lincoln | | | | | Trc, Qp | | NMLI0070, 69 to south, sand, gravel |
| R3 | Lincoln | | | | | Trc | | |
| R4 | Lincoln | | | | | Trc, Qp | | |
| R5 | Lincoln | | | | | Psg | | |
| R6 | Lincoln | gold, lode | DIS099 | high | high | Tps, Trc | NMLI0028, 354 | |
| R6 | | gold, placer | | very high | high | | | |
| R6 | | tellurium | | low | low | | | NMLI0070, 69 to south, sand, gravel |
| R6 | | REE | | low | low | | | |
| R6 | | tungsten | | moderate | moderate | | | |
| R7 | Lincoln | | | | | Psg | | |
| R8 | Lincoln | limestone | | high | high | Trc, Psa | | |
| R9 | Lincoln | | | | | Trc | | |
| R10 | Lincoln | limestone | | high | high | Psa | | |
| R11 | Lincoln | gold, lode | DIS099 | high | high | Km, fault | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| R11 | | gold, placer | | very high | high | | | |
| R11 | | limestone | | high | high | | | |
| R11 | | tellurium | | low | low | | | |
| R11 | | REE | | low | low | | | NMLI0070, 69 to south, sand, gravel |
| R11 | | tungsten | | moderate | moderate | | | NMLI0070, 69 to south, sand, gravel |
| R12 | Lincoln | | | | | Kdg | | |
| R13 | Lincoln | | | | | Psg | | |
| R14 | Lincoln | | | | | Psg | | |
| R15 | Lincoln | gold, lode | DIS099 | high | high | Tps, Km | NMLI0344 | |
| R15 | | gold, placer | | very high | high | | | |
| R15 | | limestone | | high | high | | | |
| R15 | | tellurium | | low | low | | | surrounds patented mining claims |
| R15 | | REE | | low | low | | | |
| R15 | | tungsten | | moderate | moderate | | | |
| R16 | Lincoln | gold, lode | DIS099 | high | high | Km, fault | NMLI0345 | |
| R16 | | gold, placer | | very high | high | | | |
| R16 | | limestone | | high | high | | | |
| R16 | | tellurium | | low | low | | | |
| R16 | | REE | | low | low | | | |
| R16 | | tungsten | | moderate | moderate | | | |
| R17 | Lincoln | gold, lode | DIS099 | high | high | Kmv | | |
| R17 | | gold, placer | | very high | high | | | |
| R17 | | tellurium | | low | low | | | |
| R17 | | REE | | low | low | | | |
| R17 | | tungsten | | moderate | moderate | | | |
| R18 | Lincoln | coal | DIS097 | low | low | Qp | | |
| R19 | Lincoln | limestone | | high | high | Psa | | |
| R20 | Lincoln | | | | | Tp | | |
| R21 | Lincoln | | | | | Tp | | |
| R22 | Lincoln | | | | | Qp | | |
| S1 | Lincoln | limestone | | high | high | Psa | | |
| S2 | Lincoln | limestone | | high | high | Psa | | |
| S3 | Lincoln | limestone | | high | high | Psa | | |
| S4 | Lincoln | limestone | | high | high | Psa | | |
| S6 | Lincoln | limestone | | high | high | Psa | | |
| S5 | Lincoln | limestone | | high | high | Psa | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| S7 | Lincoln | limestone | | high | high | Psa | | |
| T1 | Chaves | salt | | moderate | moderate | Trcu | | |
| T2 | Chaves | | | | | Qp | | |
| T3 | Chaves | salt | | moderate | moderate | Trcu | | |
| T4 | Chaves | | | | | Qp | | |
| T5 | Chaves | salt | | moderate | moderate | P (underground) | | |
| T5 | | gravel, caliche | | high | high | To | | |
| T5 | | uranium | | moderate | moderate | To | | |
| T6 | Chaves | | | | | Pat | NMCH0017 | |
| T7 | Chaves | salt | | moderate | moderate | Trcu | | |
| T8 | Chaves | salt | | moderate | moderate | Qep | | |
| T9 | Chaves | salt | | moderate | moderate | Trcu | | |
| T10 | Chaves | salt | | moderate | moderate | Qep | | |
| T11 | Chaves | salt | | moderate | moderate | Trcu | | |
| T12 | Chaves | salt | | moderate | moderate | Pat | | |
| T13 | Chaves | | | | | Pat | | |
| T14 | Chaves | | | | | Pat | | |
| T15 | Chaves | salt | | moderate | moderate | Pat, Qep | | |
| T16 | Chaves | | | | | Pat | | |
| T17 | Chaves | | | | | Pat | | |
| T18 | Chaves | salt | | moderate | moderate | Qep, Trs | | |
| T19 | Chaves | salt | | moderate | moderate | Qep, Trs | | |
| T20 | Chaves | salt | | moderate | moderate | Qep | | |
| T21 | Chaves | | | | | Pat | | |
| T22 | Chaves | | | | | Pat | | |
| T23 | Chaves | | | | | Pat | | |
| T24 | Chaves | | | | | Pat | | |
| T25 | Chaves | | | | | Pat | | |
| T26 | Chaves | salt | | moderate | moderate | Qep | | |
| T27 | Chaves | | | | | Pat | | |
| T28 | Chaves | | | | | Pat | | |
| T29 | Chaves | | | | | Qa | | |
| T30 | Chaves | | | | | Pat | | |
| T31 | Chaves | | | | | Pat | | |
| U1 | Otero | coal | Sierra Blanca coal field | low | low | Qp, Kmv | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| U2 | Otero | coal | Sierra Blanca coal field | low | low | Qp, Kmv | | |
| U3 | Otero | coal | Sierra Blanca coal field | low | low | Qp, Kmv | | |
| U4 | Otero | | | | | Kdg | | |
| U5 | Otero | | | | | Qp, Kmv | | |
| U6 | Otero | limestone | | high | high | Km | | |
| U7 | Otero | gypsum | | very high | high | Qe | | |
| U8 | Otero | | | | | Qp | | |
| U9 | Otero | | | | | Trm, Kmd | | |
| U10 | Otero | limestone | | high | high | Trm, Kmd | | |
| U11 | Otero | | | | | Qp | | |
| U12 | Otero | limestone | DIS132 | high | high | Psa | | |
| U12 | | REE | | low | low | | | USGS sed Cu |
| U13 | Otero | limestone | DIS132 | high | high | Psa | | |
| U13 | | REE | | low | low | | | |
| U14 | Otero | gypsum | | high | high | Py | | |
| U14 | | limestone | | high | high | | | |
| U15 | Otero | gypsum | | high | high | Py, Psa | | |
| U15 | | limestone | | high | high | | | |
| U16 | Otero | gravel | DIS127 | | | Psa,Tim | | |
| U16 | | gypsum | | high | high | | | |
| U16 | | copper | | moderate | moderate | | | |
| U16 | | molybdenum | | low | low | | | |
| U16 | | limestone | | high | high | | | |
| U17 | Otero | gravel | DIS127 | | | Psa,Tim | NMOt0008, 364 | |
| U17 | | copper | | moderate | moderate | | | |
| U17 | | molybdenum | | low | low | | | |
| U18 | Otero | copper | DIS127 | moderate | moderate | Psa,Tim | | |
| U18 | | molybdenum | | low | low | | | |
| U18 | | gypsum | | high | high | | | |
| U18 | | limestone | | high | high | | | |
| U19 | Otero | limestone | | high | high | Pa | | |
| U20 | Otero | gypsum | | high | high | Pa | | |
| U20 | | limestone | | high | high | | | |
| U21 | Otero | | | | | Pa | | |
| U22 | Otero | | | | | Pa | | |
| U23 | Otero | | | | | Pa | | |
| U24 | Otero | gypsum | | high | high | Pa, Py | | |
| U24 | | limestone | | high | high | | | |
| U25 | Otero | | | | | Qp | | |
| U26 | Otero | | | | | Qp | | |
| U27 | Otero | | | | | Qp | | |
| U28 | Otero | | | | | Qp | | |
| U29 | Otero | | | | | Qp | | |
| U30 | Otero | | | | | Qp | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| U31 | Otero | | | | | Qp | | |
| U32 | Otero | gypsum | | moderate | moderate | Qp | | |
| U33 | Otero | | | | | Qp | | |
| U34 | Otero | | | | | Qp | | |
| U35 | Otero | | | | | Qp | | |
| U36 | Otero | | | | | Qp | | |
| U37 | Otero | | | | | Qp | NMOt0151 | |
| U38 | Otero | | | | | Qp | | |
| U39 | Otero | | | | | Qp | | |
| U40 | Otero | | | | | Qp | | |
| U41 | Otero | | | | | Qp | | |
| U42 | Otero | | | | | Qp | | |
| U43 | Otero | gypsum | | moderate | moderate | Qp | | |
| U44 | Otero | gypsum | | moderate | moderate | Qp | | |
| U45 | Otero | | | | | Qp | | |
| U46 | Otero | limestone | | high | high | Pm | | |
| U47 | Otero | gypsum | | moderate | moderate | Qp | | |
| U48 | Otero | gypsum | | moderate | moderate | Qp | | |
| U49 | Otero | gypsum | | moderate | moderate | Qp | | |
| U50 | Otero | gypsum | | moderate | moderate | Qp | | |
| U51 | Otero | gypsum | | moderate | moderate | Qp | | |
| U52 | Otero | | | | | Qp | | |
| U53 | Otero | | | | | Qp | | |
| U54 | Otero | | | | | Qp | | |
| U55 | Otero | gypsum | | moderate | moderate | Qp | | |
| U56 | Otero | | | | | Qp | | |
| V1 | Lincoln | limestone | | high | high | Psa | | |
| V2 | Lincoln | limestone | | high | high | Psa | | |
| V3 | Lincoln | limestone | | high | high | Psa | | |
| V4 | Lincoln | limestone | | high | high | Psa | | |
| V5 | Lincoln | limestone | | high | high | Psa | | |
| V6 | Lincoln | limestone | | high | high | Psa | | |
| V7 | Lincoln | limestone | | high | high | Psa | | |
| V8 | Lincoln | limestone | | high | high | Psa | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| V9 | Lincoln | limestone | | high | high | Psa | | |
| V10 | Lincoln | limestone | | high | high | Psa | | |
| V11 | Lincoln | limestone | | high | high | Psa | | |
| V12 | Lincoln | limestone | | high | high | Psa | | |
| V13 | Lincoln | limestone | | high | high | Psa | | |
| V14 | Lincoln | limestone | | high | high | Psa | | |
| W1 | Chaves | limestone | | high | high | Psa | | |
| W2 | Lincoln | limestone | | high | high | Psa | | |
| W3 | Chaves | limestone | | high | high | Psa | | |
| W4 | Lincoln | limestone | | high | high | Psa | | |
| W5 | Lincoln | limestone | | high | high | Psa | | |
| W6 | Chaves | limestone | | high | high | Psa | | |
| W7 | Chaves | limestone | | high | high | Psa | | |
| W8 | Lincoln | limestone | | high | high | Psa | | |
| W9 | Chaves | limestone | | high | high | Psa | | |
| W10 | Chaves | limestone | | high | high | Psa | | |
| W11 | Chaves | limestone | | high | high | Psa | | |
| W12 | Chaves | limestone | | high | high | Psa | | |
| W13 | Lincoln | limestone | | high | high | Psa | | |
| W14 | Chaves | limestone | | high | high | Psa | | |
| W15 | Chaves | limestone | | high | high | Psa | | |
| W16 | Chaves | limestone | | high | high | Psa | | |
| W17 | Chaves | limestone | | high | high | Psa | | |
| W18 | Chaves | limestone | | high | high | Psa | | |
| W19 | Chaves | limestone | | high | high | Psa | | |
| W20 | Chaves | | | | | Qp | | |
| W21 | Chaves | limestone | | high | high | Psa | | |
| W22 | Chaves | limestone | | high | high | Qp, Psa | | |
| W23 | Chaves | limestone | | high | high | Psa | | |
| W24 | Chaves | limestone | | high | high | Psa | | |
| W25 | Chaves | | | | | Qp | | |
| W26 | Chaves | limestone | | high | high | Psa | | |
| W27 | Chaves | limestone | | high | high | Psa | | |
| W28 | Chaves | | | | | Qp | | |
| W29 | Chaves | | | | | Qp | | |
| W30 | Chaves | limestone | | high | high | Psa | | |
| W31 | Chaves | limestone | | high | high | Psa | | |
| X1 | Chaves | | | | | Qp | | |
| X2 | Chaves | limestone | | high | high | Psa | | |
| X3 | Chaves | limestone | | high | high | Psa | | |
| X4 | Chaves | | | | | Qp | | |
| X5 | Chaves | | | | | Qep | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| X6 | Chaves | diatomite | | unknown | low | Qa | | |
| X6 | | clay | | unknown | low | | | |
| X7 | Chaves | Pecos Diamonds | | unknown | low | Pat | | |
| X8 | Chaves | | | | | Qep | | |
| X9 | Chaves | limestone | | high | high | Psa | | |
| X10 | Chaves | Pecos Diamonds | | unknown | low | Pat | | |
| X11 | Chaves | limestone | | high | high | Psa | | |
| X12 | Chaves | | | | | Qep | | |
| X13 | Chaves | limestone | | high | high | Psa | | |
| X14 | Chaves | | | | | Pat | | |
| Y1 | Lincoln | limestone | | high | high | Psa | | |
| Y2 | Lincoln | limestone | | high | high | Psa | | |
| Y3 | Lincoln | limestone | | high | high | Psa | | |
| Y4 | Lincoln | limestone | | high | high | Psa | | |
| Y5 | Lincoln | limestone | | high | high | Psa | | |
| Y6 | Chaves | | | | | Qep | | |
| Y7 | Lincoln | limestone | | high | high | Psa | | |
| Y8 | Chaves | | | | | Qp | | |
| Y9 | Lincoln | limestone | | high | high | Psa | | |
| Y10 | Lincoln | limestone | | high | high | Psa | | |
| Y11 | Chaves | gravel | | high | high | Qa | | |
| Y12 | Lincoln | limestone | | high | high | Psa | | |
| Y13 | Lincoln | limestone | | high | high | Psa | | |
| Y14 | Lincoln | limestone | | high | high | Psa | | |
| Y15 | Chaves | | | | | Qp | | |
| Y16 | Chaves | | | | | Qp | | |
| Y17 | Chaves | | | | | Qp | | |
| Y18 | Chaves | | | | | Qp | | |
| Y19 | Chaves | gravel | | high | high | Qa | | |
| Y20 | Lincoln | limestone | | high | high | Psa | | |
| Y21 | Chaves | | | | | Qp | | |
| Y22 | Chaves | | | | | Qp | | |
| Y23 | Lincoln | limestone | | high | high | Psa | | |

| SLO_AIO_PN | County | Commodity | Mining District in Area (NM Mines Database) | Mineral-resource Potential | Level of Certainty | Geological units | Mine Id (NM Mines Database) | Comments |
|---|---|---|---|---|---|---|---|---|
| Y24 | Chaves | | | | | Pat | | |
| Y25 | Chaves | | | | | Qp | | |
| Y26 | Chaves | | | | | Qp | | |
| Y27 | Chaves | | | | | Qp | | |
| Y28 | Chaves | | | | | Qp | | |
| Y29 | Lincoln | limestone | | high | high | Psa | | |
| Y30 | Chaves | limestone | | high | high | Psa | | |
| Y31 | Chaves | limestone | | high | high | Psa | | |
| Y32 | Lincoln | limestone | | high | high | Psa | | |
| Y33 | Chaves | gravel | | high | high | Qa | | |
| Y33 | | Pecos Diamonds | | unknown | low | Pat | | |
| Y34 | Chaves | | | | | Qp | | |
| Y35 | Lincoln | limestone | | high | high | Psa | | |
| Y36 | Chaves | limestone | | high | high | Psa | | |
| Y37 | Chaves | | | | | Qp | | |
| Y38 | Chaves | | | | | Qp | | |
| Y39 | Chaves | gravel | | high | high | Qp | NMCH0010 | |
| Y40 | Chaves | gravel | | high | high | Qp | | |
| Y41 | Chaves | gravel | | high | high | Qp | | |
| Y42 | Chaves | | | | | Qp | | |
| Y43 | Chaves | | | | | Qp | | |
| Y44 | Chaves | gravel | | high | high | Qp | | |
| Z1 | Chaves | | | | | Trcu | | |
| Z2 | Chaves | gravel, caliche | | high | high | To | | |
| Z2 | | uranium | | moderate | moderate | | | |
| Z3 | Chaves | gravel, caliche | | high | high | To | | |
| Z3 | | uranium | | moderate | moderate | | | |
| Z4 | Chaves | gravel, caliche | | high | high | To | | |
| Z4 | | uranium | | moderate | moderate | | | |
| Z5 | Chaves | gravel, caliche | | high | high | To | | |
| Z5 | | uranium | | moderate | moderate | | | |
| AA1 | Otero | limestone | | high | high | Psa | | |
| AA2 | Otero | limestone | | high | | Psa | NMOt0209 | |
| AA3 | Otero | limestone | | high | high | Psa | | |
| AA4 | Otero | limestone | | high | high | Psa | | |
| AA5 | Otero | limestone | | high | high | Psa | | |
| AA6 | Otero | limestone | | high | high | Psa | | |
| AA7 | Otero | limestone | | high | high | Psa | | |
| AA8 | Otero | limestone | | high | high | Psa | | |
| AA9 | Otero | limestone | | high | high | Psa | | |

# APPENDIX 3

## MINERAL DEPOSIT TYPES IN NEW MEXICO

TABLE A3-1. Types of mineral deposits in New Mexico, in order of perceived age (oldest to youngest), excluding coal deposits (modified from North and McLemore, 1986, 1988; Cox and Singer, 1986; McLemore and Chenoweth, 1989, 2017; McLemore and Lueth, 1996, 2017; McLemore, 1996a, 1996b, 2001; McLemore and Austin, 2017). USGS (U.S. Geological Survey) classification from Cox and Singer (1986) and subsequent reports (see http://minerals.usgs.gov/products/depmod.html). PGE=platinum group metals. REE=rare earth elements. See Table 5 for definitions of abbreviations.

| NMBGMR CLASSIFICATION | USGS CLASSIFICATION (USGS MODEL NUMBER) | COMMODITIES | PERCEIVED AGE OF DEPOSIT IN NEW MEXICO | AREA THE DEPOSIT TYPE IS FOUND |
|---|---|---|---|---|
| Volcanogenic massive sulfide (VMS) | Volcanogenic massive sulfide (24a,b, 28a) | Au, Ag, Cu, Pb, Zn | 1650-1600 Ma | none |
| Pegmatite | Pegmatite (13a-h) | Be, Li, U, Th, REE, Nb, Ta, W Sn, Zr, Hf | Probably 1450-1400 Ma, 1100-1200? Ma, some Tertiary | none |
| Vein and replacement deposits in Proterozoic rocks (formerly Precambrian veins and replacements) | Polymetallic veins, fluorite veins (22c, 26b) | Au, Ag, Cu, Pb, Zn, Mn, F, Ba | Proterozoic to Tertiary | none |
| Proterozoic iron formation | Volcanic hosted magnetite (25i) | Fe, Au | Proterozoic | none |
| Syenite/gabbro-hosted Cu-Ag-PGE | Gabbroid-associated Ni-Cu (7a) | Cu, Ag, PGE | Probably 1450-1400 Ma, could be older | none |
| Disseminated Y-Zr deposits in alkaline rocks | Alkaline complex associated zircon (11c) | Y, Zr, REE, U. Th, Hf | 1100-1200 Ma | none |
| Carbonatites | Carbonatite and peralkaline intrusion-related REE deposits (10) | REE, U, Th, Nb, Ta, Zr, Hf, Fe, Ti, V, Cu, apatite, barite | 400-600 Ma, one about 22 Ma | P? |
| Episyenites and REE-Th-U veins | Th-REE veins (10b, 11d) | REE, U, Th, Nb, Ta | 400-600 Ma | I |
| Sedimentary iron deposits | Oolitic iron (34f) | Fe | Cambrian-Ordovician | none |
| Sedimentary-copper deposits | Sediment-hosted copper (30b) | Cu, Ag, Pb, Zn, U, V | Pennsylvanian-Permian, Triassic | L |
| Uraniferous collapse-breccia pipe (including clastic plug deposits) | Solution-collapse breccia pipe U deposits (32e) | Cu, Ag, U, Co, Se, REE? | Triassic, Jurassic | none |
| Limestone uranium deposits | none | U, V, Se, Mo | Jurassic | none |
| Sandstone uranium deposits | Sandstone uranium (30c) | U, V, Se, Mo, REE? | Pennsylvanian-Permian-Miocene | |
| Beach placer sandstone deposits | Shoreline placer Ti (39c) | Th, REE, Zr, Hf, Ti, U, Fe, Nb, Ta | Cretaceous | B |
| Replacement iron | Iron skarn (18d) | Fe | Cretaceous-Miocene (75-50 Ma) | N, P, Q, R, U, V |
| Porphyry Cu, Cu-Mo (±Au) | Porphyry copper (17, 20c, 21a) | Cu, Mo, Au, Ag | 75-50 Ma | none |
| Cu, Pb, Zn, Fe skarn | Skarn (18a, 18c, 19a) | Au, Ag, Cu, Pb, Zn | 75-40 Ma | |

| NMBGMR CLASSIFICATION | USGS CLASSIFICATION (USGS MODEL NUMBER) | COMMODITIES | PERCEIVED AGE OF DEPOSIT IN NEW MEXICO | AREA THE DEPOSIT TYPE IS FOUND |
|---|---|---|---|---|
| Polymetallic vein | Polymetallic veins (22c) | Au, Ag, Cu, Pb, Zn | 75-40 Ma | |
| Porphyry Mo (±Cu, W) | Porphyry Mo-W (16, 21b) | Mo, W, Au, Ag, Be, Cu | Probably 35-25 Ma | |
| Carbonate-hosted W-Be replacement and skarn (Mo-W-Be, F-Be, Fe-Mn) | W-Be skarns (14a) | Mo, W, Be, Pb, Zn, Cu, F, Mn | Probably 35-25 Ma | |
| Carbonate-hosted Pb-Zn (Cu, Ag) replacement | Polymetallic replacement (19a) | Pb, Zn, Cu, Ag | 75-25 Ma | |
| Carbonate-hosted Ag-Mn (Pb) replacement | Polymetallic replacement, replacement manganese (19a, b) | Ag, Mn, Pb, Zn | 75-25 Ma | |
| Great Plains Margin (GPM or alkaline-related) deposits (including polymetallic epithermal to mesothermal veins; gold-bearing breccias and quartz veins; porphyry Cu-Mo-Au; Cu, Pb/Zn, and Au skarns and carbonate-hosted replacement deposits; Fe skarns and replacement bodies; Th-REE-fluorite (with U and and Nb) epithermal veins) | Porphyry copper, polymetallic veins, copper skarns, iron skarns, placer gold (17, 22c, 18a,b, 18d, 39a), Th-REE veins (10b, 11d) | Au, Ag, Cu, Pb, Zn, Mo, Mn, Fe, F, Ba, Te, REE, Nb, Zr, U, Th | 47-25 Ma | N, P, Q, R, U, V |
| Volcanic-epithermal veins | Quartz-adularia, quartz-alunite, epithermal manganese (25b,c,d,e,g, 26b, 35[a]) | Au, Ag, Cu, Pb, Zn, Mn, F, Ba | 35-16 Ma or younger | none |
| Rhyolite/granite-hosted tin (topaz rhyolites) | Rhyolite-hosted tin (25h) | Sn, Be, REE | 28 Ma | none |
| Tin skarns | Tin skarns (15c, 14b, 14c) | Sn | | none |
| Volcanogenic Be (volcanic-hosted replacement, volcanic-epithermal, Spor Mountain Be-F-U deposits) | Volcanogenic Be deposits | Be, F, U | Miocene-Pliocene | none |
| Carbonate-hosted Mn replacement | Replacement Mn (19b) | Mn | Miocene-Pliocene | |
| Copper-silver (±U) vein deposits | Polymetallic veins (22c) | Cu, Ag, U | Miocene-Pliocene | none |
| Mississippi Valley-type (MVT) (here restricted to Permian Basin) | Mississippi Valley-type (MVT) (32a-d) | Cu, Pb, Ag, Zn, Ba, F | Oligocene-Pliocene | none |
| Surficial uranium deposits | none | U | Miocene-Recent | T, Z |
| Rio Grande Rift (RGR) Epithermal Mn | Epithermal Mn (25g) | Mn | Miocene-Recent | none |
| Rio Grande Rift (RGR) barite-fluorite veins | Fluorite and barite veins, polymetallic replacement (IM26b, c, 27e, 19a) | Ba, F, Pb, Ag, U | 12 Ma-Recent | H |
| Placer tungsten | None | W | Pliocene-Recent | none |
| Placer tin | Stream placer tin (39e) | Sn | Pliocene-Recent | none |
| Placer gold | Placer gold-PGE (39a) | Au, Ag | Pliocene–Recent | |

TABLE A3-2. Types of industrial minerals and rocks deposits in New Mexico, in alphabetical order (modified from Cox and Singer, 1986; Dill, 2010; McLemore and Austin, 2017). USGS classification from Cox and Singer (1986) and subsequent reports (see http://minerals.usgs.gov/products/depmod.html). Some deposits are listed in Table 2 because they are also considered to be metallic mineral resources as well as industrial minerals and rocks. Gems are included in this table, but are generally not considered industrial minerals and rocks. See Table A2-3 for definitions of abbreviations.

| NMBGMR CLASSIFICATION | USGS CLASSIFICATION (USGS MODEL NUMBER) | AREA THE DEPOSIT TYPE IS FOUND |
|---|---|---|
| Adobe and earthen construction | | Not evaluated |
| Aggregates (sand and gravel) | | |
| Alunite and alum | | none |
| Asbestos | Serpentine hosted asbestos (8d) | none |
| Barium minerals (Ba) | Bedded barite (31b), vein barite (31b, 27e) | H |
| Bauxite | | none |
| Beryllium minerals (Be) | | |
| Boron and borates | Lacustrine borates (35b.3) | |
| Bromide | Bromine brines (35an) | |
| Chromite | | none |
| Clay | sedimentary clay (31K), hydrothermal bentonite (251.1), hydrothermal kaolin (251.2), sedimentary bentonite (28e.1, 28e.2), sedimentary kaolin (31k.1, 31k.2, 31k.3), palygoskite (34e), residual kaolin (38h) | |
| Diatomite | Lacustrine diatomite (31s) | X |
| Evaporate | | |
| Feldspar | Feldspar in pegmatite (13e) | none |
| Fluorspar | Fluorite veins (26b) | H |
| Gallium | | R |
| Garnet | | none |
| Gems (mineral collecting) | | |
| Gilsonite | | none |
| Glauconite | | none |
| Graphite | Amorphous graphite (18k) | none |
| Gypsum and anhydrite | bedded gypsum (35ae), lacustrine gypsum (35b.4) | |
| Iron, iron oxide and magnetite | | N, P, Q, R, U, V |
| Kyanite, sillimanite, and andalusite | | none |
| Lime | | Not evaluated |
| Limestone and dolomite | Limestone (32g) | |
| Lithium | Lithium brines (35bm), lithium in smectites (251c) | |
| Magnesium Minerals and Compounds (excluding dolomite) | Metasomatic and metamorphic replacement magnesite (1981) | |
| Manganese | Sedimentary Mn (34b) | |
| Mica | | none |
| Nepheline syenite | | none |
| Nitrogen and nitrates (guano) | | none |
| Olivine | | none |
| Perlite | | none |
| potash | potash bearing-bedded salt (35ab) | |
| Pozzolans and supplementary cementitious materials | | Not evaluated |

| NMBGMR CLASSIFICATION | USGS CLASSIFICATION (USGS MODEL NUMBER) | AREA THE DEPOSIT TYPE IS FOUND |
|---|---|---|
| Pumice, pumicite, and scoria (volcanic cinder) | pumice scoria-volcanic cinders (IM25kb) | none |
| Pyrophyllite | | none |
| Rare earth elements (REE) | Thorium-rare earth veins (11d) | |
| Salt | bedded salt, marine evaporate (35ac), lacustrine halite (35b.5) | |
| Silica | Sandstone/quartzite silica (30e), silica sand (39i) | |
| Soda ash | Sodium carbonate (35ba) | Not evaluated |
| Sodium sulfate | | |
| Soil amendments (including humate) | | |
| Stone (crushed, dimension) | | |
| Strontium minerals | | |
| Sulfur | Fumarolic sulfur (25) | none |
| Talc | Metasomatic and metamorphic talc (18m) | none |
| Tellurium | | |
| Titanium | | |
| Vermiculite | | none |
| Wollastonite | Wollastonite skarn (18g) | none |
| zeolites | Sedimentary zeolites (25oa, 25ob) | |

TABLE A3-3. Abbreviations of elements used in this report.

| | |
|---|---|
| As arsenic | Au gold |
| Ag silver | Ba barium |
| Be beryllium | Bi bismuth |
| Br bromine | Cd cadmium |
| Co cobalt | Cr chromium |
| Cu copper | F fluorine |
| Fe iron | Ga gallium |
| Ge germanium | Mn manganese |
| Mo molybdenum | Ni nickel |
| Pb lead | REE Rare earth elements |
| PGM Platinum group elements | Sb antimony |
| Sn tin | Th thorium |
| U uranium | V vanadium |
| W tungsten | Zn zinc |

## APPENDIX 4
## DESCRIPTION OF FIELDS IN THE DISTRICT DETAILS GEODATABASE

**DistrictDetails**: Mining districts and prospect areas in New Mexico (updated and modified from Lindgren et al., 1910; File and Northrop, 1966; Howard, 1967; North and McLemore, 1986; McLemore and Chenoweth, 1989; McLemore, 2001, 2017). Districts and prospect areas are in alphabetical order by county then by district name. Estimated production is in dollars at the time of production. Types of deposits are summarized by McLemore (2017). Summary of metals production is in Production. REE=rare earth elements, PGE=platinum group elements, VMS=volcanic massive sulfide, MVT=Mississippi Valley type, RGR=Rio Grande rift, GPM=Great Plains Margin. Names in italics are prospect areas with no production. Note that the Grants uranium district consists of several subdistricts as indicated by McLemore and Chenoweth (1989).

District Id: Key, unique district identification number with prefix of DIS

District: Mining district, coal field, prospect area, or the geographical area as defined by File and Northrop (1966), North and McLemore (1986), McLemore and Chenoweth (1989), Hoffman (1996), and McLemore (2001)

Prospect Area: Prospect area defined as no production

County: County in which district is found in

Commodity category (major commodity): Unique commodity category, only the major commodity category is listed even though some districts may have more than one category (uranium, coal, metals, industrial minerals, aggregates)

Aliases: Other names associated with this district, including common misspellings.

Year of Discovery: Year district was discovered

Year of Initial Production: First year of known production in district

Year of Last Production: Last year of known production in district

Estimated Cumulative Production: Best estimate of total cumulative production in actual dollars at time of production, includes all commodities except aggregates and crushed stone

Commodities produced: Commodities produced from the district

Other commodities: Commodities found in the district, but never produced

Deposit type: After North and McLemore (1986), McLemore (2001), McLemore and Lueth (2017), McLemore and Austin (2017), https://minerals.usgs.gov/products/depmod.html

Description: description of district

Source for district name: Source for name of mining district

Selected references: selected references further describing the district