FRTC Modernization EIS

Supporting Study
Mineral Potential Report

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REPORT

Mineral Potential Report for the Fallon Range Training Complex Modernization

for ManTech International Corporation

Submitted to:

ManTech International Corporation
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Submitted by:

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November 2018

Executive Summary

This Mineral Potential Report (MPR) has been prepared to support an Environmental Impact Statement (EIS) for the land withdrawal extension and expansion at the Naval Air Station (NAS) Fallon Range Training Complex (FRTC), in Churchill, Lyon, Mineral, Nye, and Pershing Counties, Nevada. This MPR is intended to be used as a planning tool that provides land managers with mineral resource information to develop management plans.

The FRTC is part of the US Department of Navy (DON). The FRTC currently encompasses an area of 223,562 acres (ac). Figure ES.1 presents the areas involved. The FRTC consists of federal land that has been withdrawn from public use and reserved for military training and operations through the Military Lands Withdrawal Act of 1999, Public Law 106-65 (MLWA). The current withdrawal will expire in November 2021, unless Congress enacts legislation providing an extension.

Withdrawal of additional lands to support DON activities in ranges B-16, B-17, B-20, and the DVTA may impact public and private lands including mining and geothermal leases, as well as access to mineral exploration and production infrastructure such as roads, pipelines, and temporary and fixed facilities.

As part of the EIS process, the DON proposed three action alternatives for the land withdrawal extension and expansion for the FRTC. These action alternatives are pre-decisional from a NEPA perspective. The changes in the range withdrawal areas depend upon the alternatives. Details regarding the alternatives are as follows:

- **Alternative 1**: Increase the FRTC size to 916,168 acres by requesting to withdraw approximately 618,727 acres and proposing to acquire 65,153 acres to ranges B-16, B-17, B-20, and the DVTA.
- **Alternative 2:** Same land as Alternative 1. The difference is that under this alternative the DVTA is open to the development of geothermal and salable minerals on the westside of Nevada state route 121 and a small part of the southern portion of B-16 withdrawal (approximately 300 acres) would be left open for public access.
- **Alternative 3:** Increase the FRTC size to 904,468 acres by requesting to withdraw approximately 606,664 acres and proposing to acquire 65,520 acres to ranges B-16, B-17, B-20, and the DVTA. Land management of mineral resources in the DVTA will be same as alternative 2. Land south of US50 is not withdrawn for the DVTA. And, the existing Bell Mountain Claims in the B-17 expansion area will be recognized.

The geographic extent of Alternatives 1 and 2 are presented in Figure ES.2, and Alternative 3 is presented in Figure ES.3. For the purpose of this MPR, the maximum areal extent of the withdrawal areas, considering all alternatives will be assessed and referred to collectively as the “Study Area.”

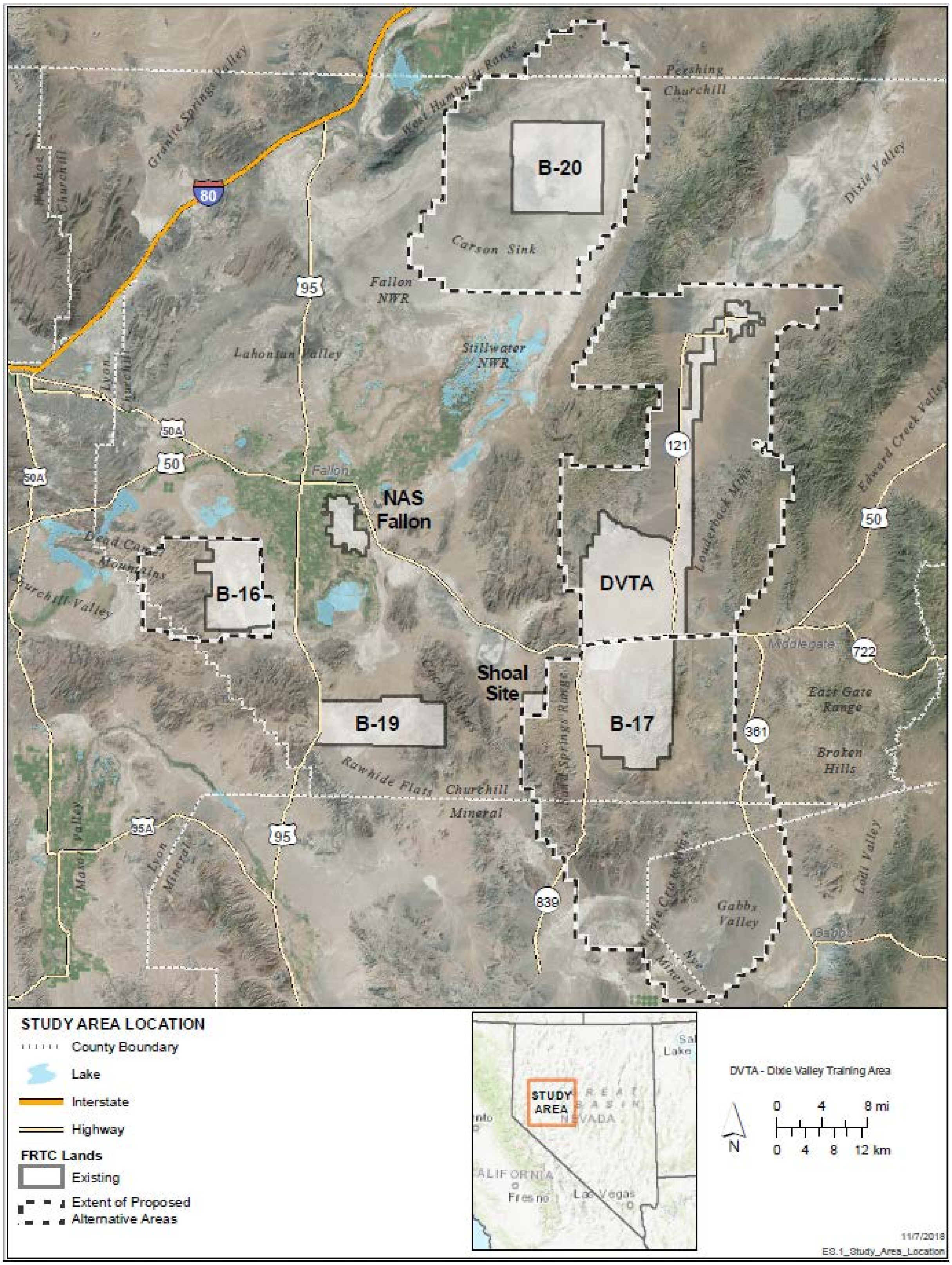

Figure ES.1: Study Area

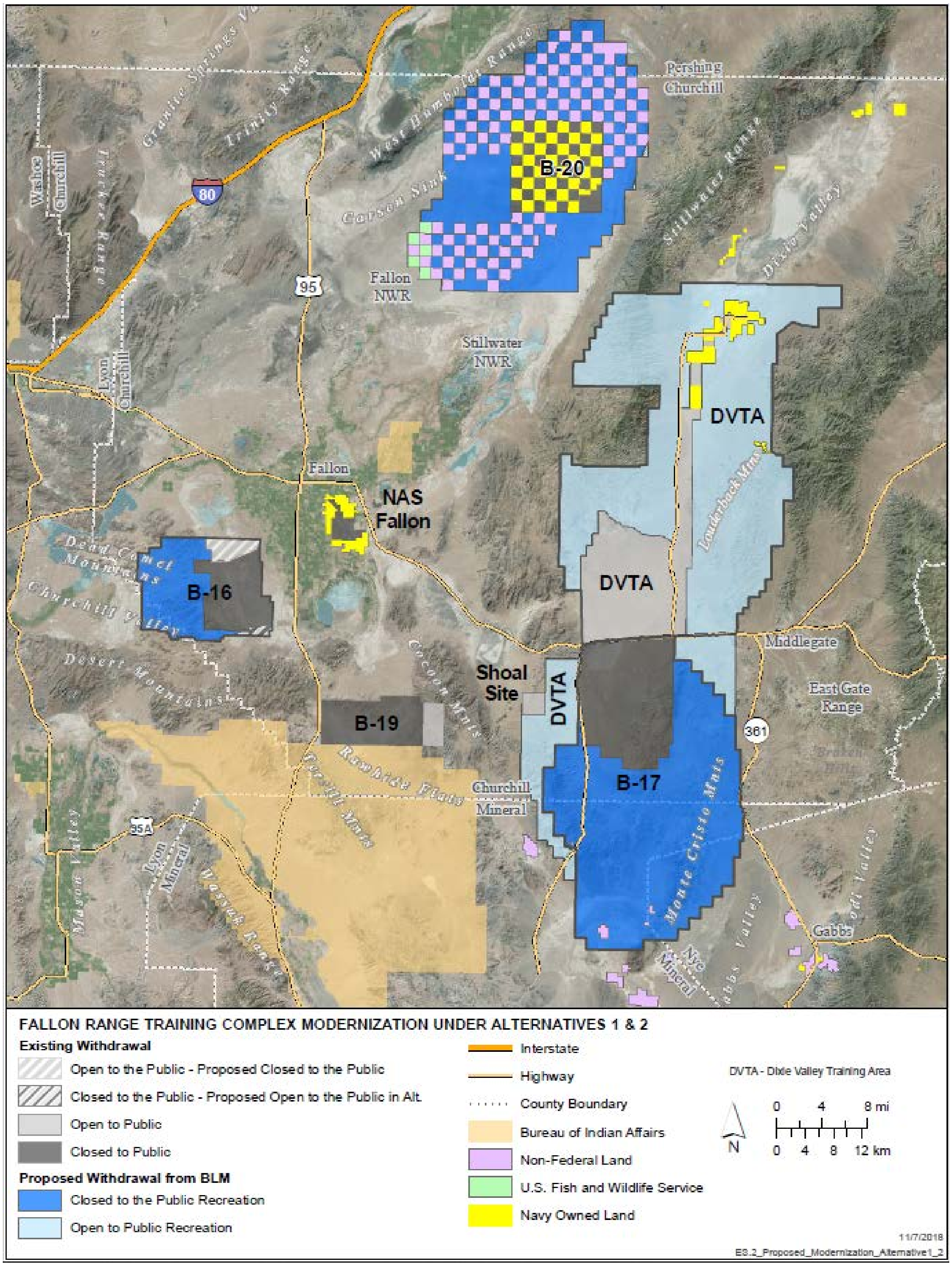

Figure ES.2: Fallon Range Training Complex Modernization Under Alternatives 1 and 2

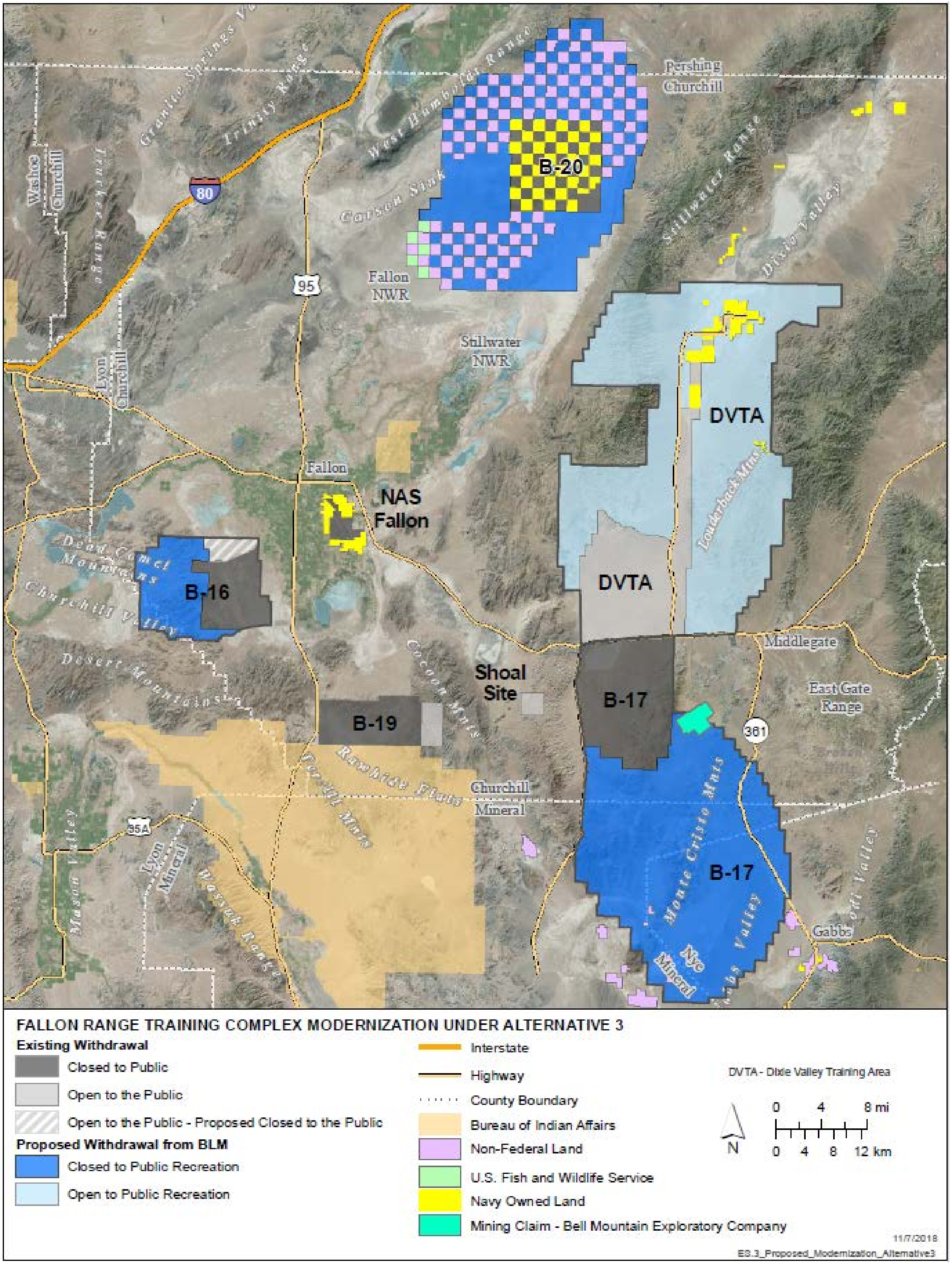

Figure ES.3: Fallon Range Training Complex Modernization Under Alternative 3

The primary, underlying assumption used in developing this assessment is that the data published in previous reports is valid and does not need to be reproduced. This Report synthesizes the vast amount of mineral potential data available and presents the information specific to the areal extent of the proposed land withdrawals. The energy and mineral potential of all proposed withdrawal areas were assessed, and results integrated into an area-wide MPR assessment update of the FRTC. This comprehensive assessment addresses advances in geologic understanding of selected deposits, changes in metal or commodity demand, and technological advances since the previous assessments.

The Mineral Potential Classification System used in this assessment is as defined in BLM Manual 3031 (BLM, 1985). In the classification system, mineral potential ranges from no potential to high potential with the certainty level that mineral potential does or does not exist ranging from highly uncertain (A) to highly certain (D). Table ES.1 presents a schematic representation.

Table ES.1: Mineral Potential Classification System

<table>
<tr><td rowspan="4">Increasing Potential >>></td><td rowspan="3">ND
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High Potential</td><td>H/B
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</table>

Notes: Source - Based on BLM Manual 3031 (1985), Illustration 3.
[1]Not commonly used and only in special circumstances.

The discussion of the mineral potentials are organized with respect to the BLM system that classifies minerals and energy for development into three categories:

- **Locatable:** Locatable minerals are those for which the right to explore, develop, and extract on federal land open to mineral entry is established by the location (or staking) of lode or placer mining claims (General Mining Law of 1872, as amended).
- **Leasable:** Leasable minerals defined by the Mineral Leasing Act (February 1920; and 43 CFR 3000-3599, 1990) include the subsets leasable solid and leasable fluid minerals. Since 1920, the Federal government has leased fuels and certain other minerals, charging a royalty on the value of the mined and sold material. BLM's Policy for Reasonably Foreseeable Development (RFD).

- **Salable:** Salable Minerals are administered by the BLM under the Materials Act of July 31, 1947, the Wilderness Act, and Mineral Materials Disposal regulations (43 CFR 3600 regulations for aggregate, sand, gravel, petrified wood, common variety materials, and so forth).

Metallic Locatables

Metallic locatable mineral resources were historically produced in 11 of the 21 mining districts in the Study Area. The precious metals, silver and gold, were the most common metals produced. Silver production occurred at eight mining districts and gold production occurred at seven of the mining districts. All the precious metal occurrences are associated with vein-hosted epithermal mineralization, base metal occurrences are generally pluton-related. The mineral resource potential for gold is presented in Figure ES.4

Other metals historically produced include: tungsten at three mining districts, lead at two mining districts, and antimony at one of the districts. With exception of the proposed B-16 area, all the proposed withdrawal areas have a history of metallic mineral resource production. Mineral districts with known mineral production are assigned a resource potential classification of H/D for the commodity produced. Copper, molybdenum, and zinc minerals were identified, but not produced, at nine of the mining districts. Mineral districts with metals, which were identified, but do not have records of production were assigned a resource potential classification of H/C.

Industrial Locatables

Lithium is an industrial locatable mineral of special interest due to the development and use of lithium-ion batteries; at present Nevada is host to the only active lithium producer in the US. Anomalous concentrations of lithium have been detected in playa sediments adjacent to the proposed withdrawal areas. The resource potential classification for lithium-bearing clay is M/B in playas where surface sediment samples have recorded between 100 and 300 ppm lithium, and M/A in all other playas. The resource potential classification for lithium-enriched brines is based on the lithium content and Li:Cl ratio of groundwater in playas. Playas are classified as M/C or M/B depending on groundwater chemistry. Playas without well data are classified as M/A.

A comparison of playas in the Study Area to playas in Clayton Valley, located in central Nevada and well outside of the Study Area, where lithium is being recovered from brine, suggests that the conditions responsible for economic lithium concentrations at Clayton Valley do not exist in the Study Area. Further surface and subsurface exploration including the completion of wells and groundwater sampling will be required to further define the potential for lithium mineralization in the Study Area. See Figures ES.5 and ES.6 for the geographic distribution of mineral potential designations for lithium.

Fluorspar and barite are the only known industrial minerals historically produced in the Study Area. Fluorspar was produced in the proposed B-17 and DVTA withdrawal areas and barite was produced in the proposed B-17 withdrawal area. Mining districts in the Study Area that historically produced fluorspar or barite have a mineral potential of H/D.

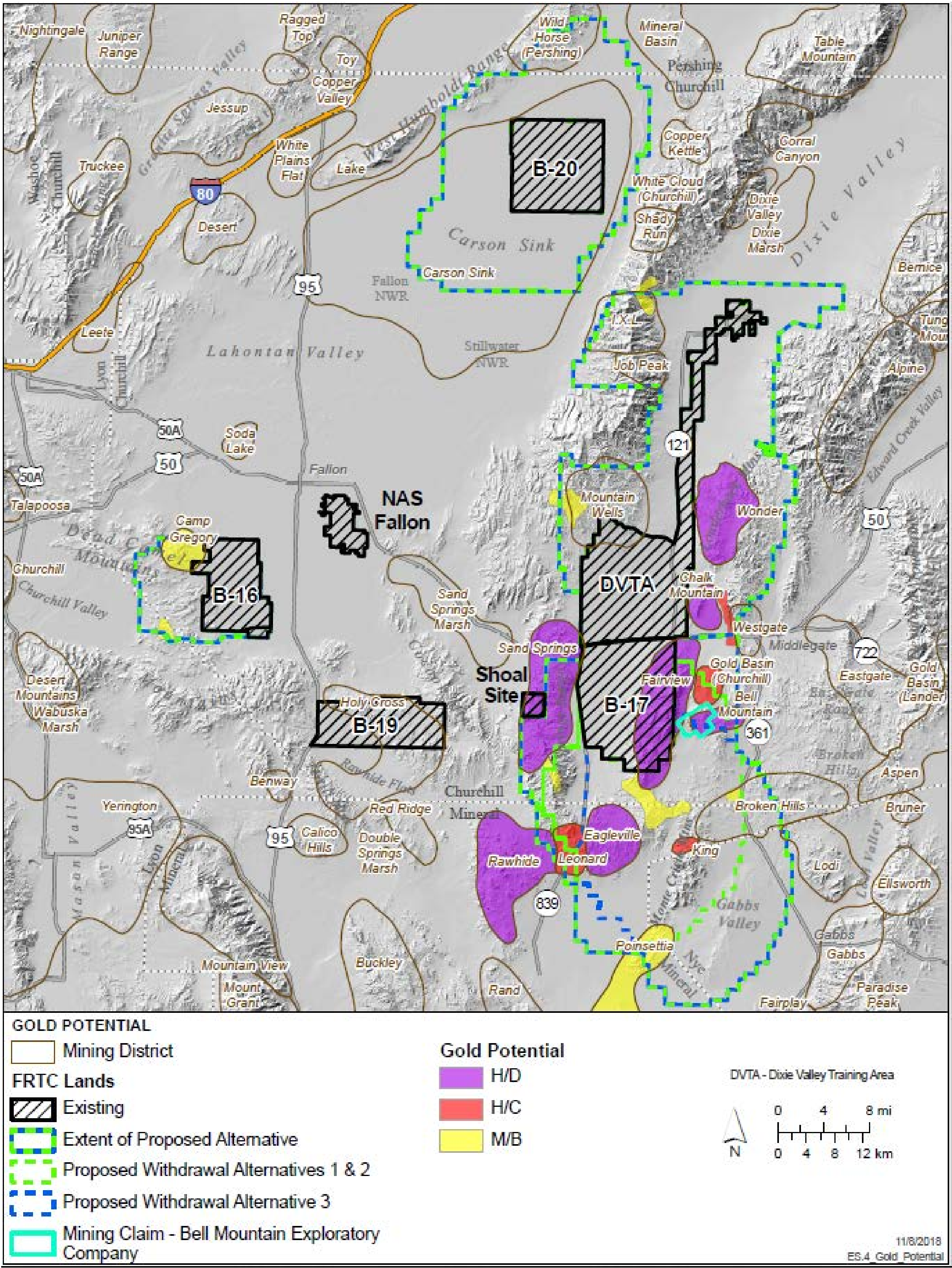

Figure ES.4: Gold Potential

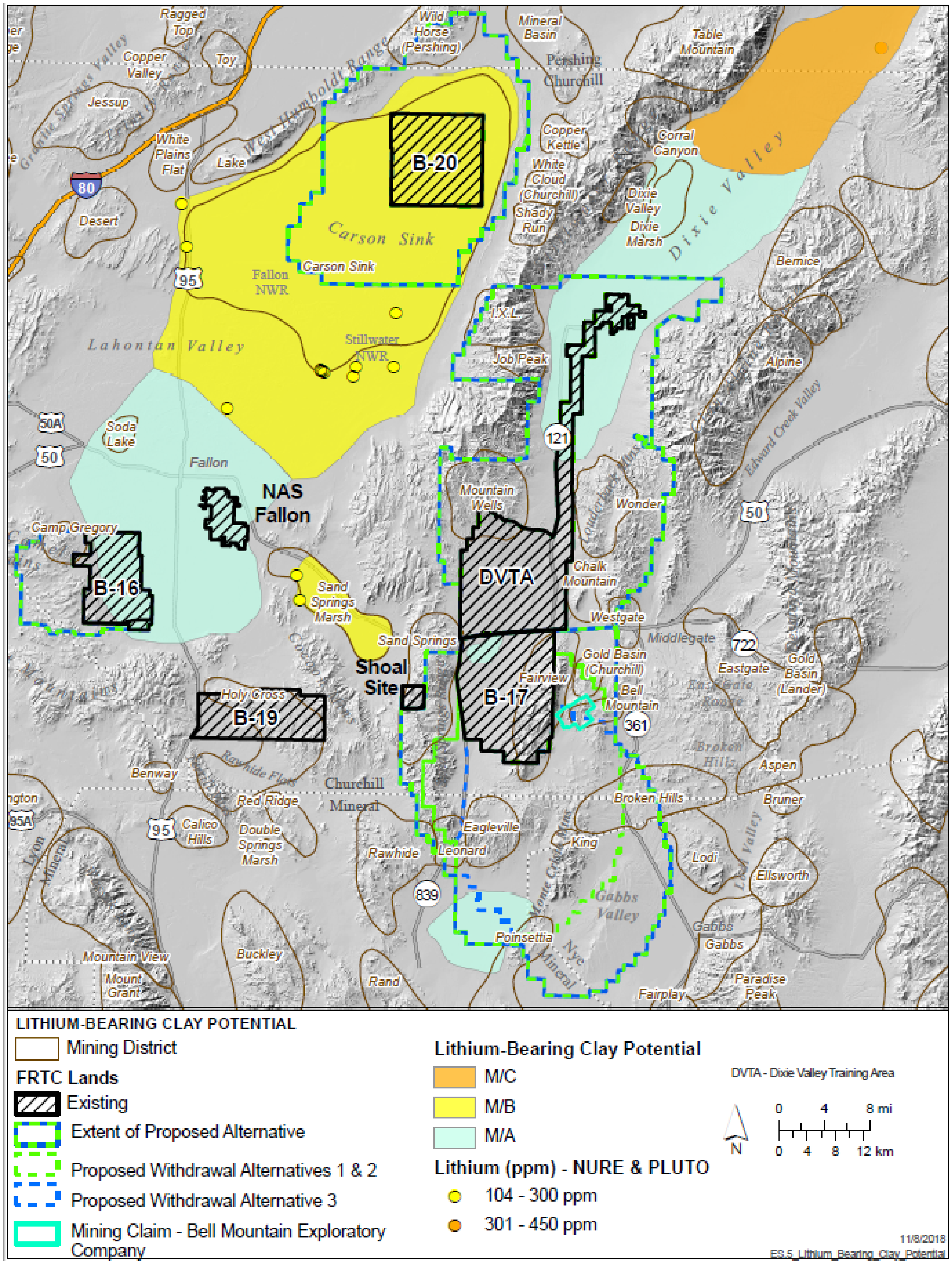

Figure ES.5: Lithium-Bearing Clay Potential

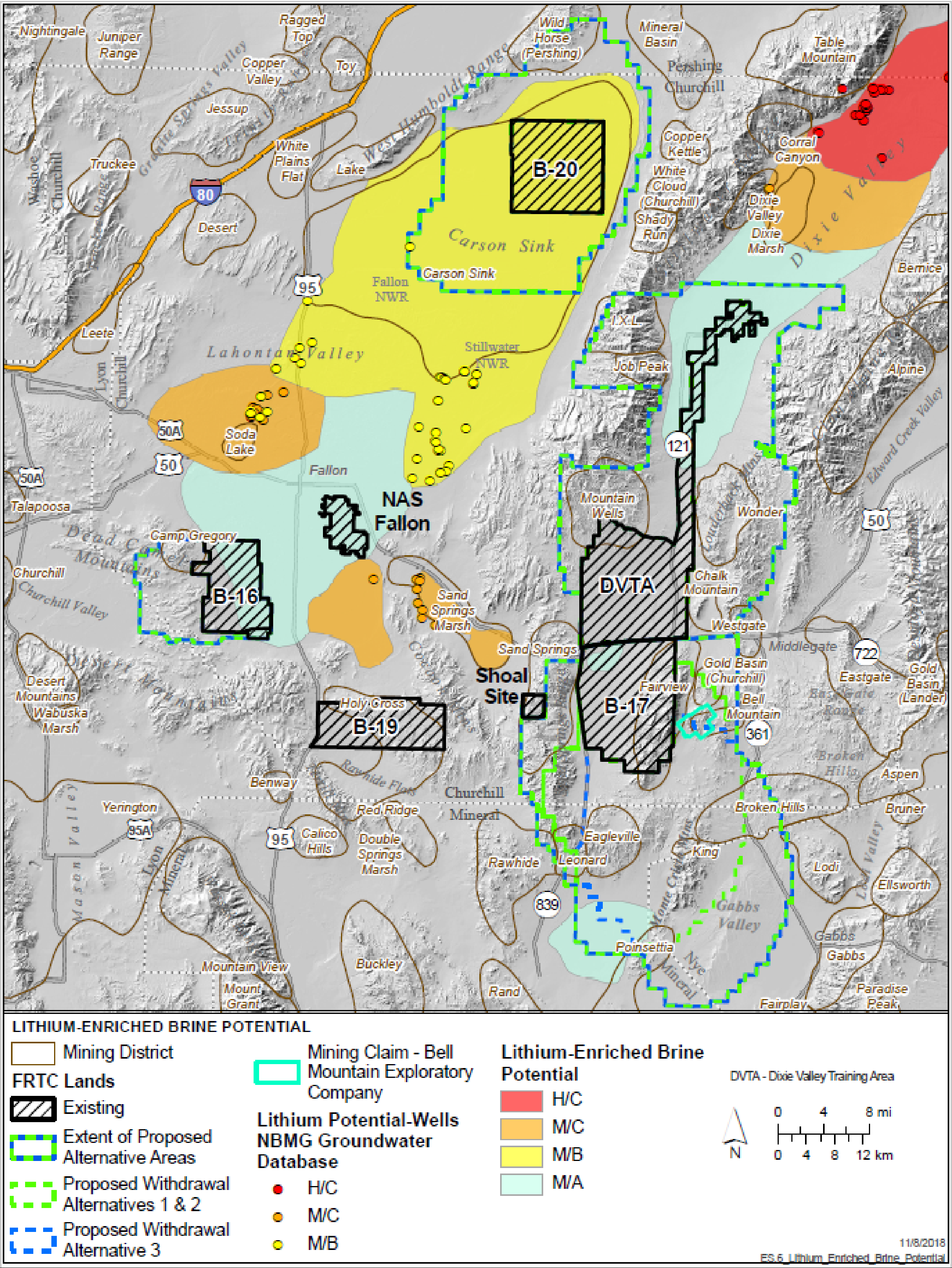

Figure ES.6: Lithium-Enriched Brine Potential

Leasable

The leasable resource with the highest potential in the Study Area is geothermal energy. The Study Area is located in a portion of the Great Basin province that has a relatively high concentration of producing geothermal power plants, geothermal occurrences (e.g. hot springs, hot wells, hot gradient holes), and geothermal exploration activity. The Study Area is characterized by Late Quaternary seismicity, a high geodetic strain rate, and a high geothermal gradient all of which are related to crustal thinning associated with the tectonic extension of the Great Basin.

The geothermal resource assessment for this study consisted of compiling and overlaying geospatial information including: locations of known geothermal power plants, well temperatures, geochemical geothermometer data, and structural data. This geospatial database was used to identify geological structures and environments, which are critical to geothermal favorability.

The range front fault settings along the margins of the mountain ranges provide geologic structural settings that can provide high permeability reservoirs and deep circulation of groundwater. Therefore, most of the Study Area that lies along the range fronts and basin settings are considered to have moderate to high geothermal potential. Areas with known hot springs, wells, or gradient holes occurrences or that are near existing geothermal power plants or areas of recent exploration activity are assigned higher certainty ratings. Figure ES.7 presents the geothermal potential of the Study Area.

In addition to leasable geothermal resources, the Study Area was evaluated for leasable oil, gas and coal resources. Nevada oil and gas production accounts for a very small fraction of the overall U.S. oil and gas production. In 2016, NBMG reported that there are 64 actively producing wells in the state; with mean maximum production of approximately 90 barrels per day. Producing fields are primarily found to the east of the Study Area in Railroad Valley (Nye County) and northeast of the Study Area in Pine Valley (Eureka County). The only producing gas field in Nevada is located in the Kate Springs area of eastern Nye County.

Commercially viable accumulations of oil and gas require a hydrocarbon source rock, a migration pathway for generated hydrocarbons, a reservoir where hydrocarbons are accumulated and a trap or seal to contain the hydrocarbons. To date, all producing Nevada oil fields occur in Neogene basins where the combination of source rock burial, heating, and valley fill seals have resulted in oil generation and preservation. All of these occur within the eastern Great Basin.

The potential for oil and gas, oil shale and native asphalt in the Study Area is low (L/D and L/C). While there are historical wells with oil and gas shows in the Study Area, there are no currently producing wells.

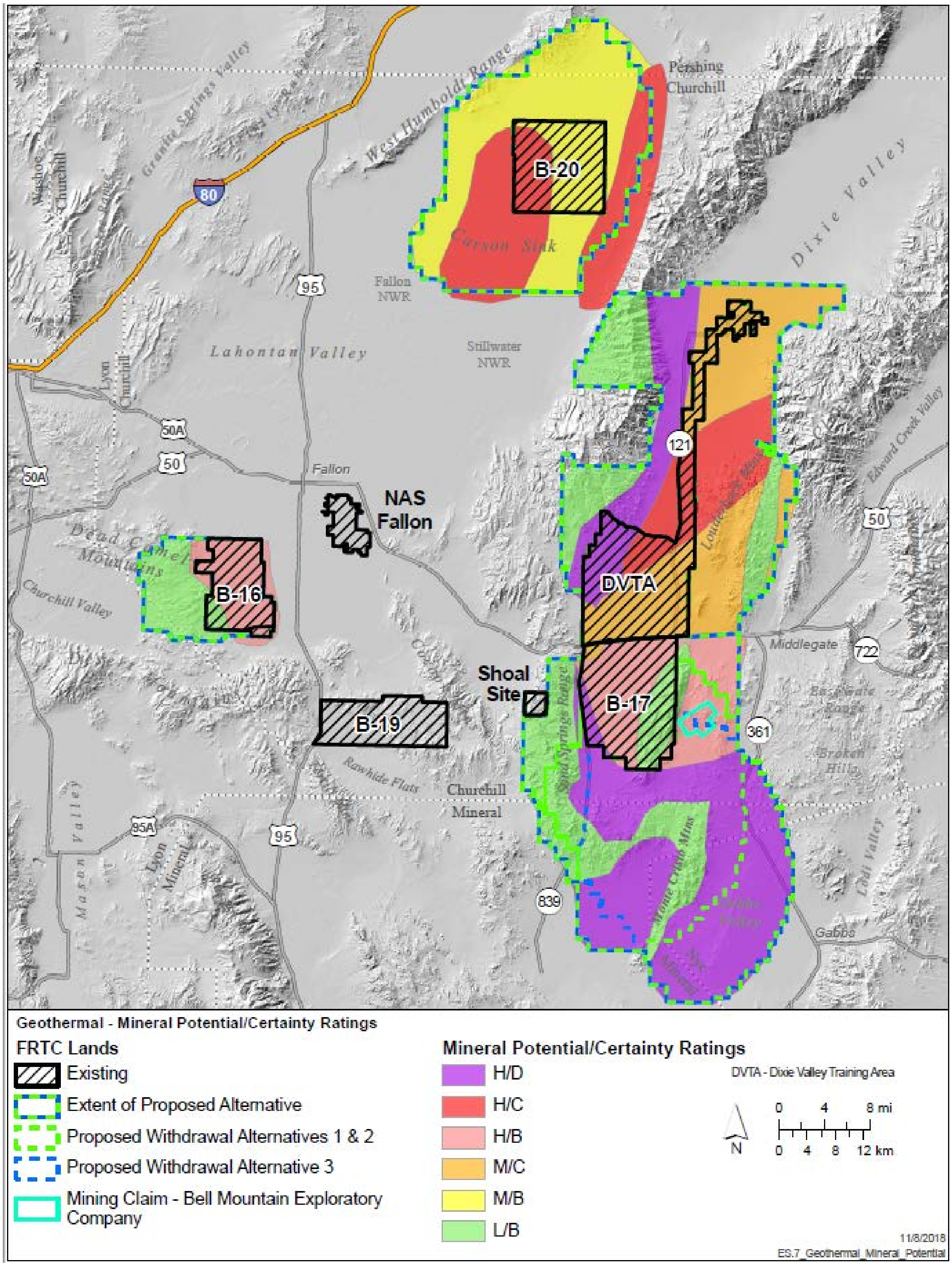

Figure ES.7: Geothermal – Mineral Potential/Certainty Ratings

With respect to coal, Nevada, in general, is not known to contain economically viable coal deposits. No coal occurrences have been identified within the Study Area. The mineral potential classification for coal in the Study Area is low (L/D) due to the unfavorable geologic environment for the formation of economic coal deposits.

Salable

Industrial minerals and commodities that are potentially abundant in the Study Area include construction aggregate from both sand and gravel deposits and quarry sources. Aggregate, sand, and gravel operations within the Study Area are typically small scale and provide material for local industrial and transportation projects. The mineral potential classification rating for aggregate, sand, and gravel in the quaternary alluvial valleys of the Study Area is high (H/D)

Clays suitable for industrial uses (kaolinite) have been mined historically in the in the Dead Camel Mountains within the proposed B-16 withdrawal area. Geologically favorable conditions exist within the Study Area for production of clay. The mineral potential classification for clay deposits in the Study Area is moderate (M/D).

Salt is mined from Nevada's only commercial producer, Huck Salt, from the Fourmile Flat playa. The operation is located south of U.S. Route 50 approximately four miles west of existing and proposed DVTA withdrawal areas and approximately four miles northeast of the existing B-19 withdrawal area in Salt Wells Basin. Although there is potential for mining of salt from playas within and adjacent to the Study Area, there is no current production of salt. The mineral potential classification for sodium minerals in the playas within the Study Area is moderate (M/D), outside of the playas the mineral potential classification is low (L/D).

Critical Minerals

Several of the minerals, which are included under Executive Order 13817 on the list of 35 mineral commodities considered critical to the economic and national security of the United States (Federal Register 83 FR 23295), have a low to moderate potential for occurrence in the Study Area. Barite and Fluorspar are the only minerals on the list of 35 with high potential (both classified as H/D) within the Study Area; both were historically produced in the Study Area, but there is no current production or exploration activity for these minerals in the proposed withdrawal areas. While there is low to moderate potential within the Study Area for several of the 35 critical minerals, all would require a significant increase in exploration activity to identify a potential economically recoverable resource for future development.

Effects of Alternatives

The proposed alternatives affect the geographic extent and management of mineral resources in the proposed land withdrawals. Alternative 1 is the most restrictive to access of mineral resources and Alternative 3 is the least restrictive. Alternative 2, has nearly the same geographic extent as Alternative 1 but allows for the development of geothermal and salable commodities in the proposed DVTA withdrawal area on the west side of Nevada State Route 121/Dixie Valley Road (Figures ES.2 and ES.3). The geothermal potential is an H/D in the area opened for geothermal development in Alternative 2. Alternative 3 significantly changes the geographic extent of the proposed DVTA and B-17 areas, provides access to the Bell Mountain gold claims, and allows for geothermal and salable development in the proposed DVTA withdrawal area. Alternative 3 provides access to the high potential geothermal resources west of State Route 121/Dixie Road, and opens up access to several mining districts with a high potential for precious and base metal development.

Reasonably Foreseeable Development

The Study Area contains several potential metallic locatable and industrial locatable minerals that could be developed. Major metals include gold, silver, copper, lead, zinc, tungsten, and molybdenum. Potential industrial locatable minerals include lithium, fluorspar, barite, diatomite, clay, and silica.

Geothermal is the primary leasable resource with a potential for development. Other leasable resources that could be potentially developed include salt and potash.

Golder's most likely reasonably foreseeable development scenario includes:

Locatable Minerals:

- One open-pit metal mine impacting roughly 700 plus ac
- One industrial mineral open-pit mine impacting 55 ac

Leasable Minerals:

- One geothermal operation impacting 125 ac

Saleable Minerals:

- One sand and gravel or rock aggregate operations impacting 4 ac

Recommendations

Golder recommends collecting field data to verify the MPR findings where possible. Field verification activities which could increase the potential or certainty classifications would include: confirmation of the geochemical anomalies outside of known mining districts, identification of hot springs deposits (sinter) and structures for geothermal targets, and possible playa sampling (groundwater, surface water, and solid samples) to better understand lithium potential.

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APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) provides this Mineral Potential Report (MPR) to support an Environmental Impact Statement (EIS) for the land withdrawal extension and expansion at the Naval Air Station (NAS) Fallon Range Training Complex (FRTC), in Churchill, Lyon, Mineral, Nye, and Pershing Counties, Nevada. The FRTC is part of the United States Department of Navy (DON). The FRTC currently encompasses an area of 223,562 acres (ac). Figure 1.1 presents the areas involved and is hereafter referred to as the "Study Area."

The FRTC consists of federal land that has been withdrawn from public use and reserved for military training and operations through the Military Lands Withdrawal Act of 1999, Public Law 106-65 (MLWA). The current withdrawal will expire in November 2021, unless Congress enacts legislation providing an extension.

The DON is proposing modernizing of the FRTC, which includes expansion of the range complex through acquisition of contiguous properties via land withdrawal of lands within the public domain and purchase of non-federal lands. The DON is developing the documentation required to support the Application Package and Case File to successfully accomplish the FRTC land withdrawal. To maintain critical test and training capabilities at the FRTC, the DON must complete all required studies in compliance with the National Environmental Policy Act (NEPA), the Engle Act, the Federal Land Policy and Management Act, the MLWA, and Land Withdrawals regulations set forth in Title 43 Code of Federal Regulations (CFR) Part 2300. The analyses and results of this assessment are needed to comply with NEPA and Land Withdrawal regulations, and to support submittal of an application to Bureau of Land Management (BLM), a provision of a Case File to the Department of the Interior (DOI), and development of draft legislation for Congressional approval of the withdrawal in accordance with applicable rules and regulations.

As part of the EIS process, the DON proposed three action alternatives for the land withdrawal extension and expansion for the FRTC. These action alternatives are pre-decisional from a NEPA perspective. Details regarding the Alternatives are presented in Section 1.2.

Several mineral resource inventories and evaluations have been completed, which include all, or portions, of the areas included in the alternatives. The Nevada Bureau of Mines and Geology (NBMG) completed a mineral resource inventory for the Navy's Master Land Withdrawal Area (Quade and Tingley, 1987). In 1990, Thompson and Boleneus (1990) completed a Mineral Resource Evaluation for the "Proposed Master Land Withdrawal at Naval Air Station Fallon." NBMG (Tingley, 1990) and Bureau of Land Management (BLM) (BLM, 2013) completed mineral resource inventories for the Carson City District, which includes the FRTC and proposed withdrawal areas.

The primary, underlying assumption used in developing this current assessment is that the data published in previous reports is valid and does not need to be reproduced. This Report synthesizes the vast amount of mineral potential data available and presents the information specific to the areal extent of the proposed land withdrawals. The energy and mineral potential of all proposed withdrawal areas were assessed, and results integrated into an area-wide MPR assessment update of the FRTC. This comprehensive assessment addresses advances in geologic understanding of selected deposits, changes in metal or commodity demand, and technological advances since the previous assessments.

This Report is organized into six sections. Section 1.0 is an introduction to the MPR; Section 2.0 summarizes the geological setting within the Study Area; Section 3.0 describes the known occurrences of leasable, locatable, and salable mineral resources in the Study Area; Section 4.0 discusses the potential for minerals within the Study Area including a brief discussion of occurrence of minerals of strategic or critical importance to the nation;

Section 5.0 includes a discussion of reasonable and foreseeable development scenarios; and Section 6.0 includes references to develop the MPR.

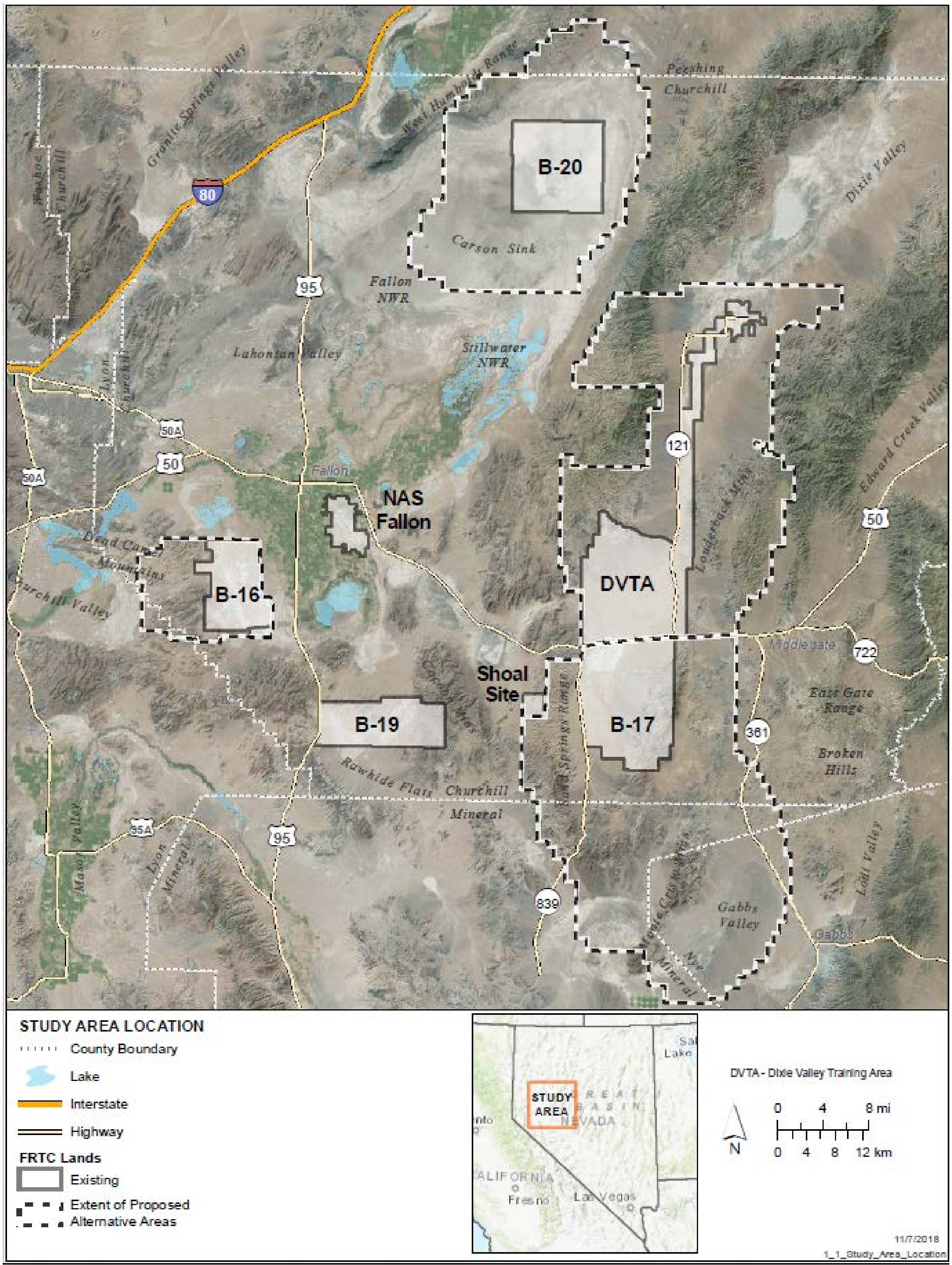

Figure 1.1: Study Area Location

1.1 Purpose and Scope

The purpose of this Report is to satisfy the legal requirements in the Federal Land Policy and Management Act (BLM, 2001) for such a study. This Act establishes public land policy and guidelines for the administration of public lands, provides for the management, protection, development, enhancement of public lands, and for other purposes. The Federal Land Policy and Management Act requires that a qualified mining engineer, engineering geologist, or geologist prepare a report that provides information on general geology, known mineral deposits, past, or present, mineral production, mining claims, and mineral leases, for actions such as the withdrawal of lands for military training, as proposed in the EIS for FRTC Modernization. This MPR evaluates the locatable, leasable, and salable minerals at proposed FRTC expansion areas, which include Bravo 16 (B-16), Bravo-17 (B-17), Bravo 20 (B-20), and the Dixie Valley Training Area (DVTA), as described in the Land Withdrawal for Land Management Purposes Environmental Assessment (BLM, 2018).

This MPR is intended to be used as a planning tool that provides land managers with mineral resource information to develop management plans. The requirements of an MPR on lands administered by the BLM are defined in BLM Manuals 3031 (BLM, 1985) and 3060 (BLM, 1994). The BLM requirements also apply to lands under the administrative jurisdiction of the United States Fish and Wildlife Service (USFWS). Some changes to the BLM reporting format were made to this MPR, due to the complexities of the withdrawal status and the Study Area.

The Mineral Potential Classification System used in this assessment is as defined in BLM Manual 3031 (BLM, 1985). Table 1.1 presents a schematic representation. The Mineral Potential Classification system qualifies the level of potential and level of certainty as follows:

- Level of Potential:
  - O = No Potential: The geologic environment, the inferred geologic processes, and the lack of mineral occurrences do not indicate potential for accumulation of mineral, or energy, resources.
  - L = Low potential: The geologic environment and inferred geologic processes indicate a low potential for accumulation of mineral resources.
  - M = Moderate potential: The geologic environment, the inferred geologic processes, and the reported mineral, or energy, occurrences, or valid geochemical/geophysical anomaly, indicate moderate potential for the accumulation of mineral resources.
  - H = High potential: The geologic environment, inferred geologic processes, the reported mineral, or energy, occurrences and/or valid geochemical/geophysical anomaly, and the known mines, or deposits, indicate high potential for the accumulation of mineral, or energy, resources.
  - ND = Potential not determined: Mineral and energy resource potential not determined, due to a lack of useful data. This notation does not require a level-of-certainty qualifier.
- Level of certainty:
  - A = The available data are insufficient and/or cannot be considered as direct, or indirect, evidence to support, or refute, the possible existence of mineral, or energy, resources within the respective area.
  - B = The available data provide indirect evidence to support or refute the possible existence of mineral, or energy, resources.

- C = The available data provide direct evidence, but are quantitatively minimal to support, or refute, the possible existence of mineral, or energy, resources.
- D = The available data provide abundant direct and indirect evidence to support, or refute, the possible existence of mineral and energy resources.

Table 1.1: Mineral Potential Classification System

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Notes: Source - Based on BLM Manual 3031 (1985), Illustration 3.
[1]Not commonly used and only in special circumstances.

The Mineral Potential Classification System addresses the potential for the presence, or occurrence, of a mineral concentration, and the level of data available for consideration. The classification system does not require an estimate of the economic significance, the commercial viability, or the quantity and concentration of potential mineral or energy resources. Note, that the BLM uses the shortened term “mineral potential” to include both mineral and energy resource potential.

1.2 Lands Involved

The FRTC is located approximately 65 miles east of Reno, Nevada, and encompasses approximately 230,000 ac of land, of which approximately 203,000 ac are withdrawn public land. The FRTC currently consists of Special Use Airspace; land training ranges (four air-to-ground training ranges [B-16, B-17, B-19, and B-20]), the Shoal Site, and the DVTA; air, simulated sea, fixed, and mobile land targets; control facilities; threat Electronic Warfare and surface-to-air missile systems, and emulators; and instrumentation facilities (Figure 1.1). The land management and ownership of the Study Area is presented on Figure 1.2. Withdrawal of additional lands to support DON activities in ranges B-16, B-17, and B-20, and the DVTA may impact combinations of public and private lands including mining and geothermal leases, as well as access to mineral exploration and production infrastructure such as roads, pipelines, and temporary and fixed facilities. It is understood that possible FRTC expansion areas may include the following:

- The existing B-16 range withdrawal area may be expanded to the West, Northwest, and South.
- The existing B-17 range withdrawal area may be expanded to the South, Southwest, Southeast, and East.

- The existing B-20 range withdrawal area may be expanded to the North, South, East, and West.
- The existing DVTA may be expanded to the North, East, and West. Additionally, a non-contiguous area east and west of existing and proposed B-17 withdrawal areas also are included as part of the alternatives for the DVTA expansion.

The changes in the range withdrawal areas depend upon the alternatives. Details regarding the alternatives are as follows:

- **Alternative 1**: Increase the FRTC size to 916,168 acres by requesting to withdraw approximately 618,727 acres and proposing to acquire 65,153 acres to ranges B-16, B-17, B-20, and the DVTA.
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The geographic extent of Alternatives 1 and 2 is presented on Figure 1.3 with Alternative 3 presented on Figure 1.4. For the purpose of this MPR, the maximum areal extent of the withdrawal areas, considering all alternatives will be assessed and referred to collectively as the “Study Area.”

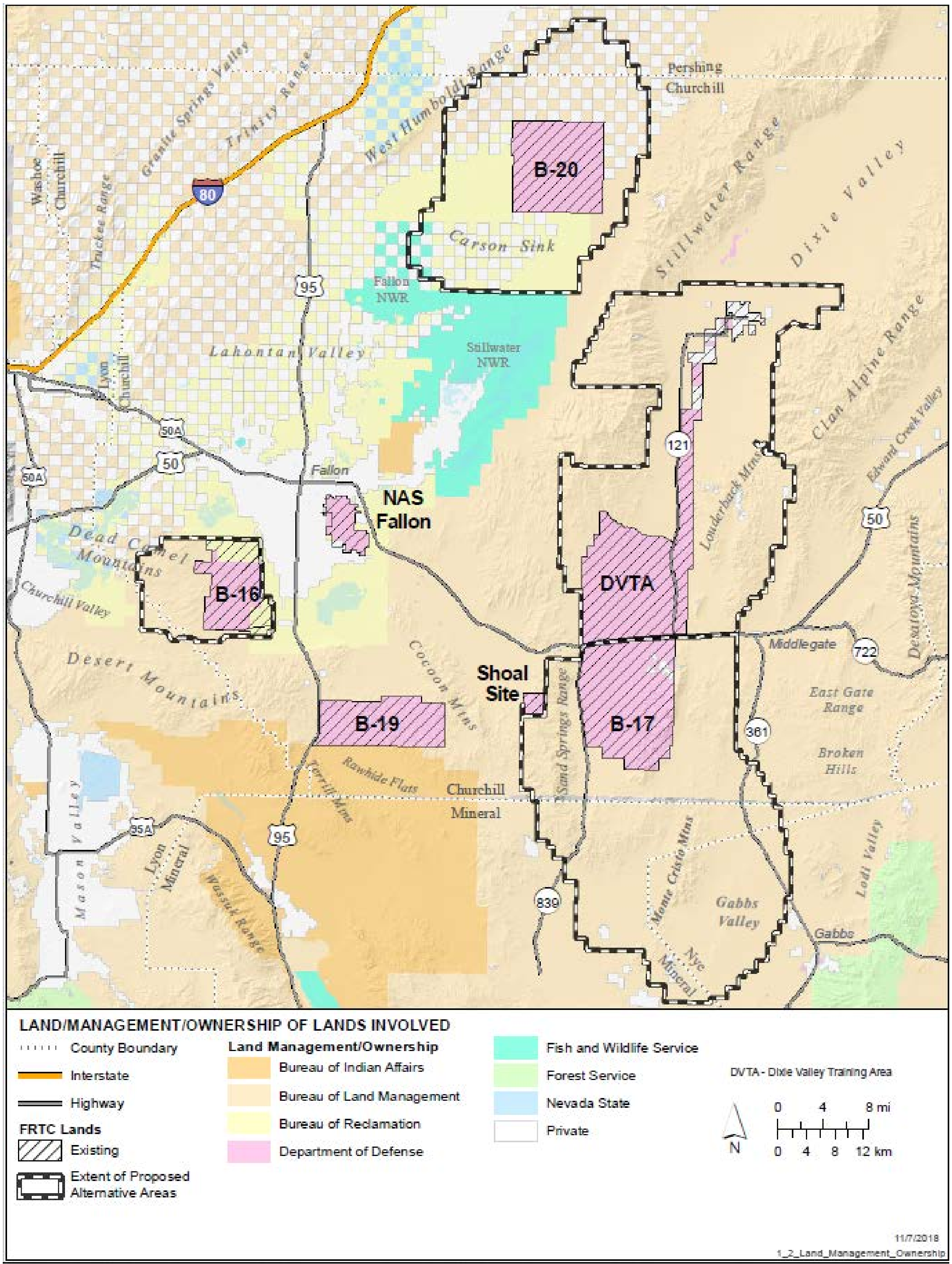


Figure 1.2: Land/Management/Ownership of Lands Involved

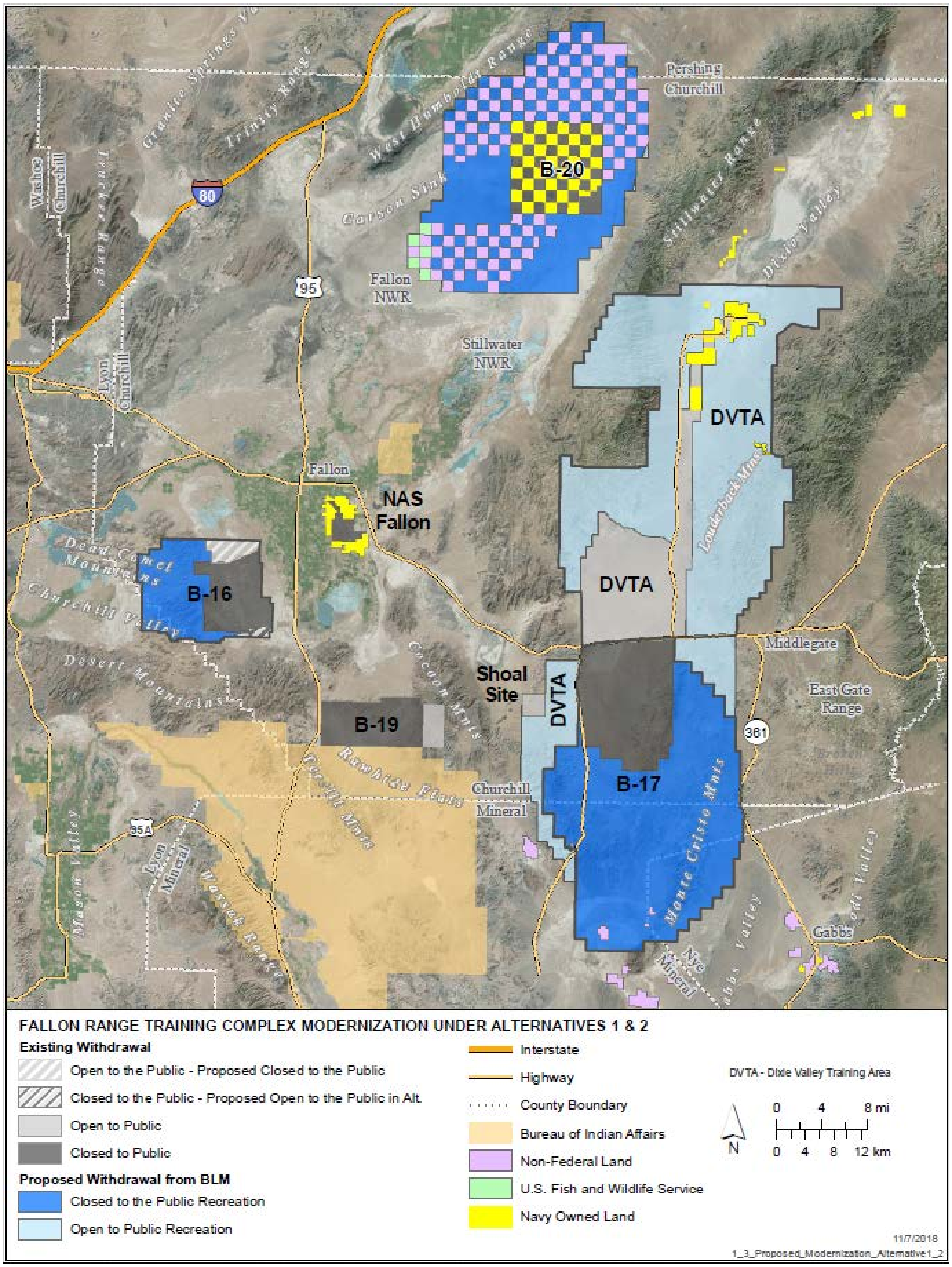


Figure 1.3: Fallon Range Training Complex Modernization Under Alternatives 1 and 2

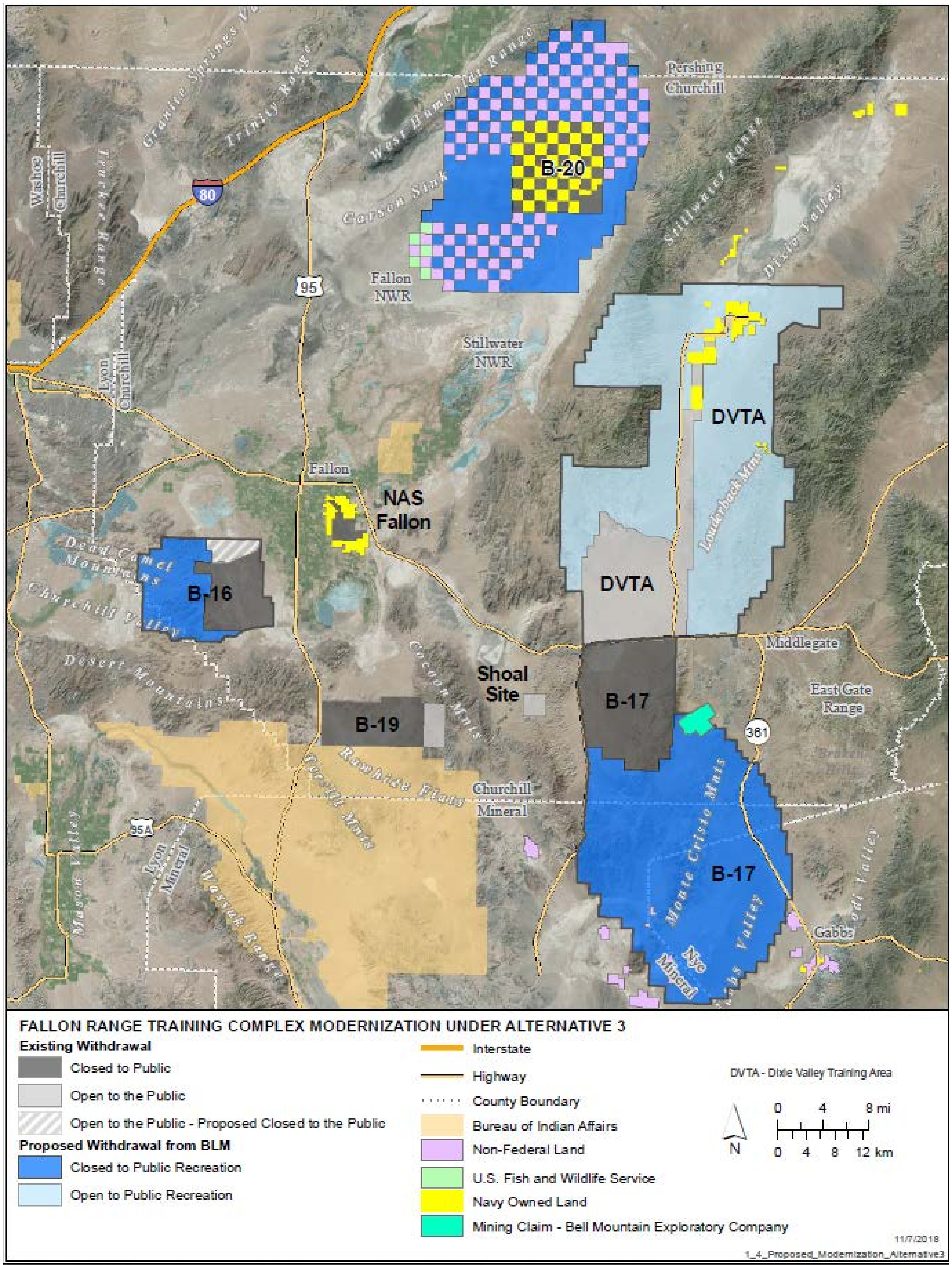


Figure 1.4: Fallon Range Training Complex Modernization Under Alternative 3

1.3 Background Information/Previous Work

The DON manages approximately 202,864 ac of public land withdrawn for the FRTC under the Fiscal Year 2000 National Defense Authorization Act (NDAA). This withdrawal will expire in November 2021. On September 2, 2016, the BLM published a Federal Register Notice (FRN) notifying the public that the DON had filed applications requesting the extension of their existing withdrawal as well as the withdrawal of an additional 604,789 ac of public land from all forms of appropriation under the public land laws, including the mining laws, the mineral leasing laws, and the geothermal leasing laws subject to valid existing rights. With the publication of the FRN, the lands were segregated from all forms of appropriation under the public land laws, including the mining laws, the mineral leasing laws, and the geothermal leasing laws, for up to two years, subject to valid existing rights. The two-year segregation expired on September 1, 2018 (Federal Register Notice 2016-21213 [81 FR 60736]).

On January 19, 2018, the DON submitted an amended application requesting the withdrawal for military use of approximately 91,054 additional ac of land from all forms of appropriation under the same laws specified above, subject to valid existing rights. This request is in addition to the 604,789 ac segregated in 2016, following the BLM's receipt of their initial application in July 2016. Under the Land Management Evaluation (LME) withdrawal, the proposed action evaluated in the Environmental Assessment prepared by the BLM (2018), the entire area subject to the DON's application, as amended, would be withdrawn, pursuant to Section 204 of Federal Land Policy and Management Act (FLPMA), for up to four years. The LME withdrawal is assisting the DON and the BLM by providing time to complete the identification and analyses of resource issues (including this MPR) relating to the DON's proposed training range land renewal and expansion at NAS Fallon. Any decision on the DON's application to renew and expand the areas at NAS Fallon reserved for military use does not lie with the Secretary of the Interior, but will be made by Congress, pursuant to the requirements of the Engle Act of 1958. The Secretary of the Interior issued a Public Land Order (PLO) on August 31, 2018, that administratively withdrew the 769,724 ac of land from all forms of appropriate use for four years for LME purposes.

An abundance of quality information is publicly available to support this MPR. This MRP relied primarily on three previous mineral assessments that cover all or portions of the Study Area. In 1987, NMBG personnel (Quade and Tingley, 1987) completed a mineral resource inventory of an FRTC land withdrawal. In 1990, the United States Geological Survey (USGS) and the NMBG (Tingley, 1990) collaboratively prepared a Mineral Resource Inventory of the BLM's Carson City District. This BLM district covers the area included in the FRTC and proposed withdrawal areas. The 1990 report focuses on metallic mineral resources. In 2013, the BLM prepared a Mineral Potential Assessment Report for the BLM's Carson City District. Unlike the original 1990 report, which focuses on metallic mineral resources, this report is more comprehensive as it assesses both mineral and energy potential. In addition to the assessments, an abundance of information is available to assess the mineral and energy resources of the Study Area. These sources will be identified as they are summarized and referenced in subsequent report sections.

2.0 DESCRIPTION OF GEOLOGY

This section presents the Study Area physiography, a description of the lithology and stratigraphy and concludes with a description of the structural geology and tectonic history.

2.1 Physiographic Setting

The major physiographic features of the Study Area are shown on (Figure 2.1). The Study Area is in the west-central part of the Great Basin, a sub-province of the Basin and Range physiographic province. The Great Basin forms the widest segment of the vast Basin and Range province, which extends approximately 1,553 miles (2,500 kilometers [km]) north to south, from the Pacific Northwest of the US to central Mexico, and east to west, from the Colorado Plateau to the Sierra Nevada Mountains. The Great Basin sub-province occupies a 375- by 375-mile (600- by 600-km) tract, which predominantly lies within the state of Nevada. Within the Study Area, this region is characterized by generally north-trending mountain ranges separated by alluvial valleys.

Six named mountain ranges are partially or fully within the Study Area (Figure 2.2). Elevation across the Study Area varies from a low of approximately 1,160 meters (m) above mean seal level (amsl) at the Carson Sink, to a high of 2,531 m amsl on Fairview Peak in an unnamed mountain range in withdrawal area B-17. The primary named mountain ranges include the West Humboldt Range, Stillwater Range, Louderback Mountains, Monte Cristo Mountains, Sand Springs Range, and Dead Camel Mountains.

Most of the Great Basin is an area of internal drainage. That is, the surface runoff does not report to rivers that eventually report to the ocean. Instead, water is captured in basins and only discharges to groundwater, or to the atmosphere via evaporation. Within the Study Area, all surface water runoff reports to playa lakes. The largest playa in the Study Area is the Carson Sink, the terminus of the Carson River, which starts in the Sierra Nevada Mountains.

2.2 Lithology and Stratigraphy

The following discussion presents the lithology and stratigraphy of the Study Area. Figure 2.2 presents the surface geology of the Study Area, and Figure 2.3 presents the geologic map legend. Figure 2.4 through Figure 2.7 present the range/area specific geologic coverages of B-16, B-17, B-20, and DVTA, respectively.

2.2.1 Mesozoic

Mesozoic rocks are the oldest exposed in the Study Area (Figure 2.2 and Figure 2.3). The majority of the Study Area lies within the Mesozoic marine province of the northwestern Great Basin. Rocks of the Mesozoic marine province were deposited in a back-arc basin east of the Sierra Nevada arc (Speed, 1978; Oldow, 1984). The Sierra-Nevada Batholith, west of the Study Area, is the local manifestation of this Cordilleran arc that extended from Canada to Central America. This back-arc basin was the site of marine deposition from the Early Triassic into the mid-Jurassic: carbonate and craton-derived siliciclastic sediments were deposited on its eastern flanks, while volcanic rocks, volcanogenic sediments, and interstratified carbonate sediments were deposited to the west. A wide range of depositional environments from intertidal, supratidal to deep basinal were documented in Triassic and Early Jurassic rocks in various parts of the Mesozoic marine province (Oldow, 1984; Oldow and others, 1993; Stewart, 1997).

Stewart and others (1997) noted that west-central Nevada contains an assemblage of litho-tectonic terranes (allochthons) that are characterized by different depositional environment, which were once widely separated.

They attempted to correlate Mesozoic lithostratigraphic units and found evidence of regionally-consistent structures across terrane boundaries.

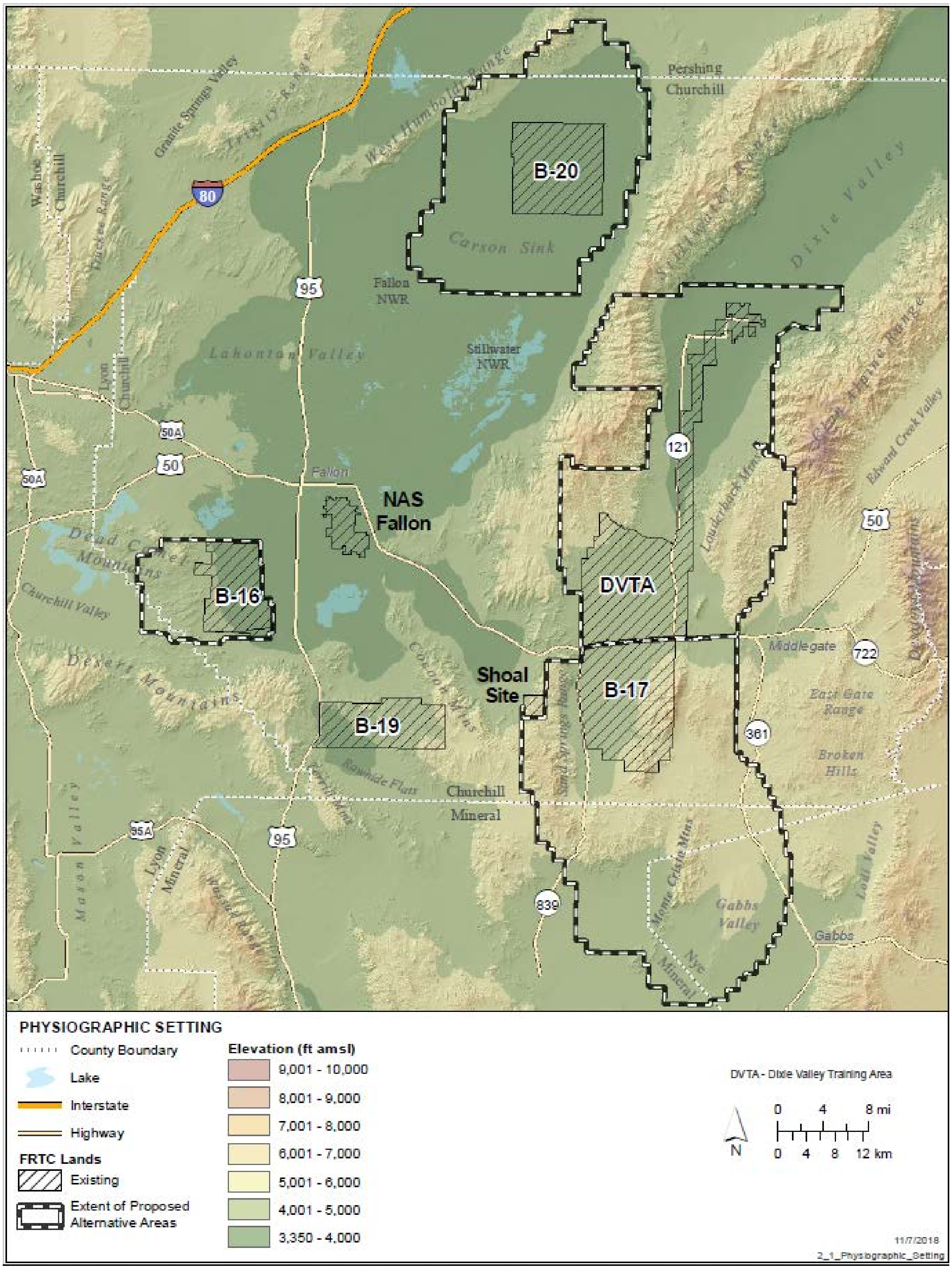


Figure 2.1: Physiographic Setting

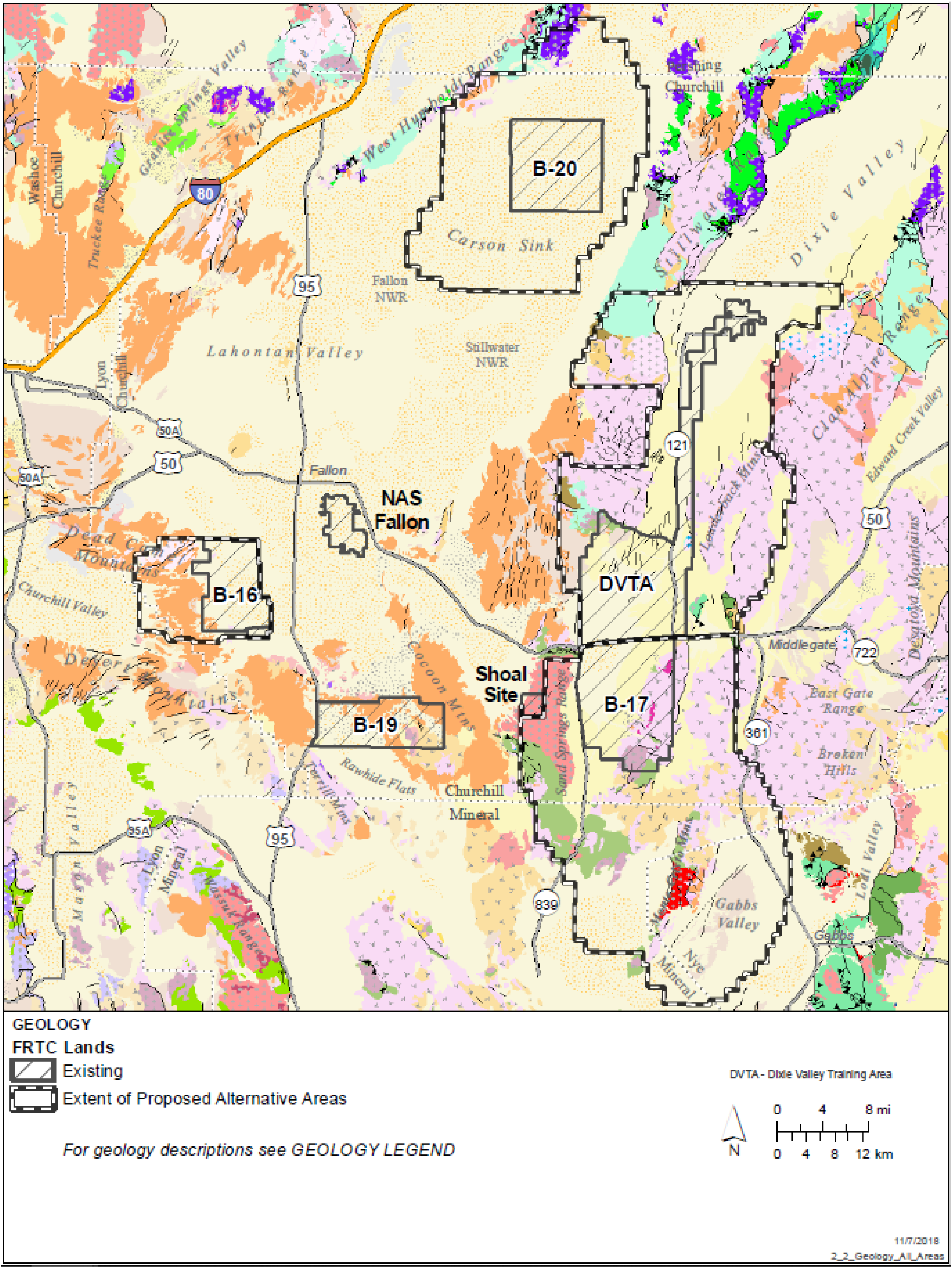


Figure 2.2: Geology

Figure 2.3: Geologic Map Legend

The Mesozoic litho-tectonic terranes within the Study Area that are identified by Stewart and others (1997) include the Sand Springs, Walker Lake, and the Jungo Terrane. The Mesozoic rocks of the Sand Springs Terrane indicate a deepwater depositional environment during the Upper Triassic and more volcaniclastics during the Early Jurassic. The stratigraphic sequence includes thinly bedded deepwater carbonaceous turbidites and carbonate conglomerate and breccia, which grade upward, and are interbedded with volcanogenic shale, sandstone, and conglomerate. This, in turn, is overlain by Lower Jurassic volcanogenic shale and sandstone, and then, by carbonate rocks interbedded with volcanic rocks. Outcrops of the Sand Springs Terrain can be found in the Stillwater Range and Monte Carlo Mountains in the B-17 area (Figure 2.5).

The Mesozoic rocks of the Walker Lake Terrane comprise three assemblages, which include the Luning-Berlin, Pamlico-Lodi, and Pine Nut Assemblages. The Luning-Berlin and Pamlico-Lodi outcrop in the Lauderback Mountains in the DVTA area (Figure 2.7). The Luning-Berlin assemblage is composed of carbonate and terrigeneous-clastic rocks. The Pamlico-Lodi is composed of Triassic carbonate sequences interstratified with volcanic and volcanogenic rocks, not continentally derived epiclastic chert, conglomerate, sandstone, and argillite (Oldow, Satterfield, and Silberling, 1993; Silberling and John, 1989). The uppermost part of the Pamlico-Lodi sequence is a regionally-extensive carbonate shelf assemblage. This is conformably overlain by quartz arenite and poorly-sorted coarse clastic rocks faunally, dated as Early Jurassic, that grade upward into volcanogenic sedimentary and volcanic rocks (Oldow, 1984; Oldow and Bartel, 1987).

The Mesozoic rocks of the Jungo Terrane include a thick sequence of fine-grained continental sediments deposited during the Late Triassic and Early Jurassic. It has been estimated that more than 5,000 feet (1,524 m) of these sediments were deposited. The youngest rocks in the Jungo Terrane are mafic volcanics associated with a Middle Jurassic gabbro (Stewart and others 1997). Outcrops of the Jungo Terrain can be found in the Stillwater Range and Monte Carlo Mountains in the B-17 area (Figure 2.5).

Stewart and others (1997) presented four competing paleogeographic models to account for the observed juxtaposition of the different Mesozoic Terranes, which include a fixed position model, and three models involving various amounts and different directions of lateral movement along the major, terrane-bounding faults. The problem of defining what brought rocks formed in distinctly different depositional environments into their current positions has not been entirely resolved; however, it is now widely accepted that Cenozoic strike-slip faulting had a prominent role.

In addition to the primarily sedimentary rocks described above, the formation of a magmatic arc was accompanied by the emplacement of plutons. This activity was accompanied with continental sediments that are interspersed with volcanogenic rocks, including ash-flow tuffs, rhyolite and rhyodacite flows, volcanogenic sandstone, and andesite (Stewart, 1980). An example of Mesozoic igneous dominated rocks can be found in the Monte Carlo Mountains in the B-17 area (Figure 2.5).

2.2.2 Cenozoic

The following subsections presents the Cenozoic lithology and stratigraphy. It is organized with respect to the Tertiary and Quaternary geologic time periods.

2.2.2.1 Tertiary

At the end of the Cretaceous Period, magmatism was intense within the batholith belt underlying the Sierra Nevada and western Nevada. But the oceanic crustal slab began to descend at a shallower angle under the continent at the close of the Mesozoic. This was associated, initially, with a sharp decline in magmatism in the

Great Basin, and later, with a southward migration of a northwest-trending volcanic front that generally swept across the Great Basin throughout the Paleogene (Dickinson, 2006). This also saw the onset of crustal extension in the Great Basin, which Dickinson (2006) attributes to intra-arc, or back-arc, deformation induced by rollback of the subducting oceanic plate.

Tertiary volcanic rocks are exposed in all the mountain ranges and constitute the primary rock type in the Study Area. Compositions range from basalt to rhyolite, with volcanic types ranging from small basalt cinder cones, or rhyolite domes to large caldera eruptions (Miller and Wark 2008). Two calderas have been identified in the Study Area, one in the central portion of the Stillwater Range (John, 1997), and a second centered around Fairview Peak (Henry, 1996). As a result of the relatively-recent caldera-style volcanism, ash-flow tuffs (ignimbrites) are the dominant rock type exposed in the Study Area.

2.2.2.2 Quaternary

The Quaternary units in the Study Area are primarily basin-fill material that consist of alluvium, colluvium, and landslide deposits. Basin-fill deposits are several thousand feet thick in some basins.

Most of the Quaternary basin-fill materials are coarse to fine-grained clastic sediments shed from adjacent mountain ranges. Alluvial fans from mouths of mountain canyons are an obvious geomorphic feature that attests to erosion of the mountains and deposition in the basins.

The basin fill deposits are in part a product of the dry climatic conditions and structural controls that have resulted in insufficient precipitation to transport sediments out of the deepening basins. The hydrologic regime in the northern Basin and Range has fluctuated over time. Playa lakebeds and salt deposits have formed during periods of dry climate, but there have also been lengthy wet periods when the large lakes connected multiple basins. Walker Lake and Pyramid Lake are both the remnants of Pleistocene Lake Lahontan, a vast freshwater body that extended throughout much of the western portion of the Study Area. Berms and scour features that formed on the shorelines of Lake Lahontan are still visible high up on the slopes of many of the basins. Basin-fill deposits consist predominantly of fine-grained clastic sediments, with some salt deposits locally interfingered with sandstone and conglomerate.

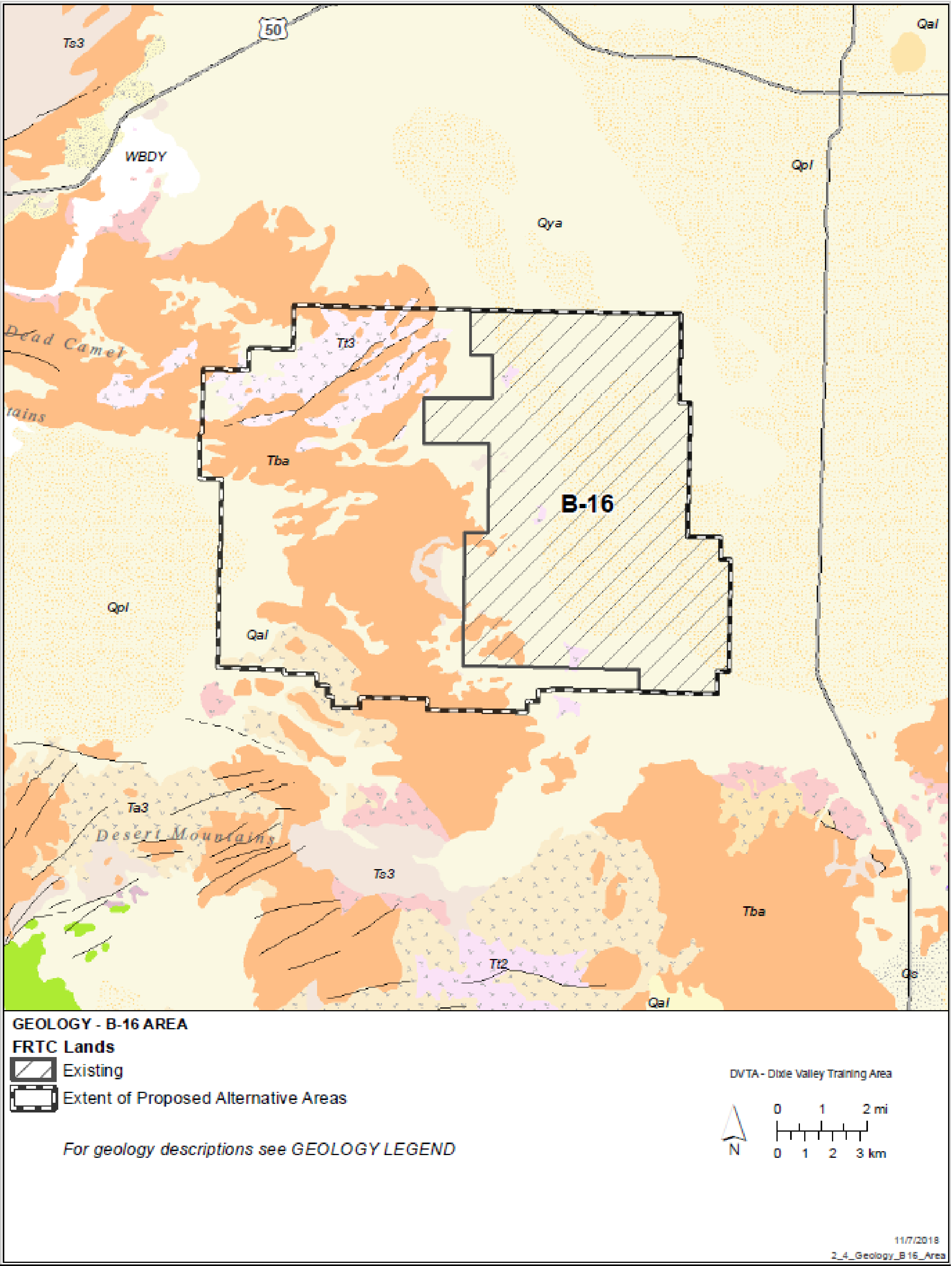


Figure 2.4: Geology - B-16 Area

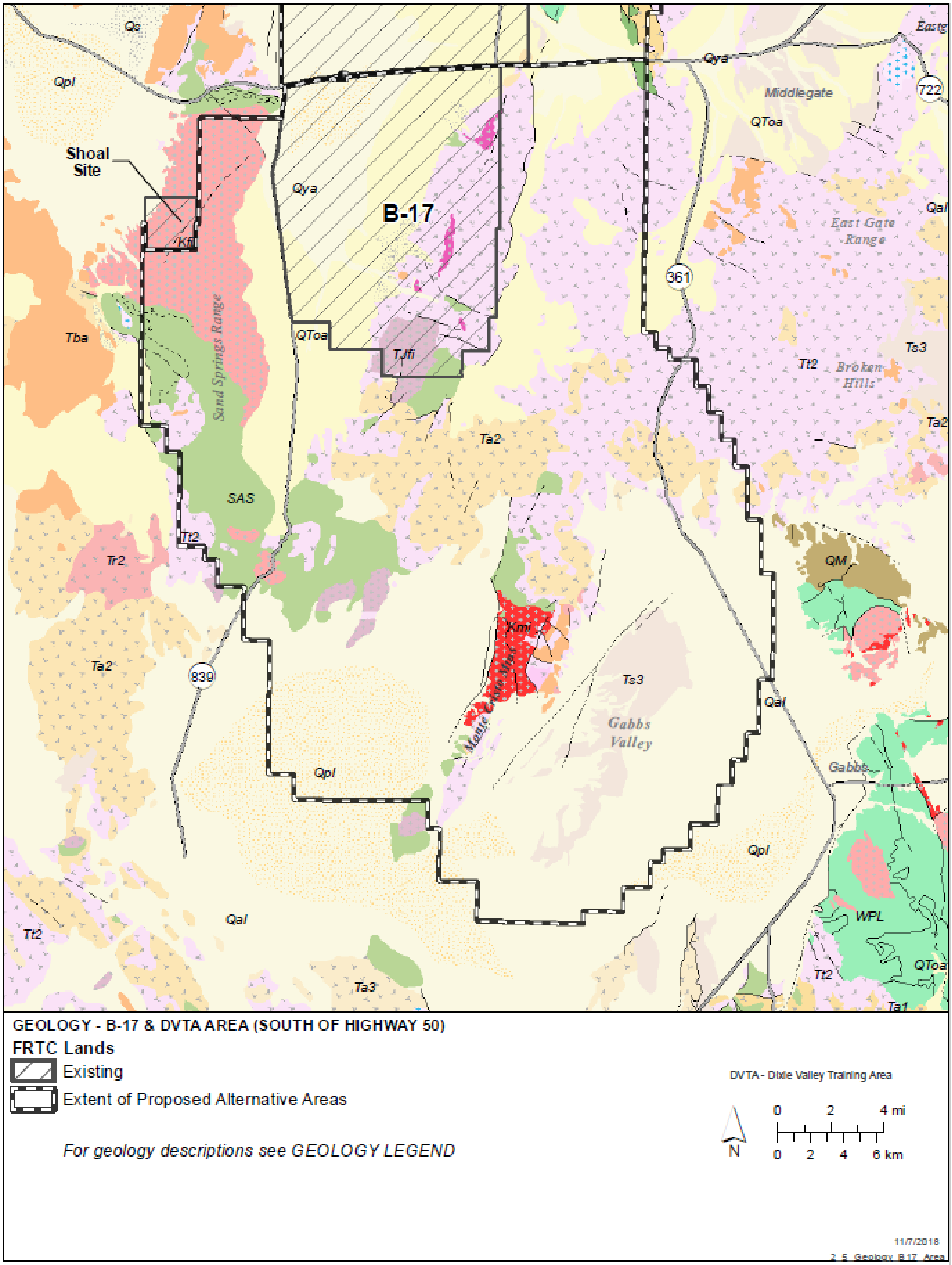


Figure 2.5: Geology - B-17 and DVTA Area (South of Highway 50)

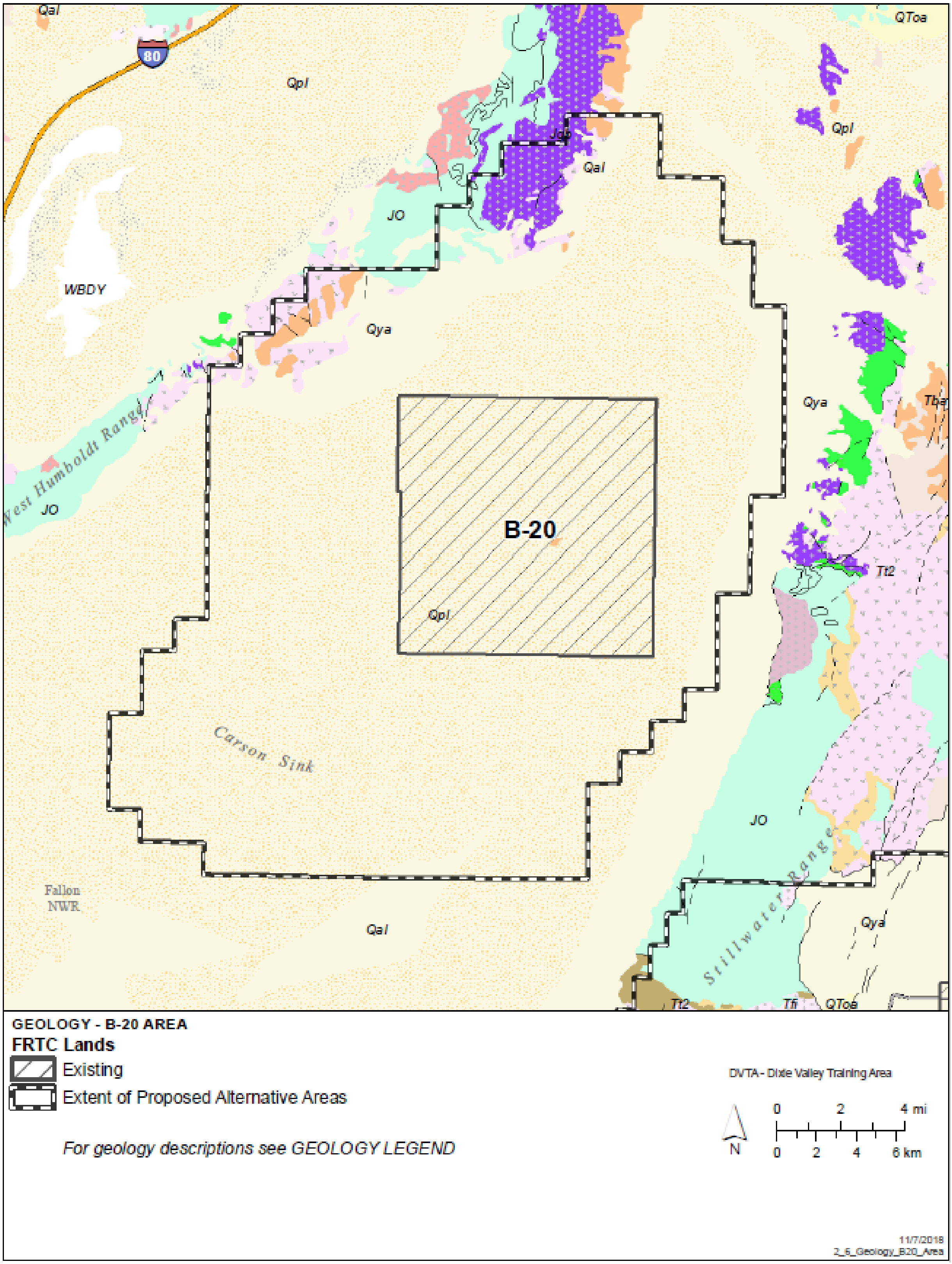


Figure 2.6: Geology - B-20 Area

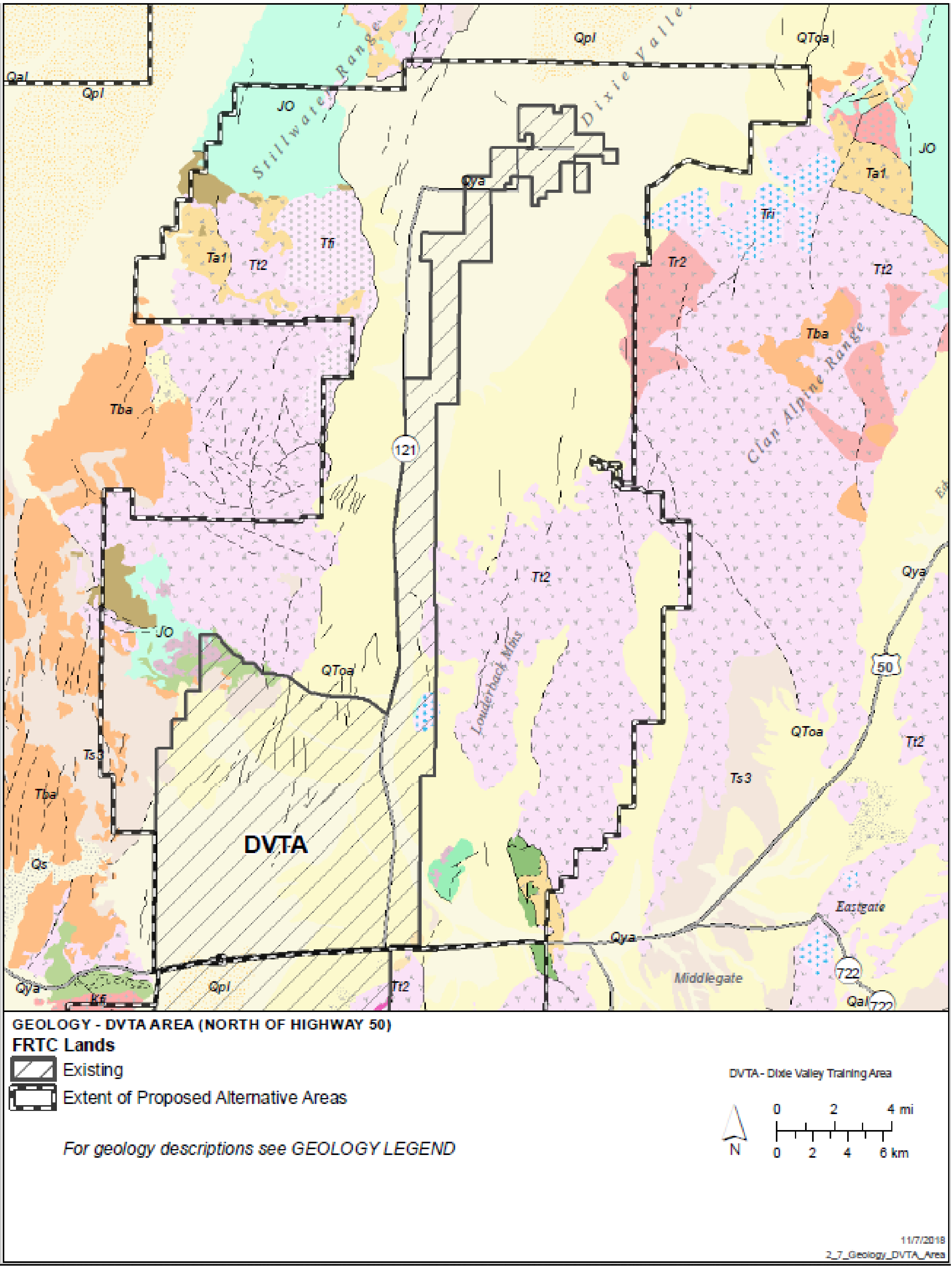


Figure 2.7: Geology of DVTA (North of Highway 50)

2.3 Structural Geology and Tectonic History

Few regions of the world have had as varied a tectonic history as the Great Basin, and its geologic complexity challenges interpretations of metallogeny (Dickinson, 2006).

2.3.1 Mesozoic

The western margin of North America underwent near-continuous eastward convergence from the Early Mesozoic to the end of the Oligocene (Engebretson and others, 1985). The oldest strata exposed in the Study Area were deposited in a back-arc basin during the Mid-Triassic to mid Jurassic. Turbidites in the Sands Springs terrane and a mixture of continental and volcanic-derived sediments in the Jungo terrane record deposition in the back-arc basin. The thrust systems associated with these compressional tectonics responsible for the back-arc basin are inboard (east) of the Study Area. The closest thrust system, the Luning-Fencemaker, is believed to be located immediately east of the Study Area in central Nevada. The Antler-Sonoma Events occurred east of the Study Area as well. During the Late Middle to Late Jurassic (165-145 million years before present [Ma]) back-arc magmatism spread across the Great Basin to the east. During the Late Cretaceous, magmatism was intense along the western side of the Great Basin. Felsic plutons believed to be associated with this magmatism are located on the north side of the Sand Spring Mountains, just south of US Highway 50 (Figure 2.5). Magmatism again swept east during the Late Cretaceous as the subducting oceanic slab flattened due to increased subduction rates (Dickinson, 2006).

2.3.2 Cenozoic

During the Oligocene, the volcanic arc migrated westward into the Study Area, renewing magmatic activity. The predominantly siliceous volcanism and profound extensional tectonism continued from Late Oligocene into the Neogene. The siliceous volcanism, including calderas and tuffaceous deposits, are the dominant rocks of the Study Area. Minor basaltic volcanic activity continued into the Holocene. Extensional tectonism, though minor in comparison to Oligocene and Neogene time, is still occurring. A Cenozoic regime of extensional tectonism created the Great Basin as an internally drained tract of mountainous topography broken by sediment-filled valleys (Dickenson, 2006).

Classic basin-and-range deformation is typified by block faulting. The Basin and Range province was initiated in early Miocene time (approximately 17.5 Ma) after the San Andreas transform system was established in California as the boundary between the Pacific and North American lithospheric plates (Dickinson, 1997). Before that time, the two regional plates were shielded by oceanic microplates. High angle basin-and-range normal faulting in the Study Area began around 14 to 13 Ma (John, 1997).

In addition to classic basin-and-range block faulting, major strike-slip faulting is present in the Study Area. The majority of the strike-slip faulting is thought to be related to the development of the Walker Lane (WL) fault system, an incipient dextral transform fault system along the evolving Pacific–North American plate boundary (Faulds and Henry, 2008). The WL fault system is a 700-km-long, northwest to north-northwest trending belt of valleys and ranges along the Nevada-California border that is dominated by strike-slip faults (Stewart, 1988; Stewart and Crowell, 1992). Deformation associated with the WL fault system extends from the Sierra Nevada into the Study Area. Global positioning system (GPS) geodetic strain rates currently indicate up to approximately 10 millimeters (mm) per year of dextral movement across the WL fault system (Kreemer and others, 2012) near the Study Area. The spatial and temporal evolution of the WL fault system is closely linked to major plate boundary events along the San Andreas Fault system. Unlike the San Andreas Fault, which is transpressional, the WL fault system consists of transtensional faults (Figure 2.8). Historically active faults, likely related to the WL, are known to exist in the Study Area as demonstrated by the 1954 fault scarp in the Dixie Valley (Slemmons, 1957; Bell and Katzer, 1987; Caskey and others, 1996).

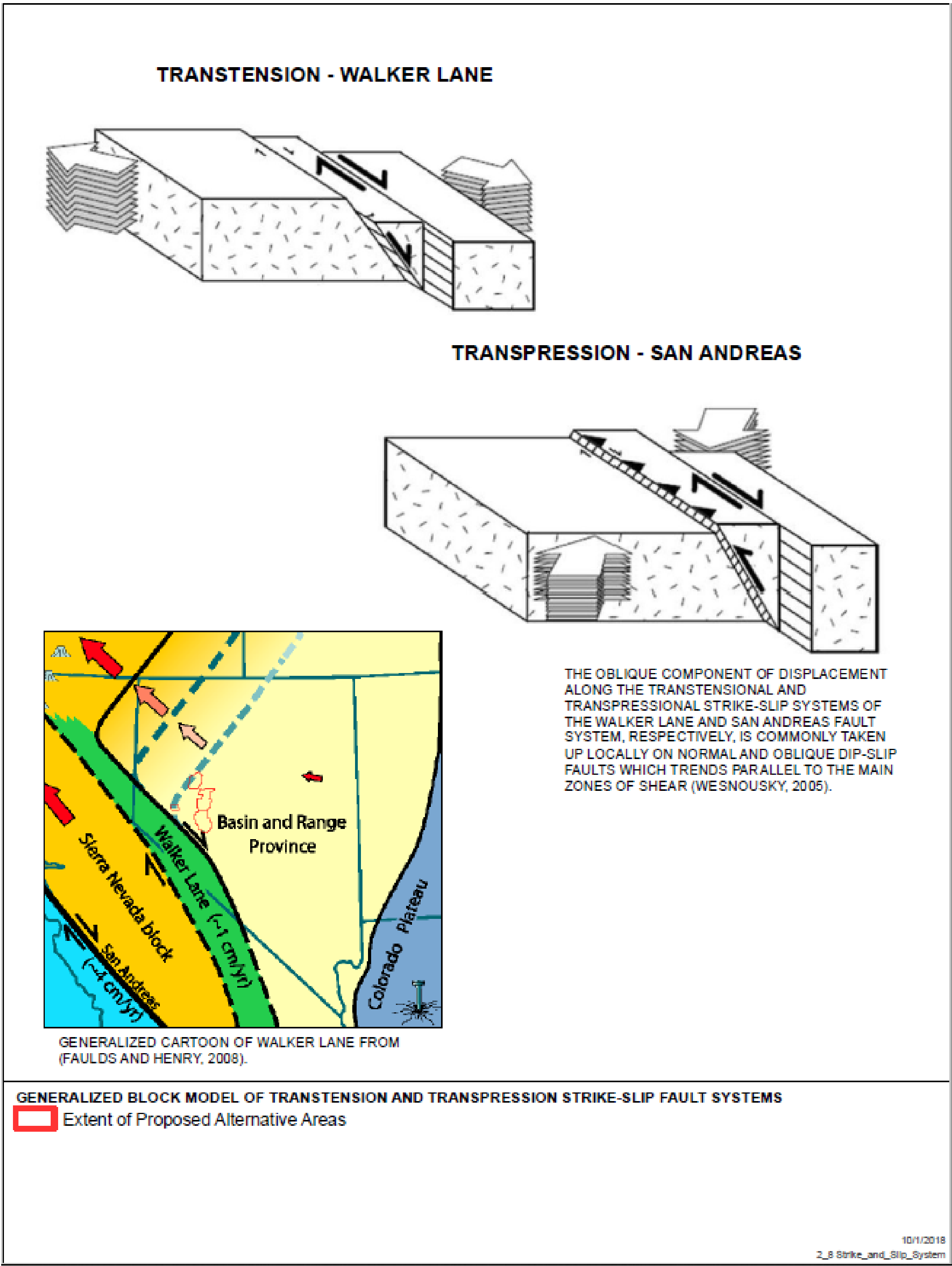


Figure 2.8: Generalized Block Model of Transtension and Transpression Strike-Slip Fault Systems

2.4 Geophysics

This section presents geophysical data that we have processed and presented with the intent of aiding in the assessment of the Study Area mineral potential.

2.4.1 Sources

Geophysical data for the MPR were obtained from publicly available sources. All data was accessed via the United States Geological Survey (USGS) Mineral Resources Online Spatial Data website in September 2018.

The geophysics data obtained for this report are large-scale composite gravity, total field magnetics, and radiometric surveys. Source data for these composites are primarily from regional airborne surveys, although some infill with higher resolution airborne and ground surveys may be possible. Resolution of the composite surveys can be as detailed as 1,000-meter grid points; however most of data was collected at coarser resolutions. Individual small-scale airborne magnetic surveys were also available. These surveys were reviewed for applicability; however, they did not provide significantly better resolution than composite data and consequently were not used for this assessment.

Ground-based magnetotelluric (MT), gravity, and seismic studies have also been completed in the Study Area for the purposes of determining geothermal potential. We did not reprocess the geothermal specific geophysics data however, we reference pertinent surveys when it supports determination of geothermal potential.

2.4.2 Processing and Presentation

Limited reprocessing of the geophysical data was performed. Post processing included re-projecting from the original datum and resampling to align with the highest resolution source. Gravity data (Kucks, 1999) was corrected for Bouguer anomalies and is presented in Figure 2.9. Total magnetic intensity data (Bankey and others, 2002) was corrected for the earth's magnetic field and secular variation using the International Geomagnetic Reference Field (IGRF) model and is presented in (Figure 2.10). Radiometric data are presented in maps showing equivalent thorium (eTh in parts per million [ppm]) (Figure 2.11), equivalent uranium (eU ppm) (Figure 2.12), and as percent (%) potassium (Figure 2.13).

The geophysical data sets are generally low resolution due to the regional level (i.e., widely spaced) data collection. Most of the geophysical surveys were performed using a fixed-wing aircraft, at high altitude, collecting geophysical lines that typically have a spacing greater than 1 kilometer (km). The coarse geophysical data acquisition results in large detection “footprints” that limits identification of geologic features to those that produce geographically large anomalies. As a result, the processed data sets (gravity, magnetic and radiometric) and subsequent interpretations are only valuable in discerning large-scale geologic features. As such, the interpretations presented herein are best used to corroborate relatively large-scale geologic features.

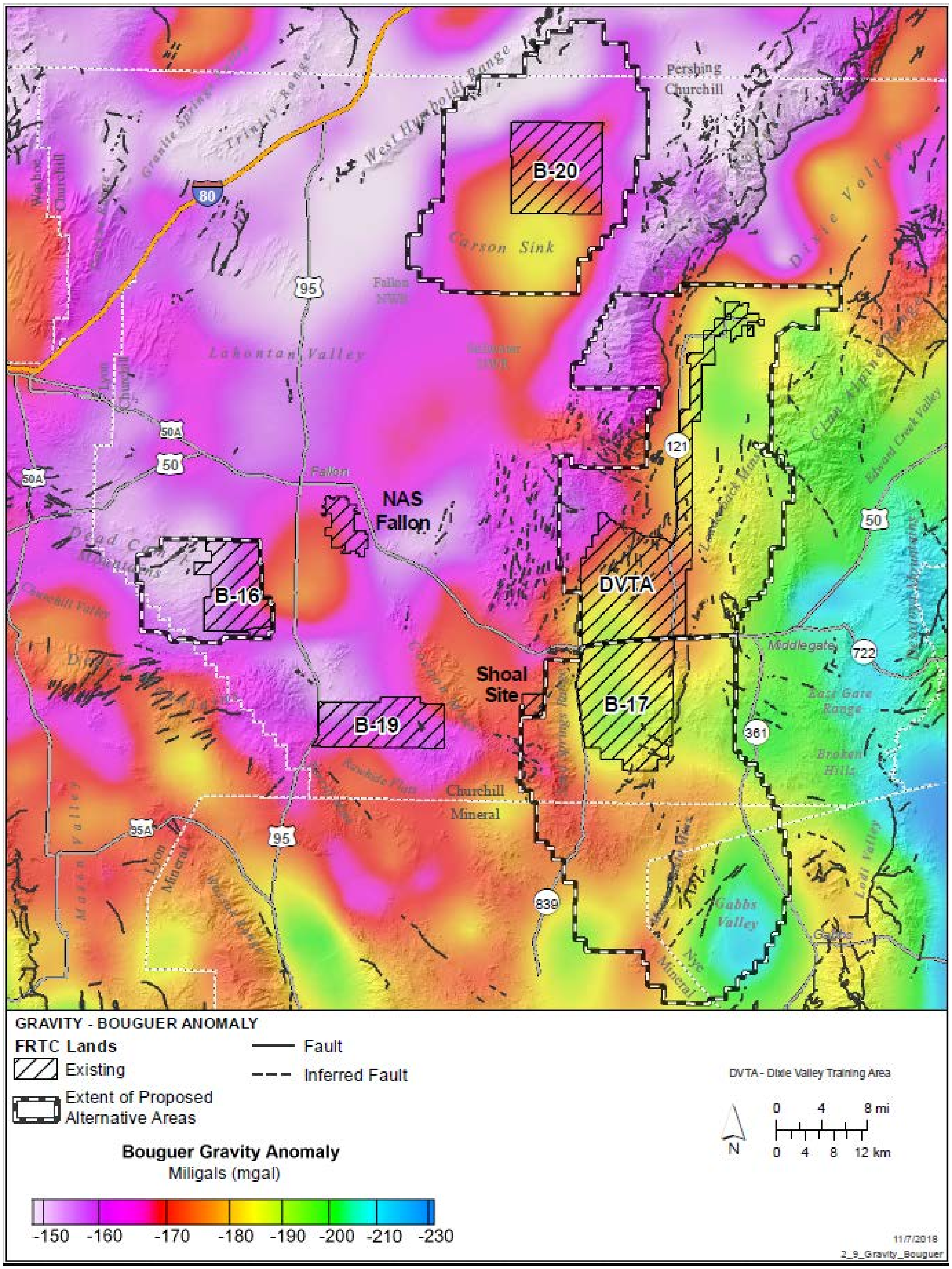


Figure 2.9: Gravity - Bouguer Anomaly

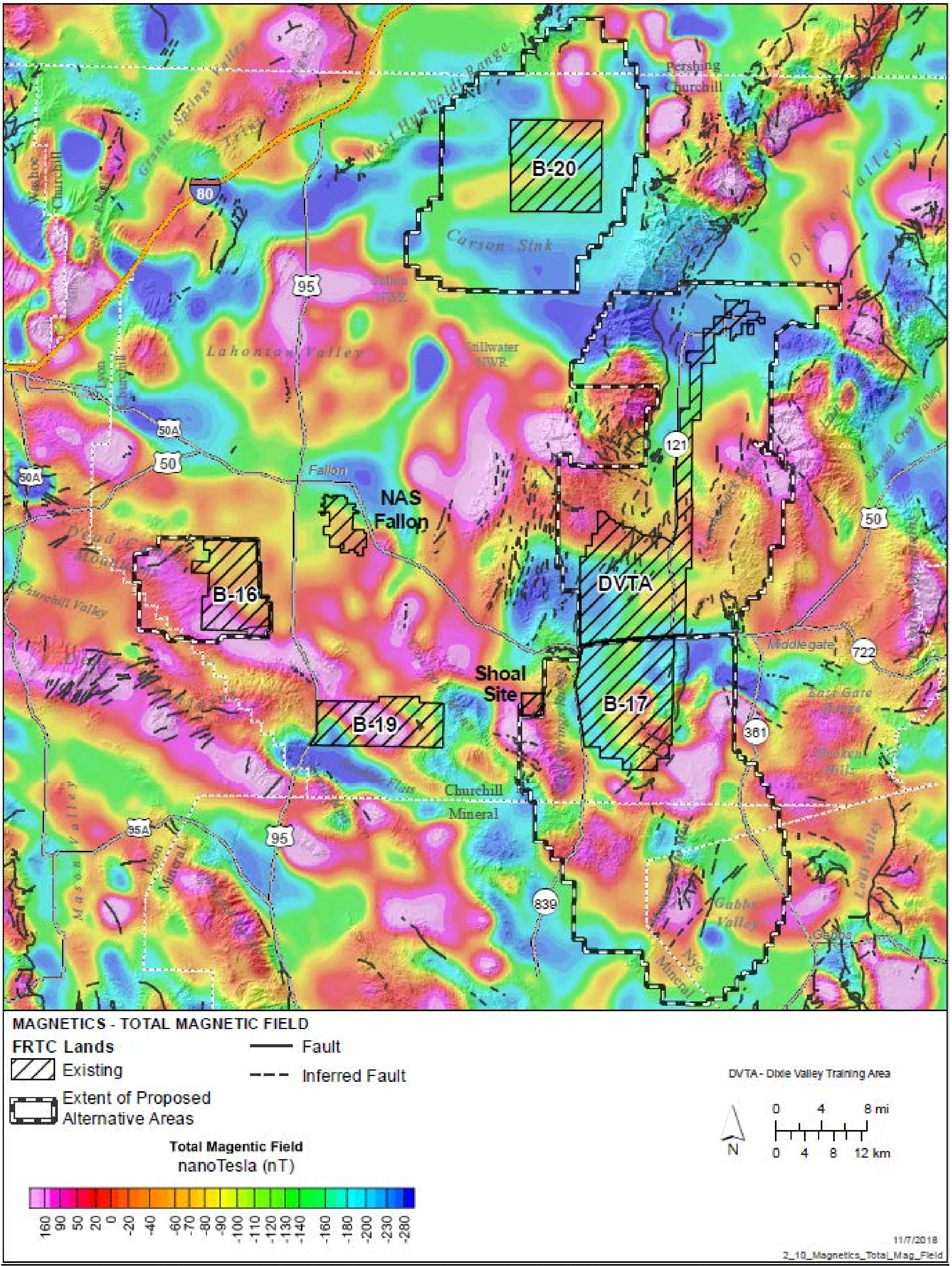


Figure 2.10: Magnetics - Total Magnetic Field

2.4.2.1 Gravity

The most conspicuous regional features on the Bouguer gravity map (Figure 2.9) are broad gravity highs in the mountain ranges and large gravity lows in basins. Gravity lows in basins mostly reflect the thickness and relatively low densities of sedimentary deposits in contrast to denser bedrock surrounding basins. There are no notable anomalies that alone may indicate a mineral potential.

2.4.2.2 Magnetics

Total magnetic field data show anomalies that are likely related to known geology. For example, basalt of the Dead Camel Mountains corresponds to a magnetic high. Some buried features may be interpreted from the magnetic data. One example is the apparent westward continuation of a magnetic high from mafic rocks on the western flank of the Stillwater Range that extends underneath the Carson Sink and connects back to the West Humboldt Range.

A northwest trend of alternating bands of magnetic highs and lows, which cut across topography and lithological units is observed in the total field magnetic data (Figure 2.10). The best example of this pattern is observed cutting across Dixie Valley from the Clan Alpine Mountains through the center of the Stillwater Range, and continuing into the Carson Sink. This orientation is orthogonal to the dominant, northeast-trending structural fabric defined by basin-and-range extensional faulting in the Study Area. The northwest trending magnetic bands do however, roughly correspond to a set of northwest-trending faults. The magnetic bands display a sharp gradient on their margins, which indicates a dramatic change in magnetic intensity over a short distance, which is consistent with the interpretation that these features are fault-related.

2.4.2.3 Radiometrics

Central and western Nevada is characterized as having higher detectable concentrations of naturally occurring radioactive elements (thorium [Th], uranium [U] and potassium [K]) in airborne surveys. This is in large part due to geology and minimal attenuation from the lack of vegetation. In general, the airborne concentrations are within expected ranges for normal, non-uranium or thorium-bearing rocks. Elevated potassium levels may simply reflect the presence of potassium-rich rocks, e.g., siliceous volcanic and granitic rocks. Elevated levels and ratios may warrant future study or be used to help better define geology.

2.4.2.4 Geophysics for Geothermal Resources

Various geophysical studies by others used one or multiple techniques, including: seismic reflection, seismological (i.e., earthquake), gravity, and magentotellurics to determine geothermal potential. The application of this data is discussed in Section 4.2.1. Of particular interest was the use of magnetotelluric studies to identify upwelling saline waters that are indicative of geothermal potential.

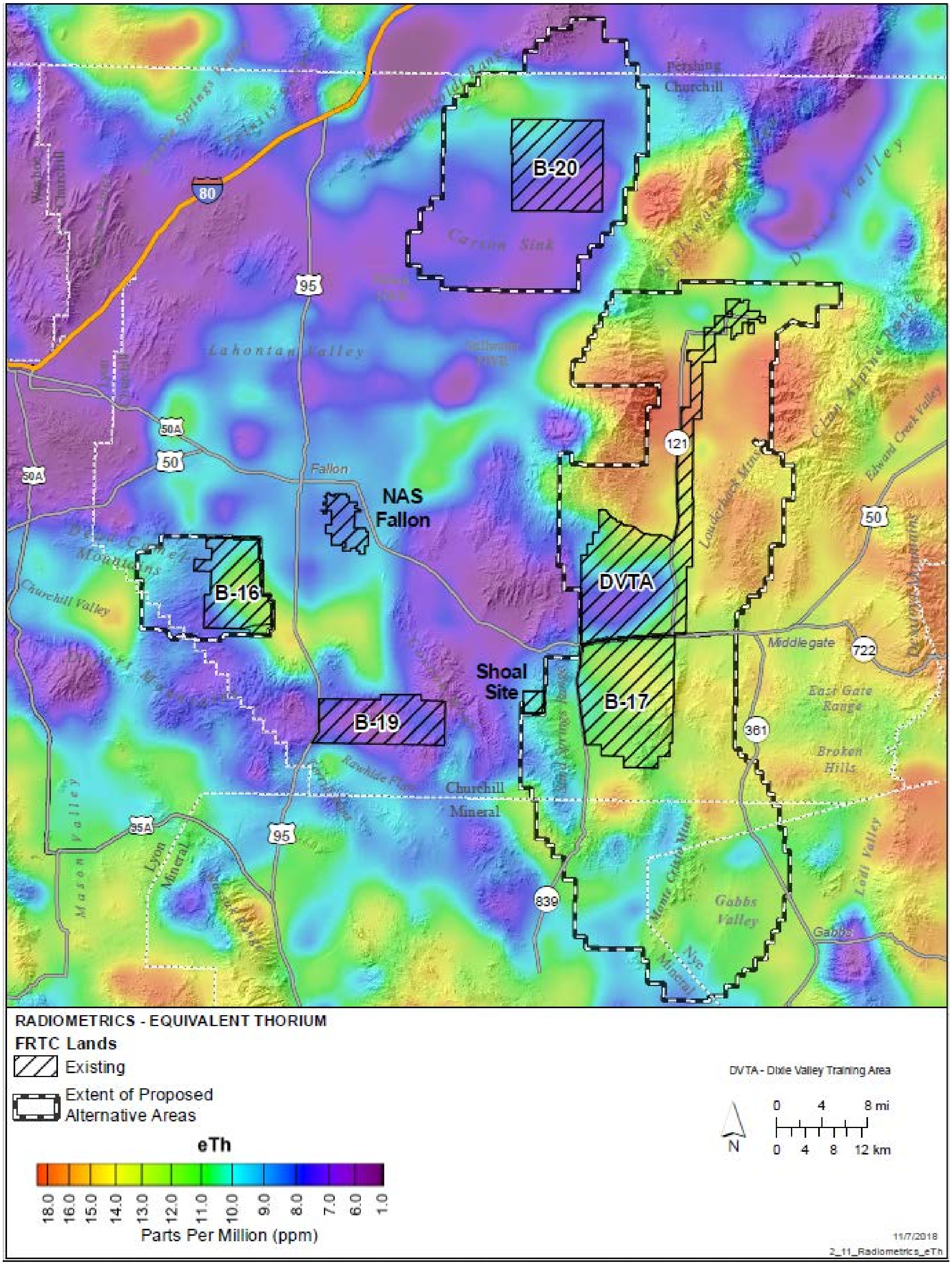


Figure 2.11: Radiometrics - Equivalent Thorium

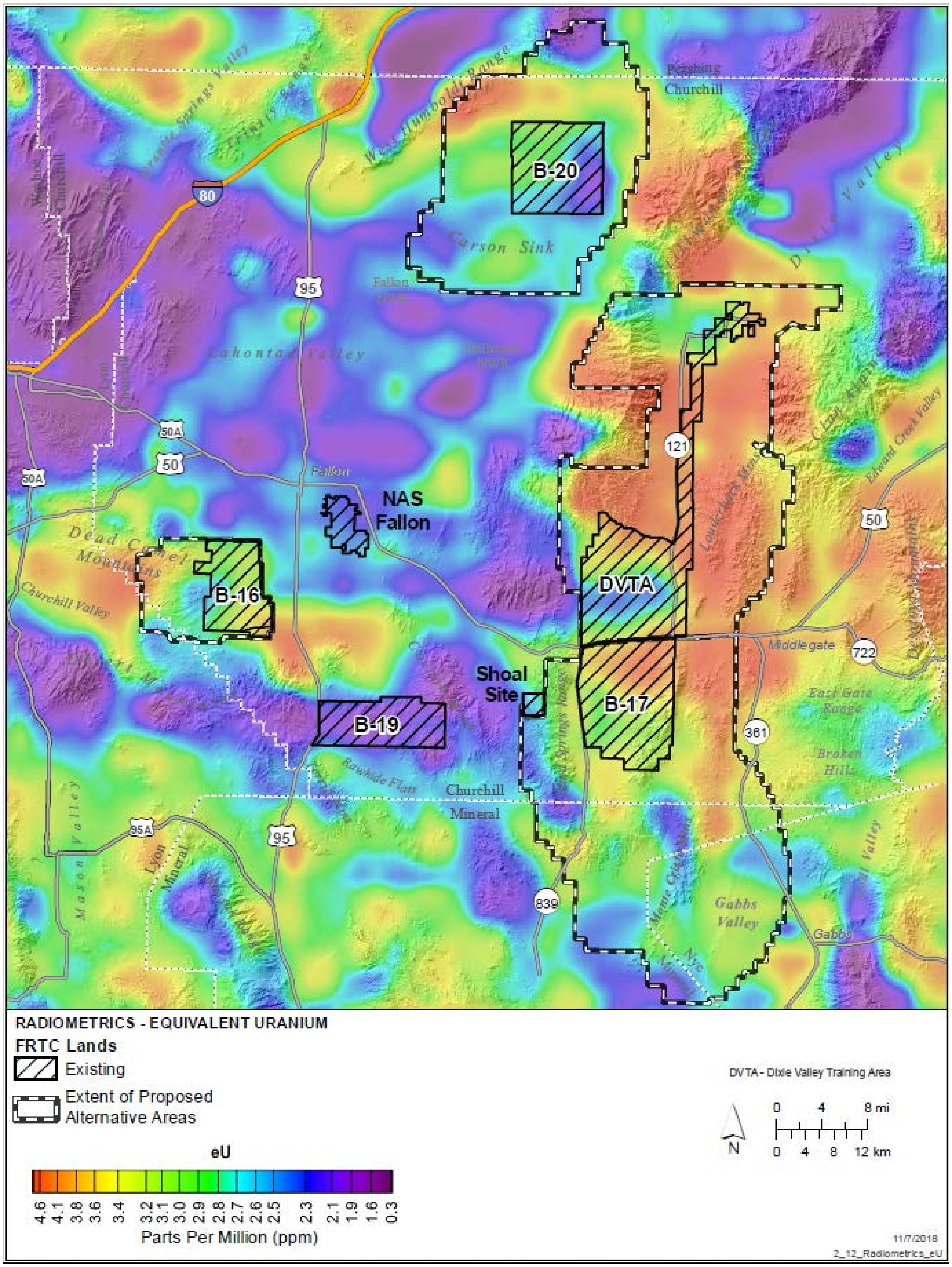


Figure 2.12: Radiometrics - Equivalent Uranium

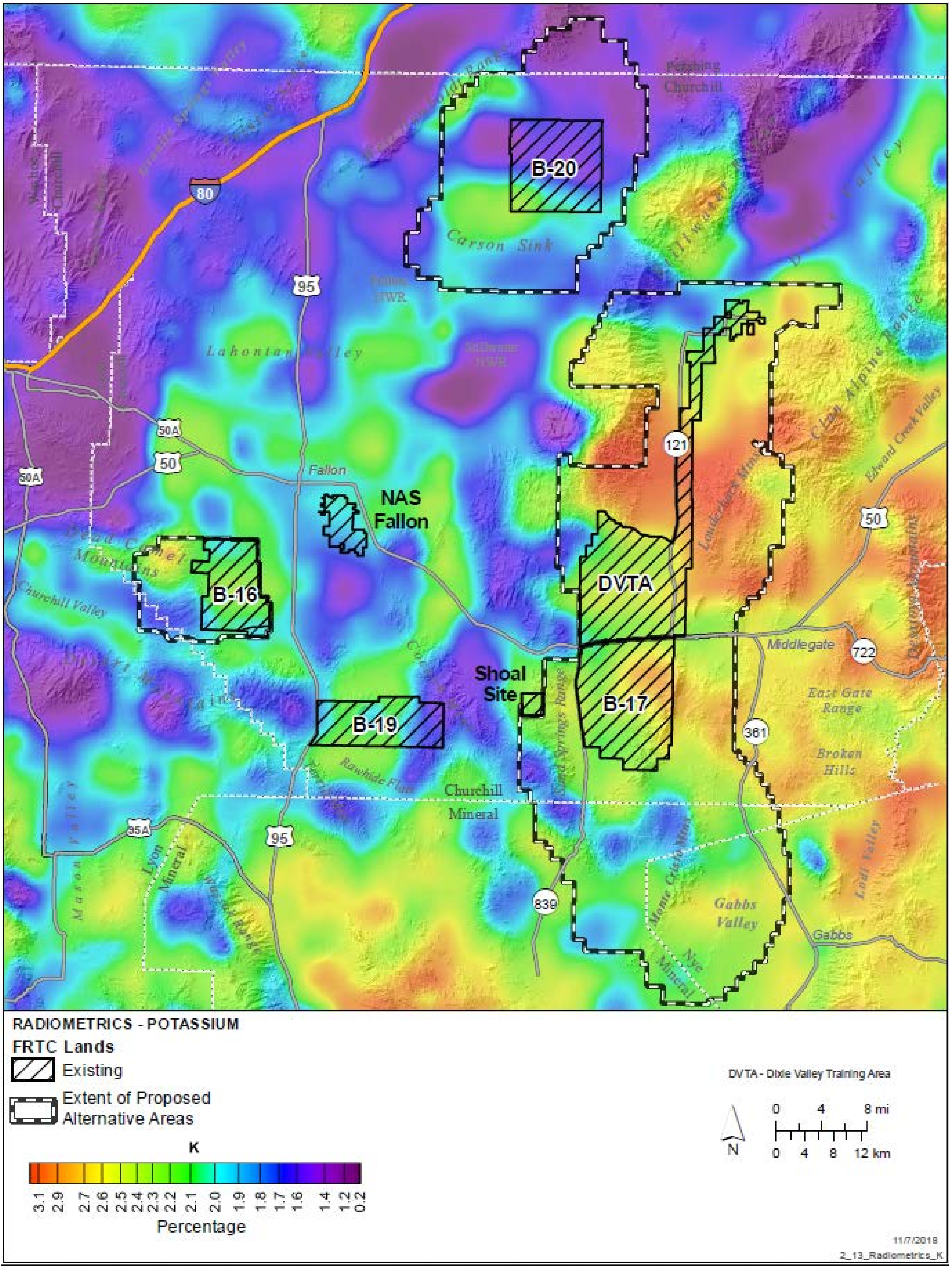


Figure 2.13: Radiometrics - Potassium

2.5 Geochemistry

This section presents publicly available geochemical data that have been processed and presented to aid in the assessment of the Study Area mineral potential.

2.5.1 Locatable Metallic Minerals

Geochemical data for the assessment of metallic minerals in this MPR were obtained from publicly available sources. Two digital, georeferenced databases from the USGS were used for the geochemical assessment: The National Uranium Resource Evaluation (NURE) dataset and the PLUTO dataset.

Two additional, Study Area specific, geochemical dataset were identified in the research for this report: Appendix C of Tingley (1990), which includes geochemical assay data of samples taken from districts within the Study Area; and Appendix C of Quade and Tingley (1987), which includes geochemical assay data of samples taken from districts within the existing withdrawal area. Neither of these data sets have been converted into digital databases, which are available for statistical interrogation. As a result, neither dataset were incorporated into the geochemical analysis of this MRP.

2.5.1.1 National Uranium Resource Evaluation (NURE)

Geochemical data were collected by the USGS as part of the NURE program from 1976-1980. The program consisted of analyzing sediment, soil, and water samples with a focus on uranium, but up to 58 other elements were also analyzed as part of the study. However, as the focus was on uranium, samples were not routinely analyzed for trace metals typically associated with ore vectoring studies such as base and precious metals.

The NURE dataset consists of samples collected within the conterminous United States, but only samples that fell within a mile radius of the FRTC boundary were selected (Figure 2.14). After spatial filtering, the NURE dataset used for this study consisted of 752 samples. Additional filtering was performed to use only elements from the NURE data set that were also available in the PLUTO dataset (Section 2.5.1.2). This resulted in 26 elements being included from the NURE data set. NURE data used in this assessment is included in Appendix A.

2.5.1.2 PLUTO

Geochemical data were collected by the USGS as part of the PLUTO program from 1960-1995. Similar to the NURE program, the PLUTO program collected samples from the conterminous United States in support of various USGS geochemical surveys. Because the PLUTO database represents an amalgam of data from multiple geochemical surveys, samples were not always analyzed for the same elements nor elements relevant to ore vectoring studies such as base and precious metals.

To be consistent with the NURE dataset, only PLUTO samples that fell within the FRTC boundary were selected and only elements that were contained in both datasets were used. This resulted in 107 samples of 26 elements from this dataset (Figure 2.14). PLUTO data used in this assessment is included in Appendix A.

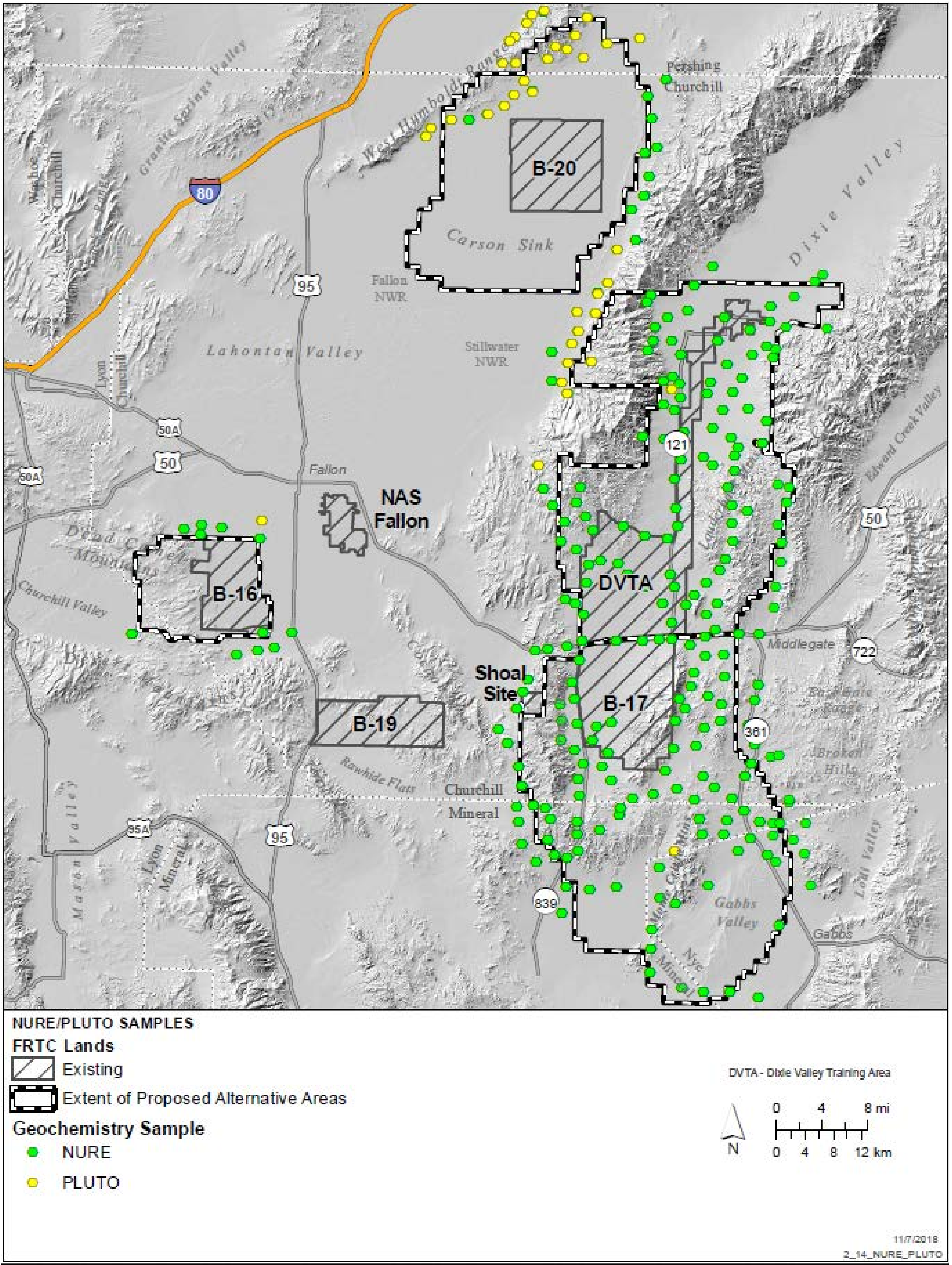


Figure 2.14: PLUTO/NURE Distribution Map

2.5.1.3 NTTR Geochemical Sampling Program

A geochemical sampling program was conducted at the Nevada Testing and Training Range (NTTR) as part of the 1998 Mineral and Energy Resource Assessment (Tingley and others 1998). This geochemical sampling program collected three types of samples: geochemical characterization samples (GSC), mineralized area samples (MA), and silt and float samples. GSC samples were collected from non-mineralized "typical" outcrops and were intended to represent a "background" geochemical signature of the area. Tingley and others (1998) further divided the GSC samples into three sets, which represented three distinct geologic provinces within the NTTR boundaries: a Cenozoic zone based on the predominance of Tertiary volcanics; a Paleozoic zone based on the predominance of pre-Cambrian to Permian carbonate rocks; and a Transition zone representing the area between the two distinct geologic areas.

The present study uses the GSC data from the NTTR Cenozoic zone to determine the background geochemical signature of the FRTC for metallic minerals. The use of a proxy geochemical data set is possible because the Cenozoic geology of the NTTR is reasonable analogue of the geologic environment where metallic mineral deposits are encountered in the FRTC.

2.5.1.4 Methods

Single-element geochemical anomalies (SEA) were used to provide a quantitative basis for mineral potential evaluation. This method relies on establishing baseline concentrations for selected elements. Due to the lack of a baseline geochemical survey within the FRTC boundary, or expansion boundary areas, a surrogate geochemical data set was used to determine the baseline values for the SEA calculations.

The SEA evaluation relied on comparison of the combined NURE/PLUTO geochemical data to the NTTR Cenozoic baseline. An anomalous concentration is defined as exceeding a 'threshold' value of the NTTR Cenozoic median plus three standard deviations for that particular element. Table 2.1 presents the threshold values used for the SEA calculations in this study. NURE and PLUTO samples that exceeded the calculated thresholds were plotted on maps and the watersheds above the sample locations were highlighted to indicate the anomalous value. SEA maps were produced for the following elements: cobalt, copper, lead, tungsten, and zinc (Figure 2.15 through Figure 2.19).

Table 2.1: Threshold Values for Single Element Anomalies (SEA)

Element	Median	Standard Deviation	Threshold FRTC 2018
Co	2.5	5.91	20.23
Cu	3.44	6.28	22.28
Li*	64	87.55	326.66
Pb	4.48	19.86	64.06
W	3	3.22	12.66
Zn	27.4	34.23	130.09

Notes: Source is Tingley and others (1998) geochemical database.
*Li data compiled from Davis (1976), and Bohannon and Meier (1976)

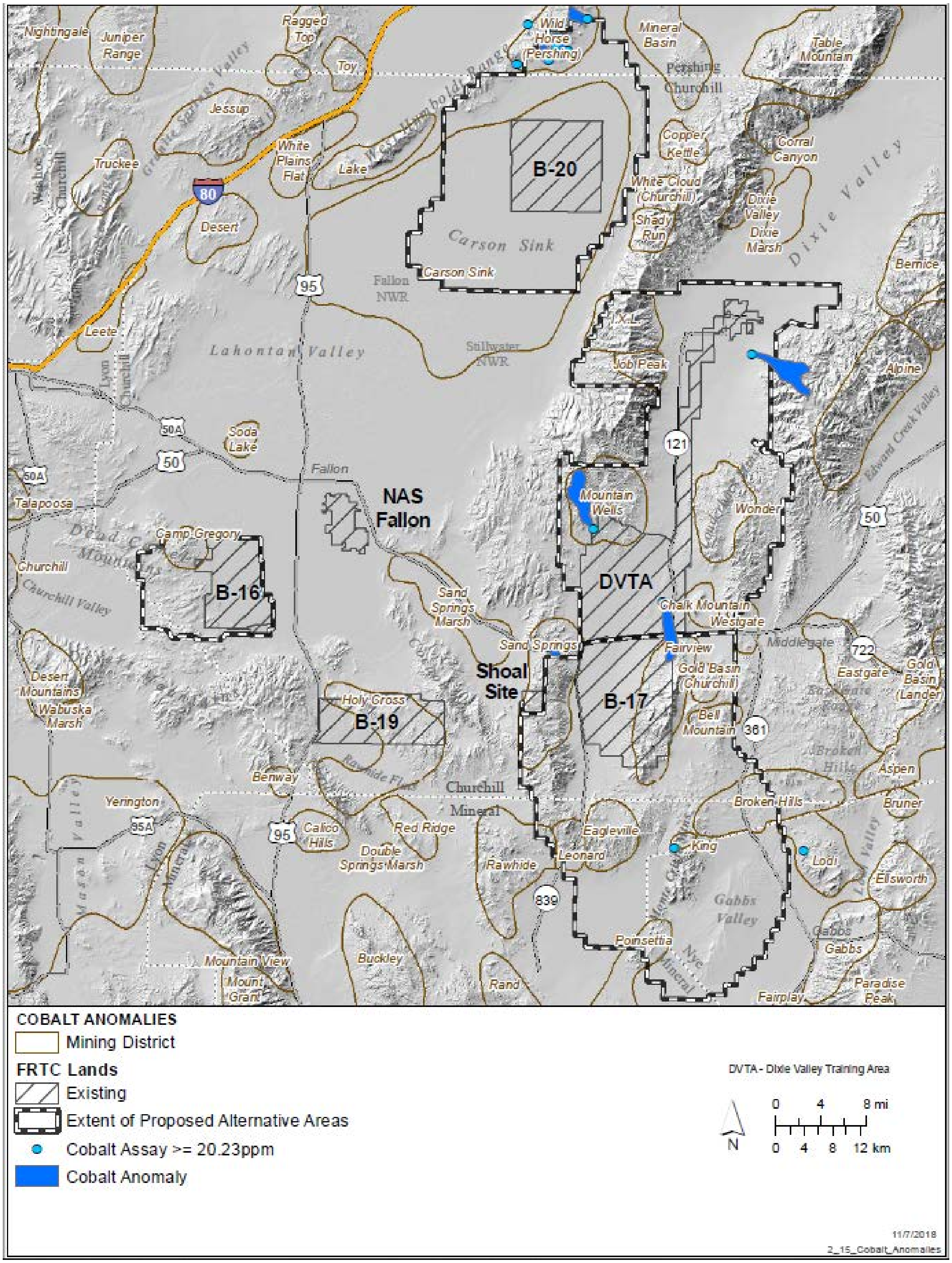


Figure 2.15: Cobalt Anomalies

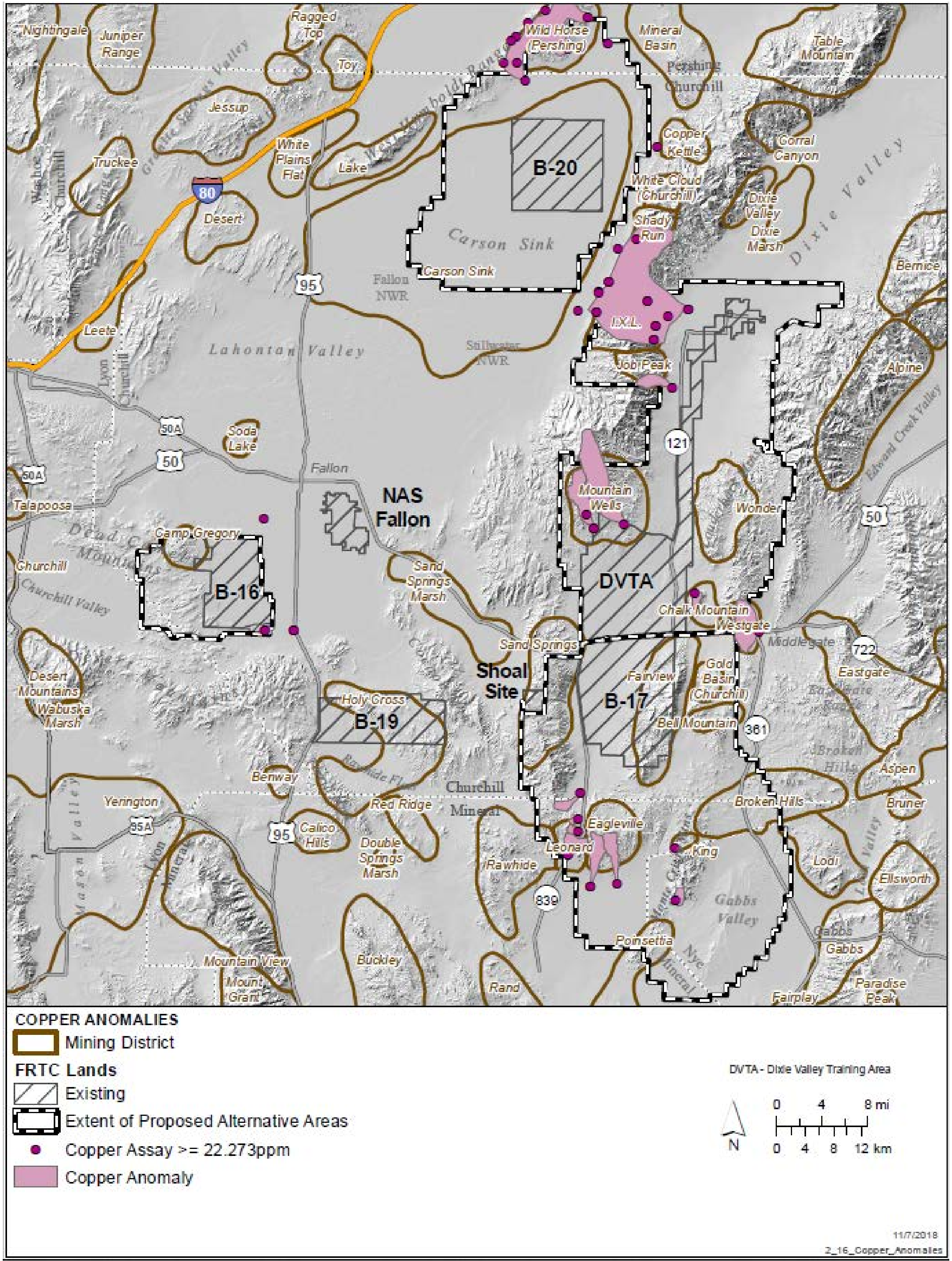


Figure 2.16: Copper Anomalies

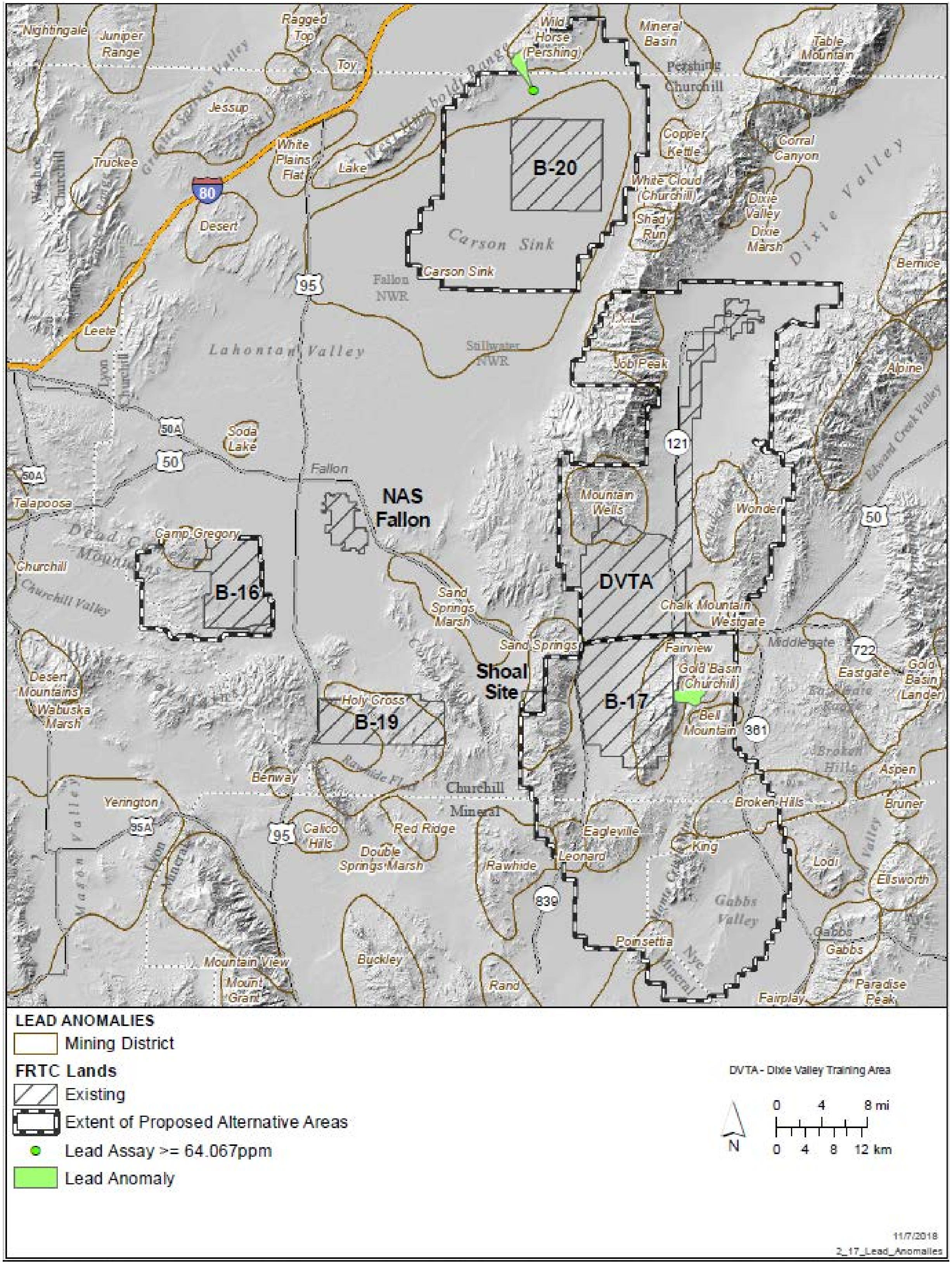


Figure 2.17: Lead Anomalies

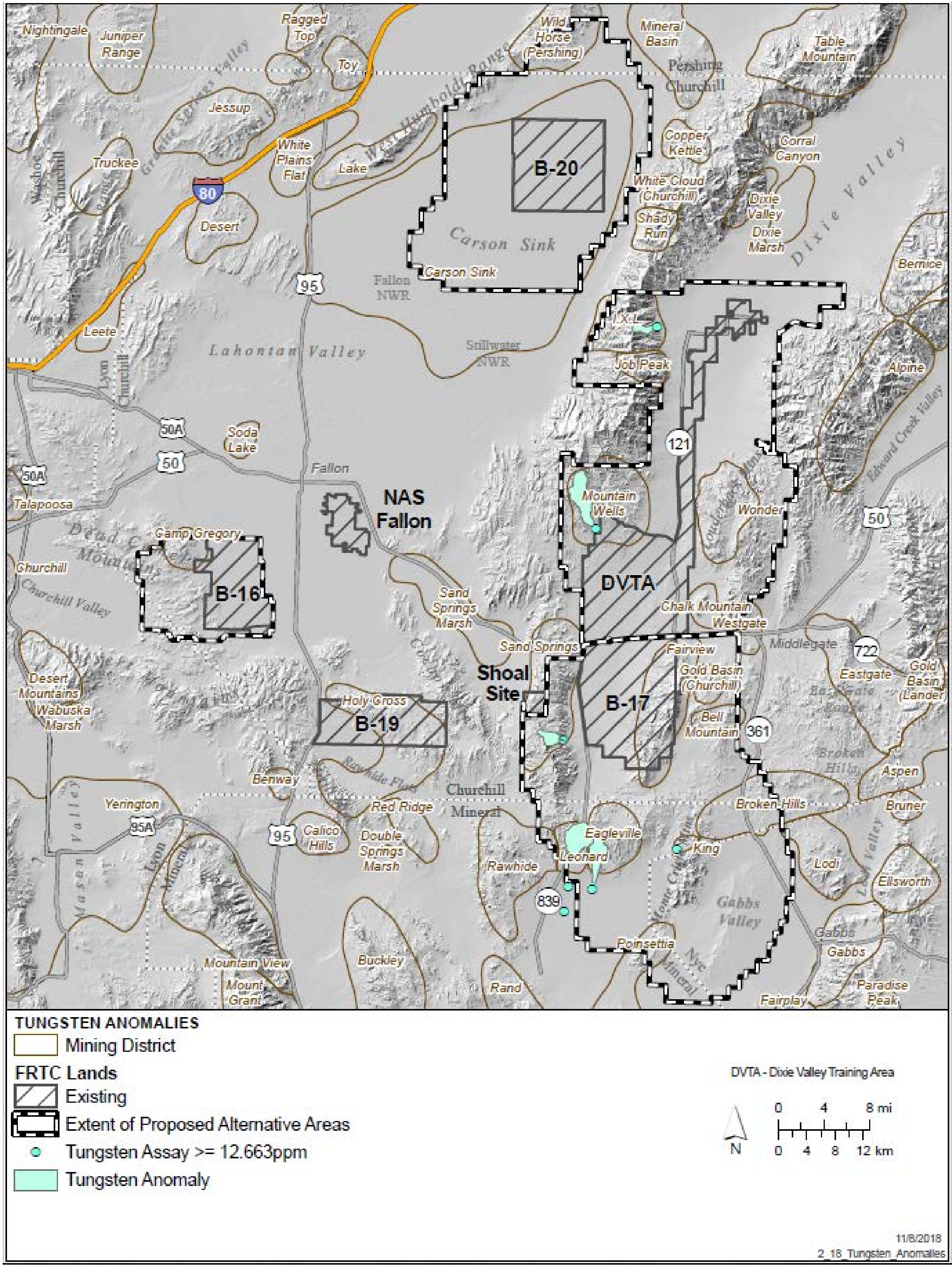


Figure 2.18: Tungsten Anomalies

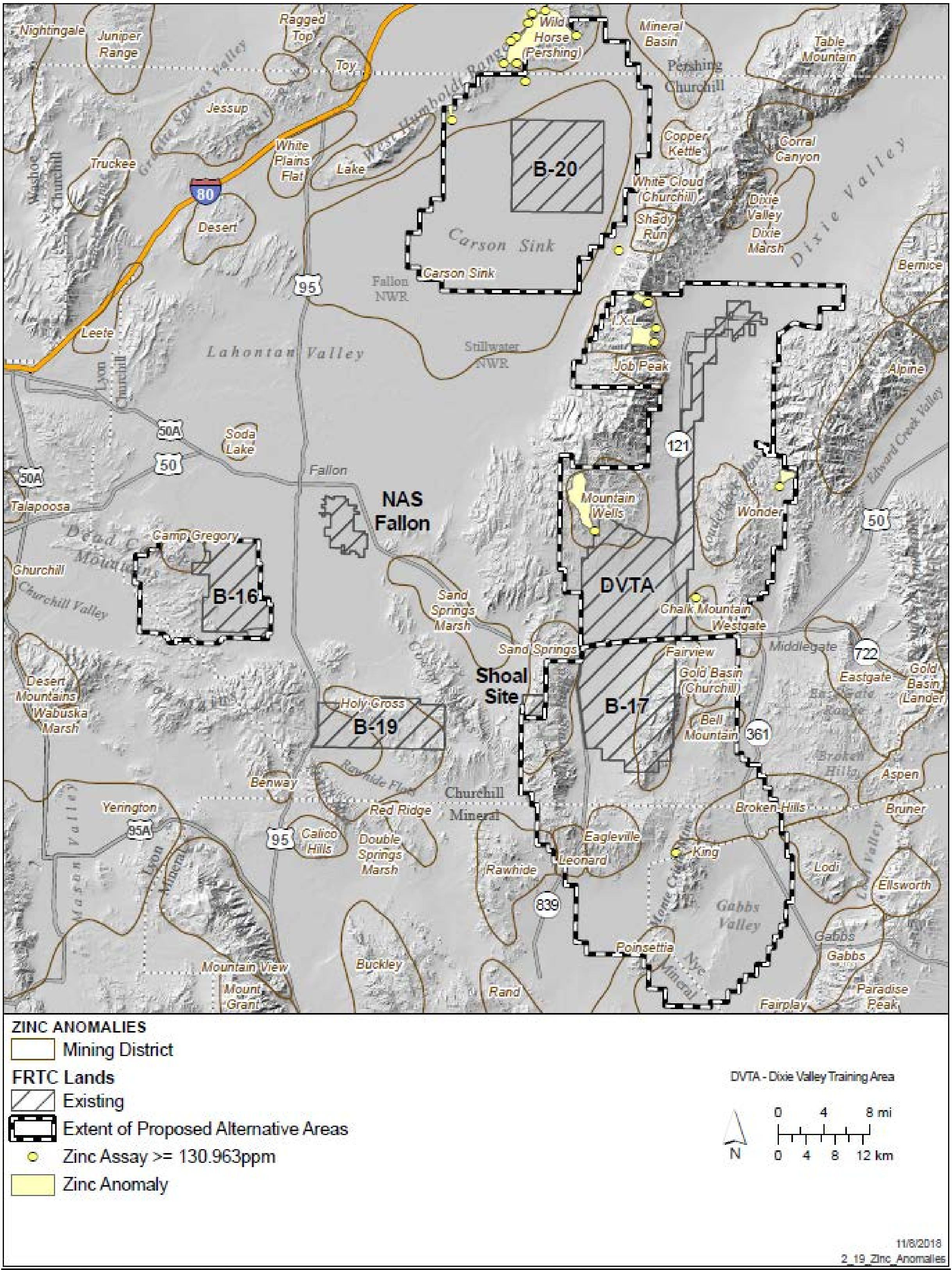


Figure 2.19: Zinc Anomalies

2.5.2 Lithium

The coming subsections discuss playa geochemical sources and groundwater geochemical sources, respectively.

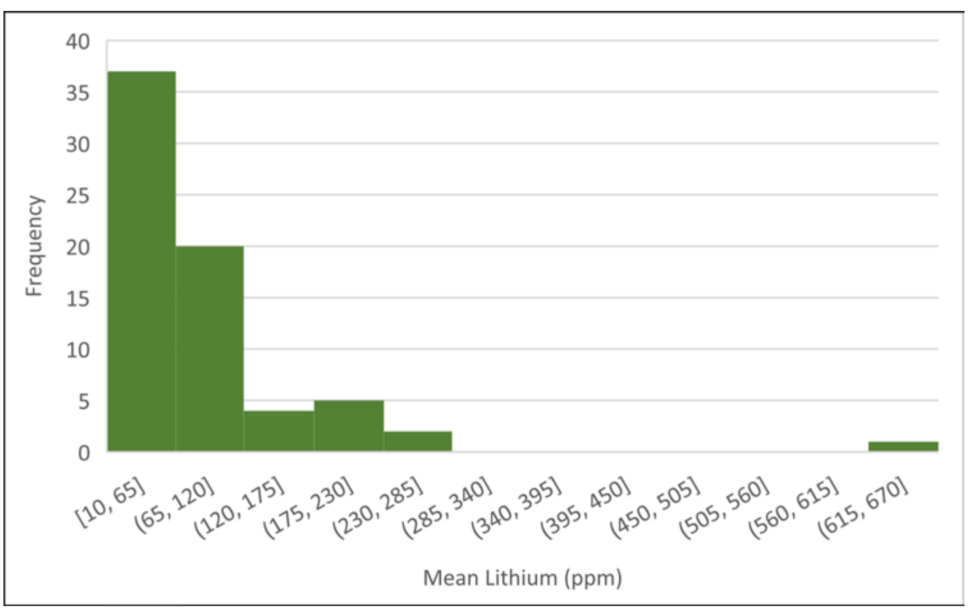
2.5.2.1 *Playa Geochemical Sources*

The NTTR Cenozoic zone GSC sample set is not an accurate analogue of the geochemical environment where lithium deposits occur (see Section 3.2.3 for a detailed discussion on lithium deposit models). For this reason, geochemical data from two dedicated lithium occurrence studies were used to develop the threshold for lithium anomalies. The studies are: Davis (1976), which sampled sediments from 41 playa deposits throughout the basin and range province, and Bohannon and Meier (1976), which sampled sediments from 58 playas in Nevada.

Davis (1976) collected a total of 156 surface sediment samples from 41 different playas throughout the basin and range province to study the influence of drainage basin size on lithium concentrations in the playas. Bohannon and Meier (1976) conducted reconnaissance geochemical sampling of playa sediments from 58 playas within Nevada to determine if areas of anomalous lithium could be identified by surface sampling techniques. Both studies sampled sediments from the upper 6ft of playas using hand augers and occasionally trenching with a back-hoe.

Golder combined these two data sets, eliminating data points which were not taken from playas. Often more than one location within a playa was sampled; in these cases Golder reported the mean value and the number of samples for each playa system. Where playas were sampled by both studies a weighted average of the two mean values is reported. The combined data sets represent 344 individual samples from 69 playas throughout the basin and range province (Appendix B). Golder used this data set to calculate the threshold for anomalous lithium using the same methodology described in Section 2.5.1; the median value + 3 x standard deviation. Applying this method, the threshold for anomalous lithium in basin and range playas is 326.66 ppm. No sample within the Study Area from any of the geochemical datasets presented in this study: Davis (1976), Bohannon and Meier (1976), and NURE/PLUTO) exceeds this threshold value. See Figure 2.20 for a histogram of the lithium contents in the playas.

Figure 2.20: Histogram of Mean Lithium in Basin and Range Playa Sediment Samples



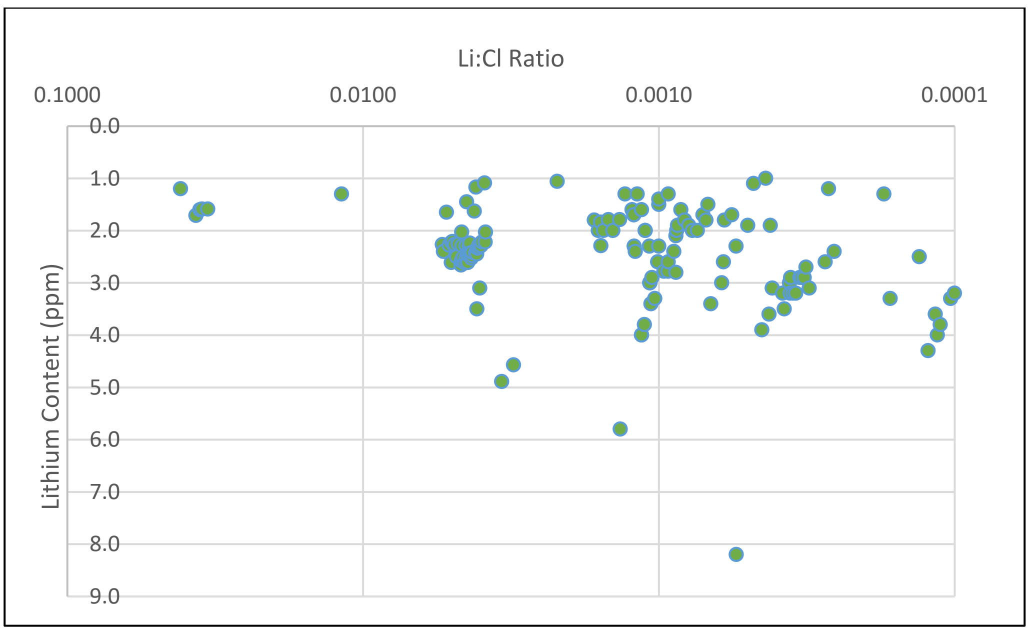
2.5.2.2 Groundwater Geochemical Sources

In addition to lithium-bearing clay and carbonate deposits, lithium deposits can take the form of sub-surface lithium-enriched brines. Section 3.2.3.2 describes the model for lithium-enriched brine deposits. To assess the potential for lithium-enriched brines it is necessary to analyze the geochemistry of the groundwater in playas, the geological environment where lithium-enriched brine deposits form. In addition to the lithium content of groundwater, the lithium to chlorine (Li:Cl) ratio is also an important indicator of potential for lithium brine formation. High Li:Cl ratios occur in hot spring environments associated with silicic volcanism. Source waters with a relatively high Li:Cl ratio have the potential to become enriched in lithium when concentrated by evaporation to the point where NaCl precipitates (Vine, 1980)

Groundwater geochemical data for the Study Area was obtained from the NBMG's online Great Basin Groundwater Geochemical Database (GBGGD). The GBGGD contains geochemical data from over 47,500 samples collected throughout the Great Basin. For this study, only wells located within one of the valleys, which occur within the Study Area and contained lithium and chlorine data were considered. There were 143 samples, which met those criteria (Appendix C). Figure 2.21 displays the relationship between Li concentration (ppm) and the ratio of lithium to chlorine (Li:Cl), this chart is referenced in Section 4 in the discussion on lithium-enriched brine potential.

None of the wells in either of these two data sets have a lithium concentration greater than 8.2 ppm, which is at least an order of magnitude below the lower limit of economic lithium brines. However, there are wells whose Li:Cl ratios are favorable for lithium concentration, see Section 4.1.2.5.2 for a discussion on lithium potential in relation to Li:Cl ratio.

Figure 2.21: Lithium Content and Li:CL Ratio



2.5.3 Geochemical Results

The geographic distribution of SEAs and the groundwater geochemical analysis is discussed further in Section 4.0. In that section, the geochemical results are used in conjunction with other geologic, and historical production information to develop the mineral potential assessments for locatable minerals.

3.0 DESCRIPTION OF KNOWN MINERAL AND ENERGY RESOURCES

This section describes the historic and known mineral and energy resources including locatable, leasable, and salable minerals in the Study Area.

3.1 Mining Claims (locatable), Leases (leasable), and Material Sites (salable)

The BLM classifies minerals and energy for development into three categories:

- **Locatable**
- **Leasable**
- **Salable**

The following section describes the mineral and energy claims as they pertain to the three BLM categories.

3.1.1 Locatable

Locatable minerals are those for which the right to explore, develop, and extract on federal land open to mineral entry is established by the location (or staking) of lode or placer mining claims (General Mining Law of 1872, as amended). Locatable minerals are divided into metallic minerals and industrial minerals. Examples of metallic minerals include: gold, silver, copper, molybdenum, tungsten, iron, and uranium. Examples of industrial minerals include: gypsum, barite, diatomite, fluorspar, lithium and sulfur. This section discusses “unpatented” and “patented” mining claims. An “Unpatented” mining claim is federal land for which an individual or company has leased the rights to explore, develop, and extract minerals. Whereas “Patented” mining claims are private land where the owner has demonstrated a known viable economic resource.

Figure 3.1 shows the density of active unpatented mining claim listings per section for locatable minerals for the entire Study Area, as of June 2018 (http://data-ndom.opendata.arcgis.com/pages/frtc). The Nevada Division of Minerals (NDOM) uses data from the BLM’s LR2000 claim records to track the claim listings per section. Claim maps are filed at both the county recorder’s office and at the Nevada BLM State Office in Reno. As of June 2018, there were approximately 1,117 active unpatented claim listings within the Study Area. Mining claims filed by more than one claimant, and mining claims, which cross sections lines are given multiple listings in the BLM LR2000 system even though they represent the same claim. This report presents active mining claim listings, which likely represents an overestimation of the active mining claims in the Study Area.

Claims types include, lode, placer and mill site claims. Lode claims can be as large as 20.1 ac with dimensions not to exceed 600 by 1,500 feet. Placer claims can be as large as 20 ac with a special stipulation that association claims, that include between 2 to 8 members, can stake claims that are two to eight times larger than a claim staked by an individual (i.e. a two-member association can stake a claim that is 40 ac and an eight-member association can stake a claim that is 160 ac). Mill site claims are 5 ac in size. According to Mike Visher, the Deputy Administrator of the NDOM, (verbal communication, September 29, 2018), there are eight placer claims (none of which are association claims) and nine mill site claims in the Study Area. The remaining claims are lode claims.

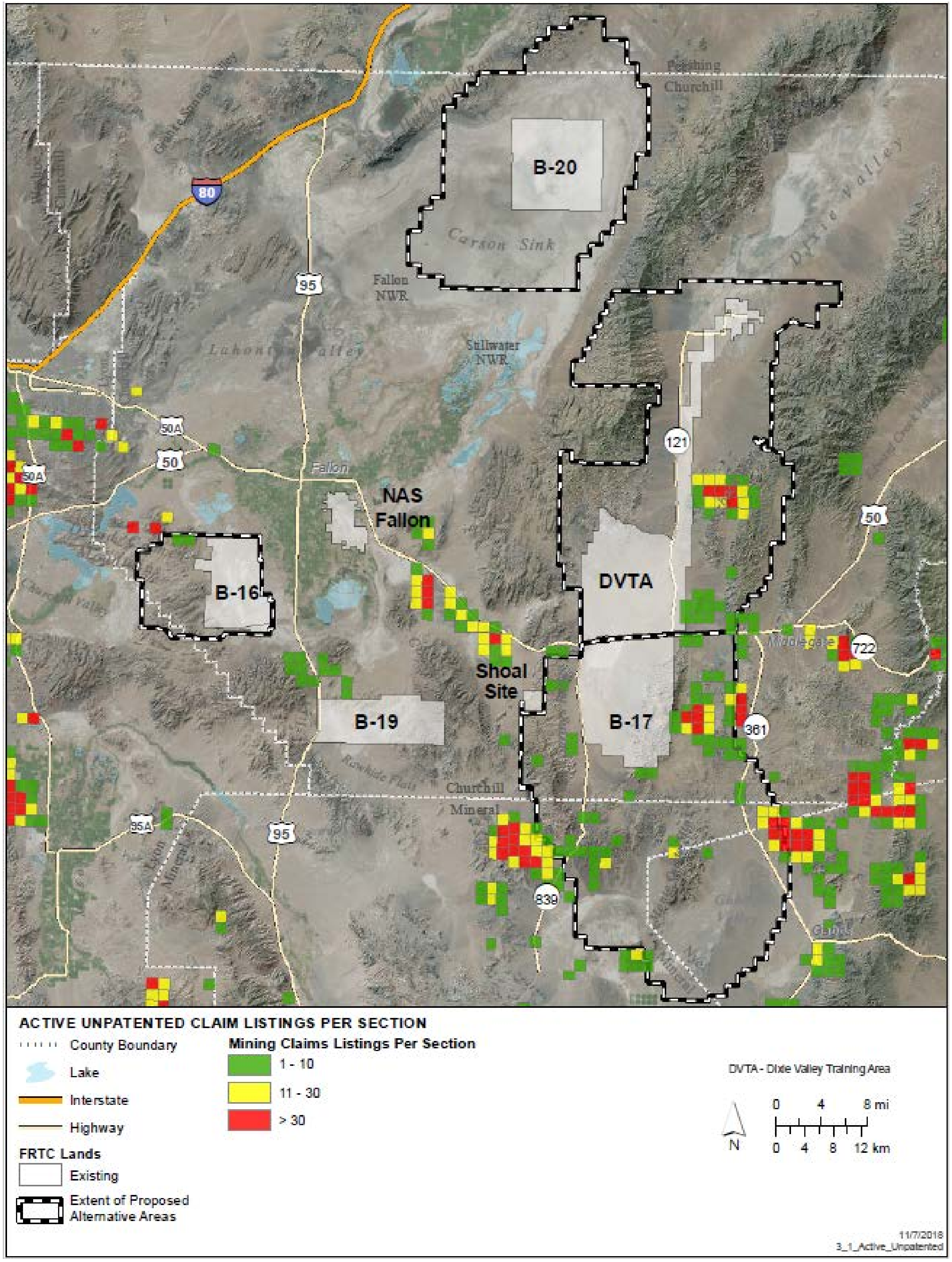


Figure 3.1: Active Unpatented Claim Listings per Section

Figure 3.2 through Figure 3.5 shows the number of claim listings in each section for each of the Study Area ranges. In summary, the total number of active unpatented claim listings for each range/area (including existing and proposed withdrawal areas) is as follows:

- B-16: Eight active unpatented claim listings
- B-17: 730 active unpatented claim listings
- B-20: Two active unpatented claim listings
- DVTA: 377 active unpatented claim listings

Patented mining claims are private land that represent land, which had, at least at the time of patented application, a known viable economic resource. Five of the mineral districts included in the Study Area have patented mining claims. The patented claims are summarized below in Table 3.1.

Table 3.1: Patented Mining Claims

Mining District	Study Area (range/area)	Number of Claims	Total Acreage
Leonard	B-17	4	76
Wonder Mountain	DVTA	80	1,167
Chalk Mountain and Westgate	DVTA	3	40
Fairview	DVTA	8	135
I.X.L/Job Peak	DVTA	9	135

3.1.2 Leasable

Leasable minerals defined by the Mineral Leasing Act (February 1920; and 43 CFR 3000-3599, 1990) include the subsets leasable solid and leasable fluid minerals. Since 1920, the Federal government has leased fuels and certain other minerals, charging a royalty on the value of the mined and sold material. Today, solid minerals subject to lease include coal, oil shale, native asphalt, phosphate, sodium, potash, and potassium. Leasable fluid minerals include oil, gas, coal bed natural gas and geothermal. The BLM has developed rigorous guidelines to be used in development of a Resource Management Plan (RMP) for Fluid Minerals that are described in BLM Handbook H-1624-1, Planning for Fluid Mineral Resources (BLM, 1990). This handbook is supplemented by Information Memorandum No. 2004-089 (BLM, 2004) that presents the BLM's Policy for Reasonably Foreseeable Development (RFD).

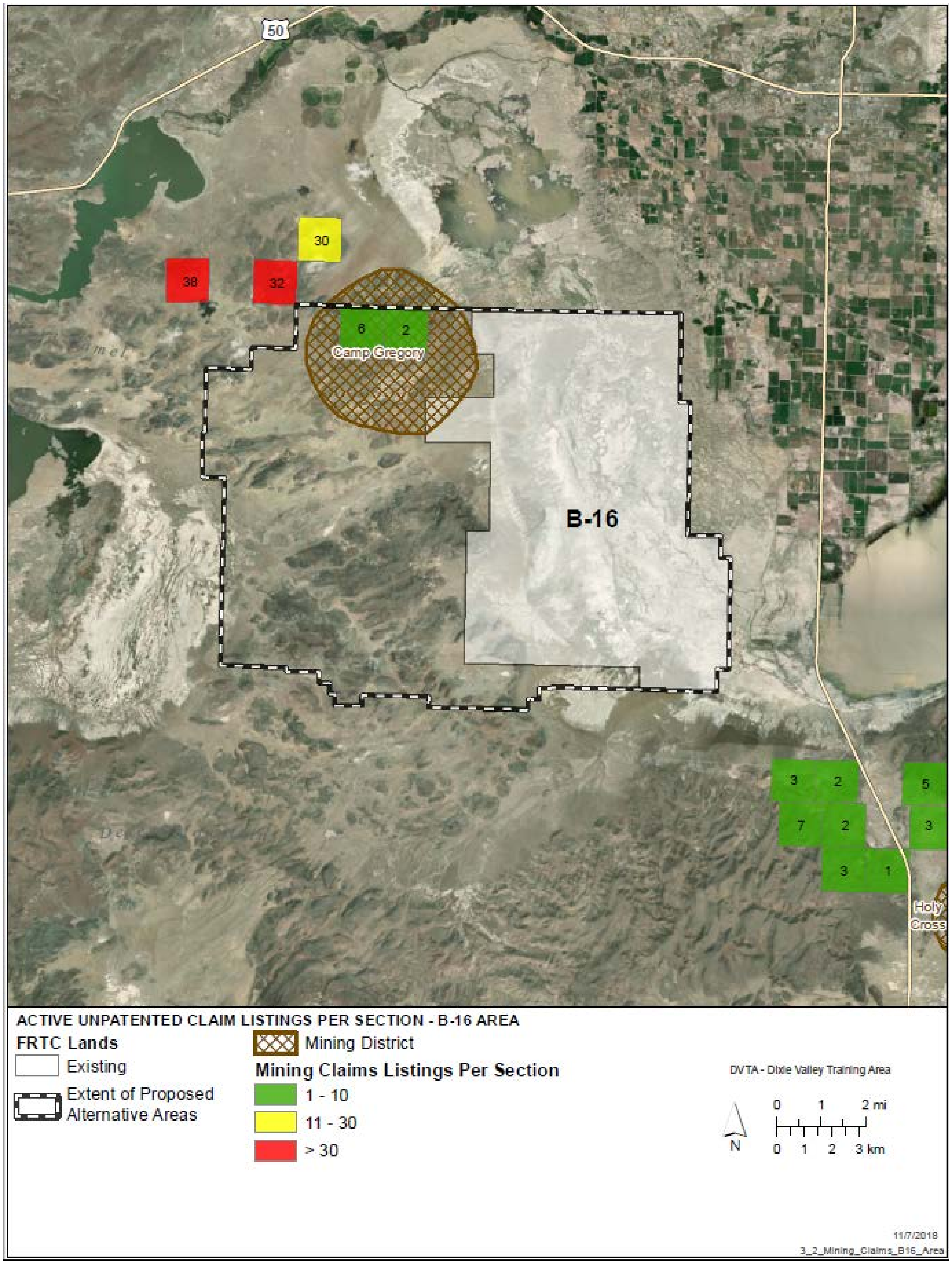


Figure 3.2: Active Unpatened Claim Listings per Section – B-16 Area

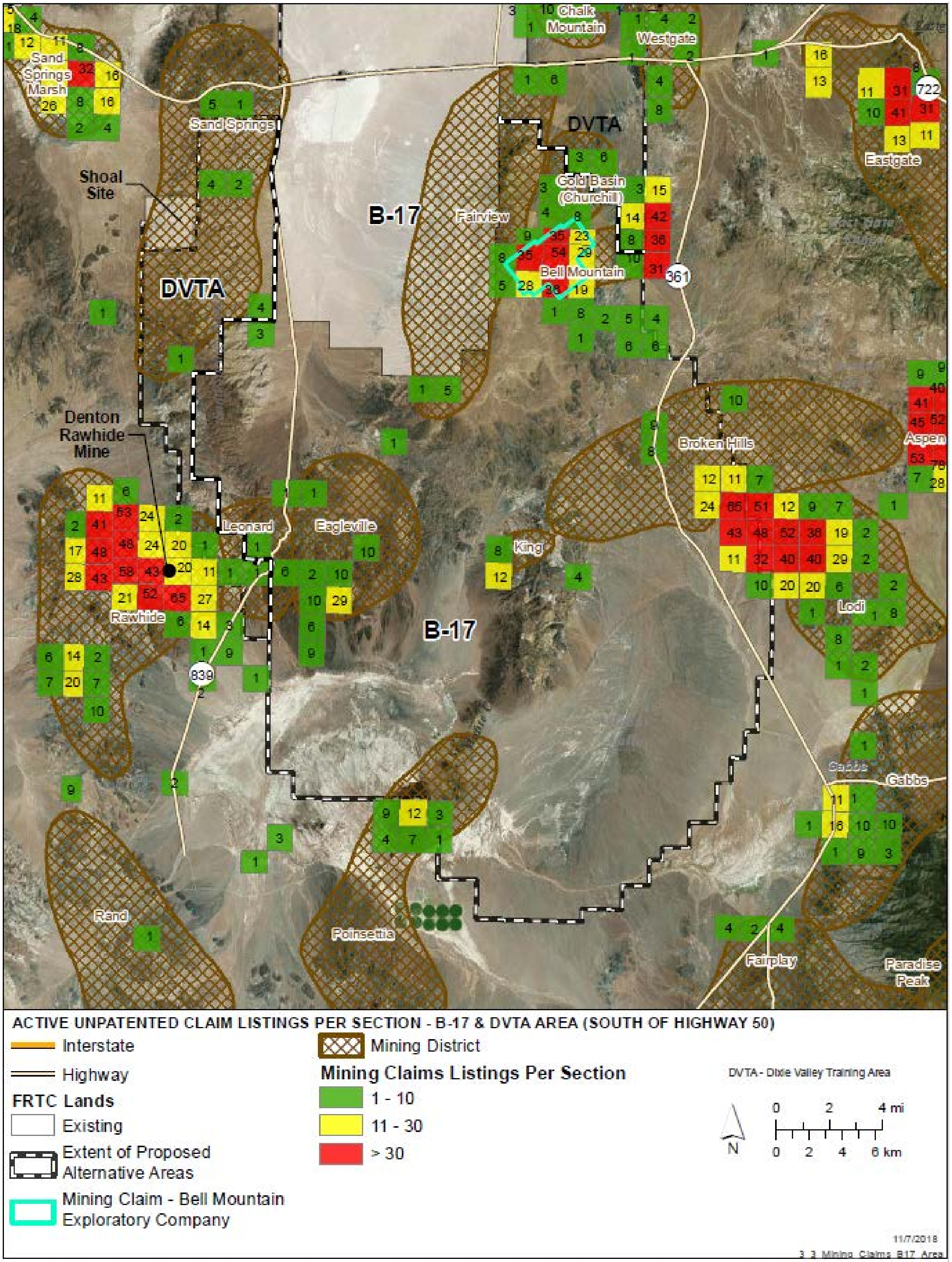


Figure 3.3: Active Unpatened Claim Listings per Section – B-17 DVTA Area (South of Highway 50)

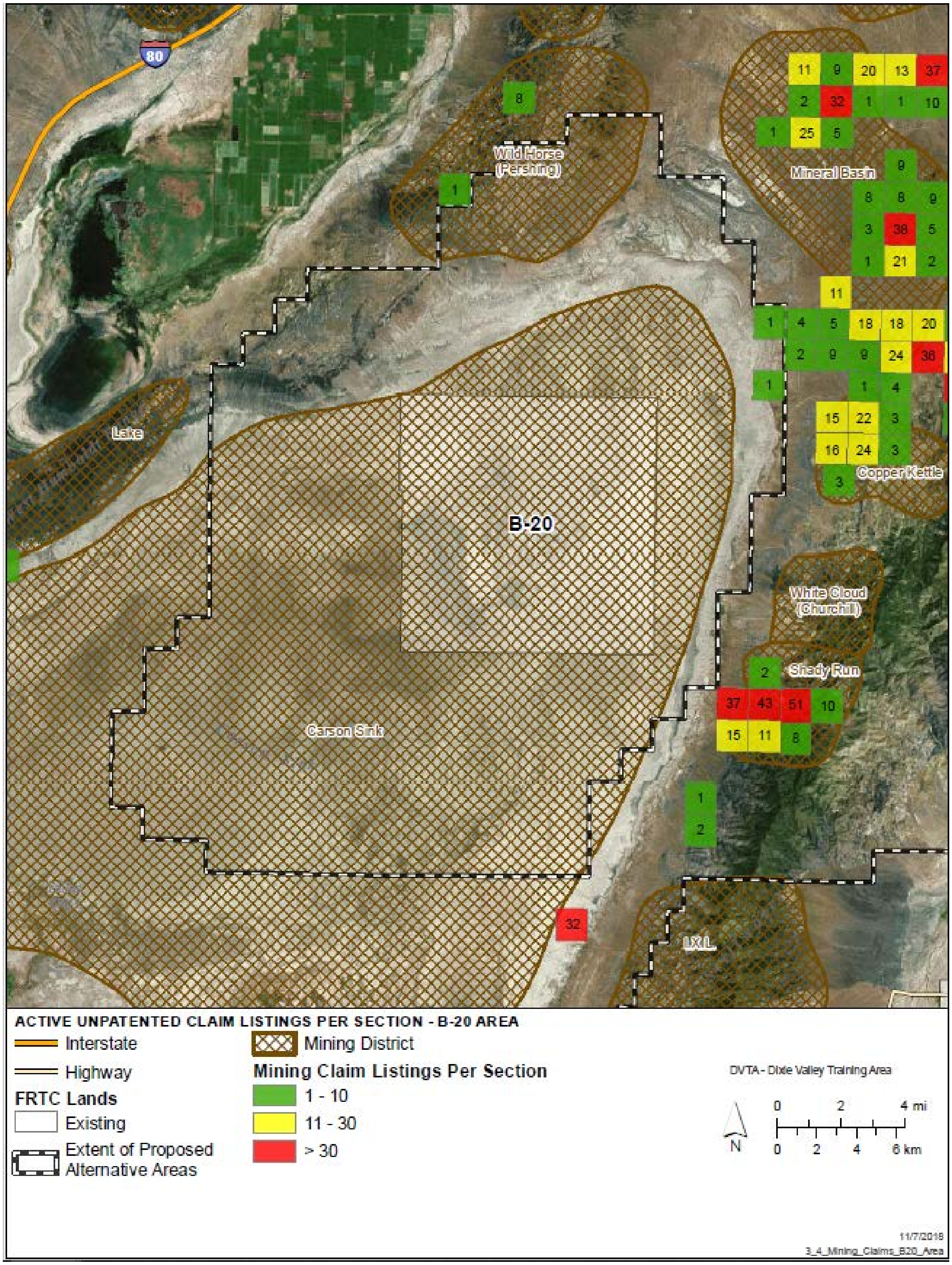


Figure 3.4: Active Unpatened Claim Listings per Section B-20 Area

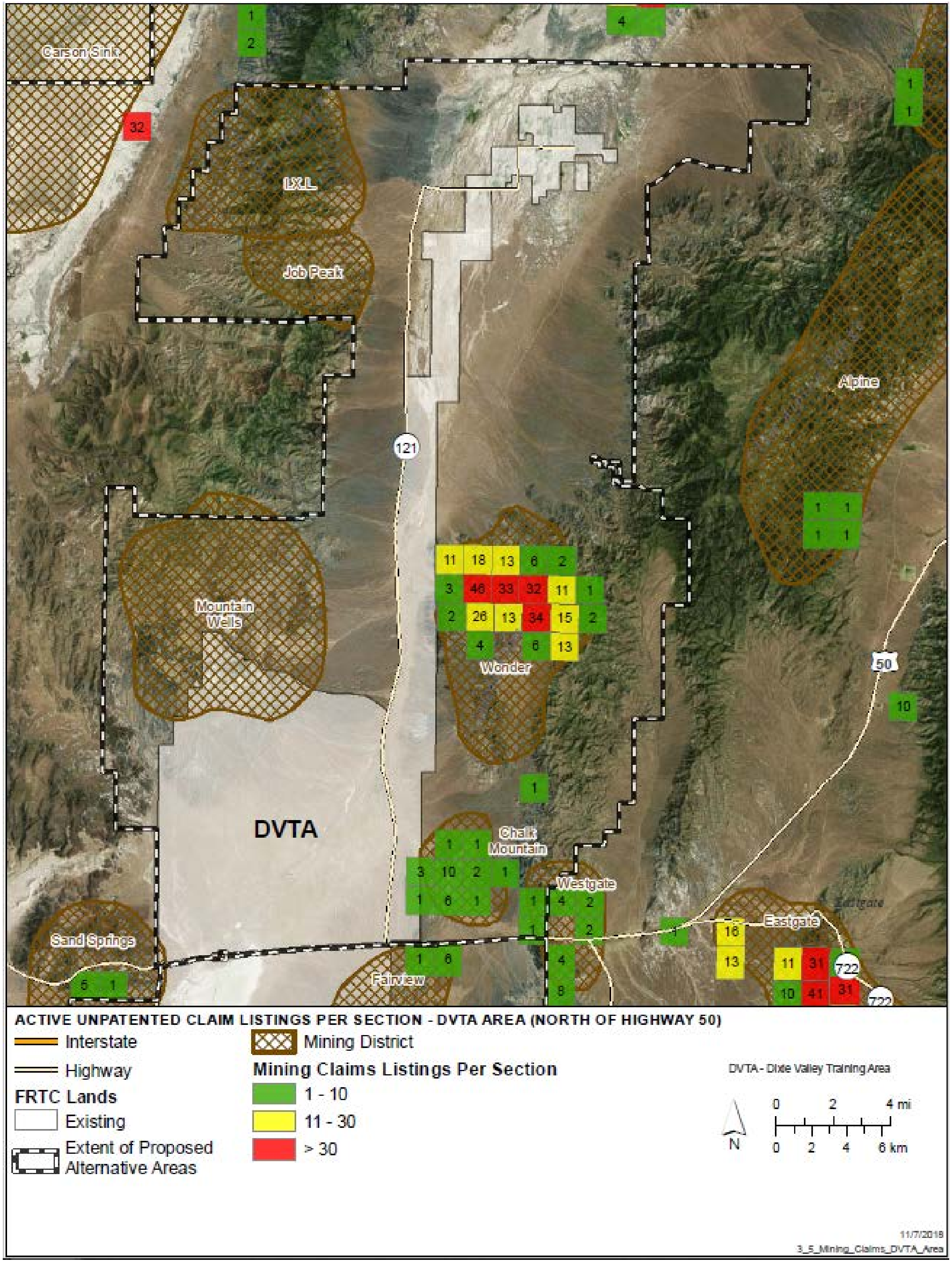


Figure 3.5: Active Unpatened Claim Listings Per Section – DVTA Area (North of Highway 50)

Figure 3.6 shows the locations of active geothermal, oil, and gas leases. As with the active unpatented claim listings, the data to create the figure was downloaded from the NDOM and represents all the leasable land in the Study Area as of June 2018. The figure shows one contiguous block of leased land in the southern portion of the B-17 withdrawal area, this is the only leased land included in the Study Area.

3.1.3 Salable

Salable Minerals are administered by the BLM under the Materials Act of July 31, 1947, the Wilderness Act, and Mineral Materials Disposal regulations (43 CFR 3600 regulations for aggregate, sand, gravel, petrified wood, common variety materials, and so forth). In addition, Material Site Rights-of-Way are granted to State Departments' of Transportation (DOTs) under title 23, Section 317 of the U.S. Code. Regulations governing contracts and permits for mineral materials are contained in 43 CFR, Subparts 3610 and 3620, respectively. The BLM conducts inspection and production verification to assure compliance with contract or permit terms and conditions and prevent and abate unauthorized use.

Research indicates there are no commercial aggregate and/or sand and gravel mining operations within or adjacent to Study Area boundaries. However, numerous (historical and active) small scale sand and gravel quarries and borrow pits exist within the Study Area. A number of these features are administered by BLM and other governmental agencies such as Nevada Department of Transportation (NDOT). Extracted material typically is used for local purposes including road base material, concrete additive, and other construction related uses. Local sand and gravel mining efforts generally occur at alluvial channel or terrace deposits, or in basin fill sediments in proximity to communities or along highways roads. Review of BLM LR2000 records indicates there are five NDOT borrow pits located within the Study Area. The borrow pits are summarized in Table 3.2.

Table 3.2: Summary of Study Area NDOT Borrow Pits

Township	Range	Section	County	Ac	Physical Location	Withdrawal Area
21 N	34 E	22	Churchill	41	NA	Alternative 1 DVTA
18 N	34 E	9	Churchill	60	Dixie Valley	Alternative 1 DVTA
13 N	35 E	3	Nye	---	---	---
14 N	35 E	34	Nye	80	NA	Alternative 3 B-17
16 N	35 E	5	Churchill	---	---	---
17 N	35 E	32	Churchill	160	U.S. 50 / Westgate	Alternative 1 DVTA
16 N	33 E	18	Churchill	40	Scheelite Road	Alternative 1 DVTA

NA = Physical Location is not available within the BLM LR2000 records database.

Review of USGS Mineral Resource Data System (MRDS) indicates that six borrow pits were located along U.S. 50 between Middlegate and west of Summit Pass in Churchill County. Due to inconsistencies in the type of information available via the MRDS, the sand and gravel pits are described narratively: The Middlegate Pit is located in Section 6 of Township 18 North, Range 35 East. According to USGS information, the pit was operated by Nevada Department of Highways circa 1975. An unnamed borrow pit was located in Section 5 of Township 16 North, Range 34 East. This operator name and dates of operation were not provided in the MRDS record. A second unnamed pit was located further to the west along U.S. 50 in Section 1 of Township 16 North, Range 33 East. Operator name and dates of operation were also omitted in the record. However, based on the stated reference material, the pit may have been in operation during the early to mid-1970s. The Scheelite Pit was in Section 6 of Township 16 North, Range 33 East. The USGS record indicates the pit was operated by Nevada State Highway Department circa 1975. The Sand Springs Pit #1 and Pit #2 were located along U.S. 50 in Section

8 of Township 16 North, Range 32 East just west of Summit Pass. According to the USGS record, these pits were operated by Churchill County Road Department from the mid-1970s through 1982. Additional information regarding historical and current aggregate, sand and gravel operations within the Study Area is not readily available.

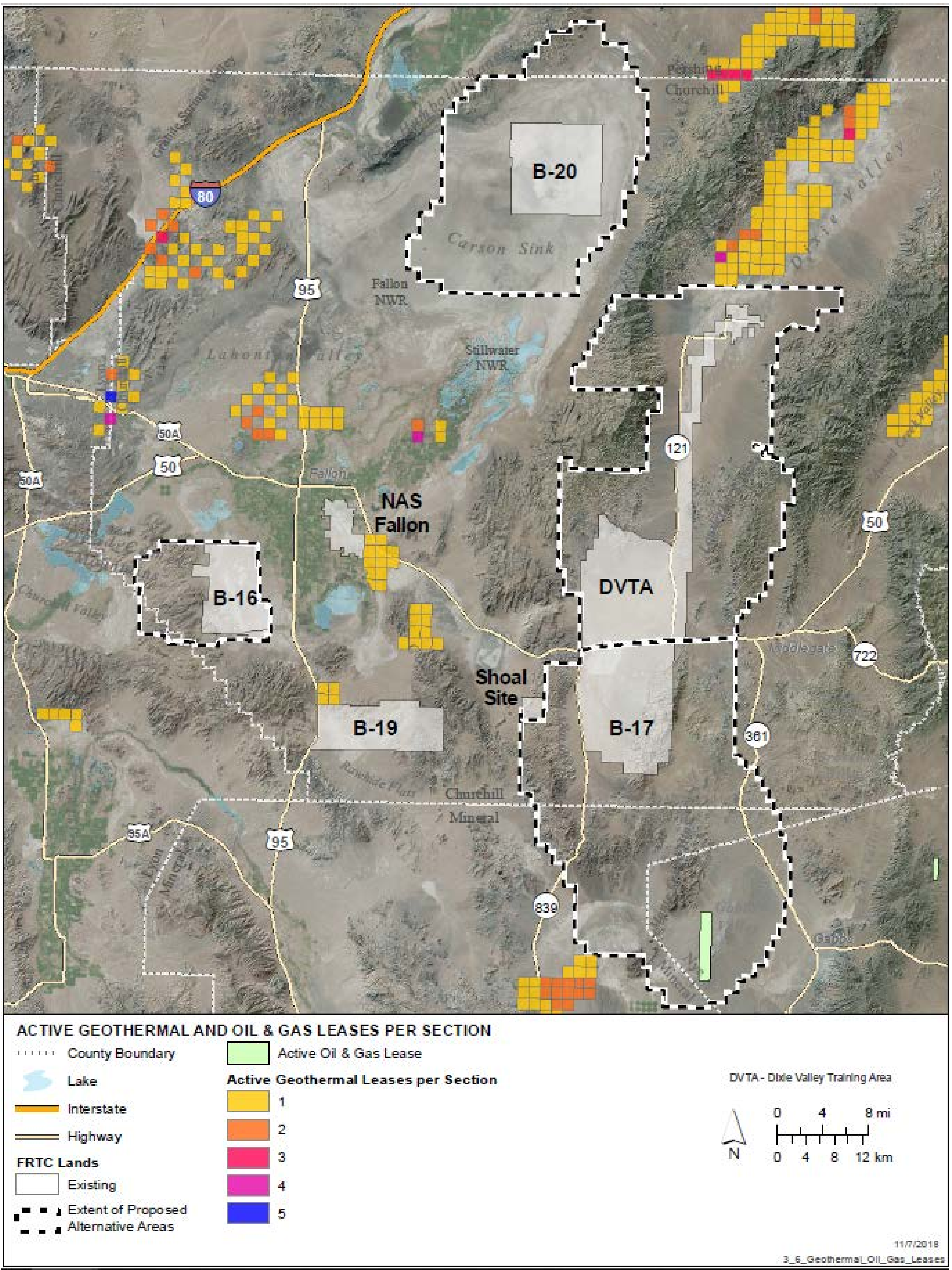


Figure 3.6: Active Geothermal and Oil and Gas Leases per Section

3.2 Types of Metallic Mineral and Energy Deposits

Within the Study Area the most important types of mineralization include: epithermal vein hosted-gold-silver (Au-Ag) deposits, and pluton-related polymetallic deposits of which tungsten skarns are an important sub-class.

The major metallogenic events, which occurred within the Study Area include: felsic pluton emplacement in the Late Mesozoic through Early Tertiary; and periods of extension and volcanism in the Tertiary.

3.2.1 Epithermal Au-Ag veins

Epithermal mineral deposits generally form at shallow depths, rarely greater than 1 mile below the surface. In the Study Area they commonly occur as deposits in veins, but they can also be formed by replacement of or dissemination of metals into permeable sedimentary and volcanic rocks (Wallace and others, 2004). The deposits in the Study Area are frequently found in discrete veins systems hosted in volcanic rocks. Ore minerals are commonly silver sulfides and sulfosalts, gold occurs both in combination with the silver minerals and free. Quartz and adularia are the dominant gangue minerals.

Epithermal deposits are related to local, or regional volcanic systems, which were active in the Study Area from the Tertiary to the present. The volcanic products of these systems, voluminous ash-flow tuffs, rhyolitic to basaltic flows, are common throughout the Study Area and often host the deposits. The heat flow produced by these systems creates deep circulation of ground water, and the faults and volcanic-related structures provided conduits through which the water is circulated, and minerals are deposited. Proximity to a volcanic center is a criterion for this style of mineralization (Wallace and others, 2004).

3.2.2 Pluton-Related Polymetallic deposits

Pluton-related deposits form during the intrusion of magma into the upper crust. In general, these types of mineralizing systems are large, however, they can also manifest as localized contact deposits such as skarns. The most important historical production from pluton-related deposits in the Study Area have been from tungsten skarns.

In the Study Area Mesozoic and Tertiary plutons intrude complex Mesozoic basinal systems, and early Tertiary volcanics. Mesozoic plutons occur in the Sand Springs Range, Big Kasock Range (Leonard District), the West Humboldt Range. Tertiary plutons occur in the Fairview Range, Chalk Mountain, Sand Springs Range, Slate Mountains, and the Stillwater Range.

3.2.2.1 Tungsten Skarn

Tungsten skarn deposits in the Study Area are almost universally found where carbonates within Triassic-Jurassic basinal sediment sequences of the Sand Springs or Jungo terranes are intruded by granitic intrusive bodies. Localization of skarn deposits is generally along irregular contacts that have been faulted, or where intrusive bodies form reentrants into host carbonate rocks (Doebrich and others, 1996). These deposits are generally irregular and discontinuous.

Scheelite is the dominant ore mineral. Gangue minerals of the skarns are predominantly iron-rich silicate minerals such as andradite, epidote, hedenbergite, hornblende, and actinolite. Quartz and calcite are also present, and small to large amounts of magnetite, pyrite, pyrrhotite, molybdenite, chalcopyrite, sphalerite, galena, tetrahedrite-tennantite, and (or) fluorite may be present (Stager and Tingley, 1988).

Throughout the text historic production of tungsten is reported in “units” produced. A “unit” of tungsten trioxide (WO_3) is equivalent to 20 pounds (lbs) of WO_3, which in turn, is 15.86 lbs of tungsten.

3.2.2.2 Porphyry Systems

Porphyry systems – copper, gold, molybdenum, tungsten, and tin deposits are generally spatially and temporally associated with dioritic to granodioritic magmatism in subduction-related tectono-magmatic systems (Seedorff and others, 2005). Porphyry systems are characterized by a large hydrothermal footprint with recognizable hydrothermal alteration (potassic, sericitic, and argillic) patterns. Late-stage meteoric (propylitic) alteration overprint, as well as a distinct base metal zonation pattern are also common characteristics of porphyry systems. Common metal associations include copper, gold, molybdenum, and tungsten, with peripheral lead, silver, and zinc.

3.2.3 Lithium

Lithium mineralization can occur in several modes, including: lithium-rich pegmatite, lithium-bearing clays, lithium-bearing carbonates, and lithium-enriched brines. Global lithium production is dominated by extraction from lithium-enriched brines and lithium bearing-pegmatites with lesser production from clay, carbonate and evaporite deposits. In Nevada lithium is produced from clay and brine deposits, which are the focus of the following discussion.

3.2.3.1 Lithium-Bearing Clay Deposits

Lithium-bearing clay deposits develop where lithium is leached from host rocks, generally felsic lava and volcanic ash, by meteoric and hydrothermal fluids and is bound in clay minerals, typically forming hectorite. Due to the mobility of lithium in solution, this deposit type requires a closed basin to retain all the leached lithium which reports to it and minimize hydrologic flushing. As a result of the lithologic and topographic requirements of this deposit type they are typically associated with lacustrine clay deposits found in intra-caldera basins. An example of this type of deposit is found in the McDermitt Caldera in Humboldt County in northern Nevada.

3.2.3.2 Lithium-Enriched Brines

Lithium-enriched brine deposits and lithium-bearing clay deposits form in similar environments and share a number of key characteristics, with the primary difference being that lithium-enriched brine deposits accumulate in solution rather than in a clay host. Lithium-enriched brine deposits world-wide share several essential characteristics: arid climate; closed basin often containing a playa; tectonically driven subsidence; associated igneous or geothermal activity; suitable lithium source-rocks; one or more adequate aquifers; and sufficient time to concentrate a brine (Bradley and others, 2013). In these systems the source of the lithium is either: weathered lithium-bearing rocks outcropping within the basin, or hydrothermal fluids, which interact with bedrock, or magma (Bradley and others, 2013). Lithium, being highly soluble, remains in solution rather than forming evaporite minerals. Lithium, therefore, becomes enriched in brines in the shallow subsurface of playas as other minerals precipitate out of solution and form evaporites (Bradley and others, 2013). Clayton Valley located in Esmeralda County, Nevada, outside of the Study Area, is an example of this type of deposit.

The Study Area demonstrates several of the characteristics mentioned above: large playa systems undergoing tectonically-driven subsidence occur within the proposed withdrawal areas and along their margins, lithium-bearing felsic volcanic rocks occur throughout the Study Area, and the climate is arid. There are no known studies reporting potentially economic lithium concentrations of brines within playas in the Study Area.

3.2.3.3 Geothermal Systems

Geothermal systems within the Study Area are amagmatic and lack an upper crustal magmatic heat source (Faulds and others, 2017). Instead, the high thermal gradients are the result of crustal and lithospheric thinning associated with right lateral trans-tensional displacement along the Walker Lane shear zone and basin-and-range extension (Kreemer and others, 2012).

Sites suitable for geothermal power production generally have high crustal heat flow, and fractured (permeable) bedrock, which allow deep circulation of water. Often, the intersections of regional fault systems provide fractured rock and serve as conduits to deep crustal heat sources and are therefore permissive locations for geothermal systems. Productive high-temperature geothermal systems capable of electric generation are generally associated with areas where temperatures exceed approximately 150 degrees Celsius (°C) at depths less than 3,000 m. Binary power plants use a second working fluid with a much lower boiling point than water that is heated by the geothermal waters and can produce power at temperatures below 150°C.

Several test projects are underway such as the Frontier Observatory for Research in Geothermal Energy (FORGE) Project near Fallon, NV and Milford, UT, and the Newberry Demonstration Project in Oregon, which are testing enhanced geothermal systems (EGS), and which induce permeability of the system through hydraulic fracturing. This new technology has the potential to open-up large areas of high heat flow in Nevada to geothermal development. However, the current focus of geothermal development in Nevada is on conventional geothermal systems. Therefore, this assessment focuses on the identification of settings that could host conventional geothermal systems characterized by high heat flow, high permeability bedrock, and deep circulating reservoirs.

3.3 Known Occurrences of Locatable Metallic Minerals –Mining Districts

The Mining Districts discussed in this section are located either entirely or partially within the proposed withdrawal areas. The information provided below relies entirely on the work of previous studies, for more detail on the production records and site-specific geology of the Mining Districts, please see Schrader 1947, Quade and Tingley 1987, and Tingley 1990.

3.3.1 B-16

Figure 3.7 displays the mining districts, which occur within the proposed B-16 withdrawal area. The mining districts are discussed in the coming subsections.

3.3.1.1 Camp Gregory District

The Camp Gregory District, Churchill County, is located on the northeast slope of the Dead Camel Mountains. Mining-related activity in this district is confined to just two small areas, neither of which have a record of metal production. The majority of the district lies within the proposed B-16 withdrawal area.

History

There is no record of production from the Camp Gregory District, however, several large dumps around shaft collars were observed by Quade and Tingley (1987), these same authors suggest that the activity probably occurred between 1920 and 1935. In the 1980s, there was renewed interest in the area, and at least two exploration company staked claims and prospected (Quade and Tingley, 1987).

Geologic Setting and Mineral Deposits

The Dead Camel Mountains are a low, arcuate range between the Churchill Valley to the west, and the Lahontan Valley to the east. The Dead Camel Mountains are composed of recent basalt flows, which are underlain by older, Tertiary-aged rhyolite and andesite flows and domes (Quade and Tingley, 1987). In the vicinity of the mining district the youngest volcanic rocks display a wide variety of volcanic facies, including: flow breccias, lahars, tephra, fallback breccia, and siliceous sinter. Quade and Tingley (1987) report that the sinter deposits are indicative of hot-spring activity, and they identified steep northeast-trending faults, which they determine were associated with the geothermal activity. Widespread hydrothermal alteration is found in the area resulting in the argillization of tuffaceous sediments and volcanic rocks.

The large, fossil hot-spring system and the silicified, brecciated faults, which are exposed in the Camp Gregory mine area have been prospected for metallic deposits. Quade and Tingley (1987) report that in the 1980s these areas received renewed attention.

A diatomite deposit occurs in Tertiary lakebed sediments several miles south of the district.

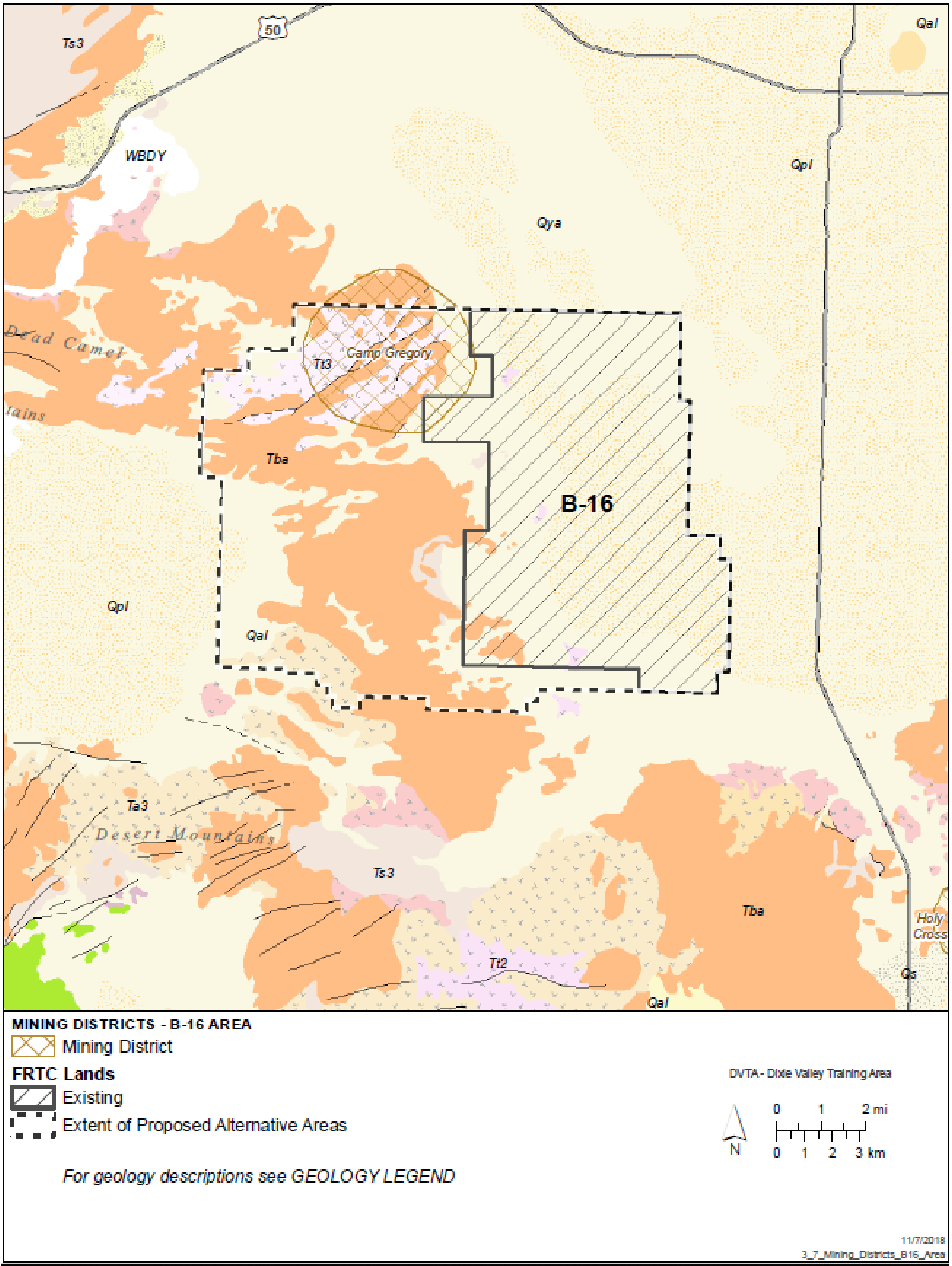


Figure 3.7: Mining Districts - B-16 Area

Identified Mineral Resources

Diatomite

3.3.2 B-17

Figure 3.8 displays the mining districts, which occur within the proposed B-17 withdrawal area. The mining districts are discussed in the coming subsections.

3.3.2.1 Fairview District

The Fairview District, Churchill County, encompasses the Fairview range, a roughly north-south trending range, which forms the eastern boundary of Fairview Valley. The range is separated from the Clan Alpine Mountains to the north by the Stingaree Valley.

History

The initial discovery in this district dates to 1905, by 1906 over 400 claims were staked. The most valuable claims were all consolidated in 1911 by the Nevada Hills Mining company, which became the major producer in the district (Schrader, 1947). From 1906 to 1922 the district produced 48,000 ounces (oz) of gold and 4,700,000 oz of silver, the vast majority of which was mined by the Nevada Hills company. During this period there was also extensive prospecting elsewhere in the range, where similar geological conditions were found, despite sizeable workings at some of these satellite discoveries no production records are available (Quade and Tingley, 1987).

The Nevada Hills mine closed in 1917 and activity in the district subsequently subsided. In the late 1960’s there was renewed interest and exploration in the district. Quade and Tingley (1987), report that in the late 1970’s an exploration company began underground mapping and sampling program of the Nevada Hills to determine if there was sufficient ore to support an open-pit mine. Many of the smaller satellite deposits also received renews attention during this period.

Geologic Setting and Mineral Deposits

The Fairview range in the vicinity of the mining district is predominantly composed of an assemblage of intermediate to silicic volcanic, and hypabyssal rocks of Tertiary age. A minor amount of older Triassic-Jurassic aged metasedimentary rocks are exposed on the northwest margin of the range.

The volcanic assemblage is interpreted by Henry (1996) to be the products of a caldera collapse. The Fairview Peak caldera is a complex assemblage of ash-flow tuff, lava domes and flows, debris deposits and megabreccias, and small intrusions, which occupy the core of the Fairview Range (Henry, 1996). Caldera collapse occurred roughly 19.2 Ma and is coincident with the eruption of the Fairview tuff (Henry, 1996). Caldera collapse appears to have been largely piston-style subsidence, which is evident from the near vertical (when accounting for post-caldera structural deformation) contact between pre-collapse and post-collapse rocks (Henry, 1996).

In addition to the major structures resulting from caldera collapse, the present topography of the range is largely the result of late Tertiary basin-and-range style extensional faulting. The Fairview fault, which runs roughly north-south along the eastern margin of the range and dips to the east is the dominant fault of this type. Henry (1996) estimates close to 6,000 ft. of east-side-down offset along this fault. In addition to uplift the fault has also tilted the caldera rocks westward.

Epithermal gold-silver mineralization in the district occurs primarily in west-northwest striking, steeply dipping quartz veins which cut the Fairview tuff and other caldera-related rocks (Schrader, 1947; Henry, 1996). The veins are intensely silicified, with quartz and adularia replacing gouge and altered rock. Silicification permeates into the wall rock creating altered selvages around the veins. The ore minerals are: acanthite, cerargyrite, embolite, ruby silver, bromyrite, polybasite, pyrite, sphalerite, stephanite, tetrahedrite, and native gold, these are found both within the veins, and in the altered wall rock adjacent (Schrader, 1947; Quade and Tingley, 1987). Ore grades diminished dramatically with depth; falling from 1-3 oz gold and 100 oz silver per ton in the upper workings to 0.08 oz gold and 7.8 oz silver per ton in the lower levels (Vanderburg, 1940).

The most important of the gold-silver bearing veins was the Nevada Hills vein, which was reportedly over 2,200 feet long, between 1 and 15 ft wide and extended to a depth of 800 feet (Quade and Tingley, 1987). A parallel vein system, the Eagle vein, ran for 1,000 ft and was up to 40ft wide, was the second most productive vein in the district (Schrader, 1947).

Two general groupings of geochemical associations are apparent with the Fairview district: 1) Southern Fairview District (Jelenik-Mizpah-Gold Crown area); where silver, gold occur with anomalous beryllium, some anomalous molybdenum, low arsenic, antimony and minimal base metals, and 2), the Main Fairview District (Nevada Florence-Nevada Hills area); where silver, and spotty gold are associated with high copper, lead, zinc, and anomalous molybdenum, moderately anomalous beryllium (Tingley, 1990).

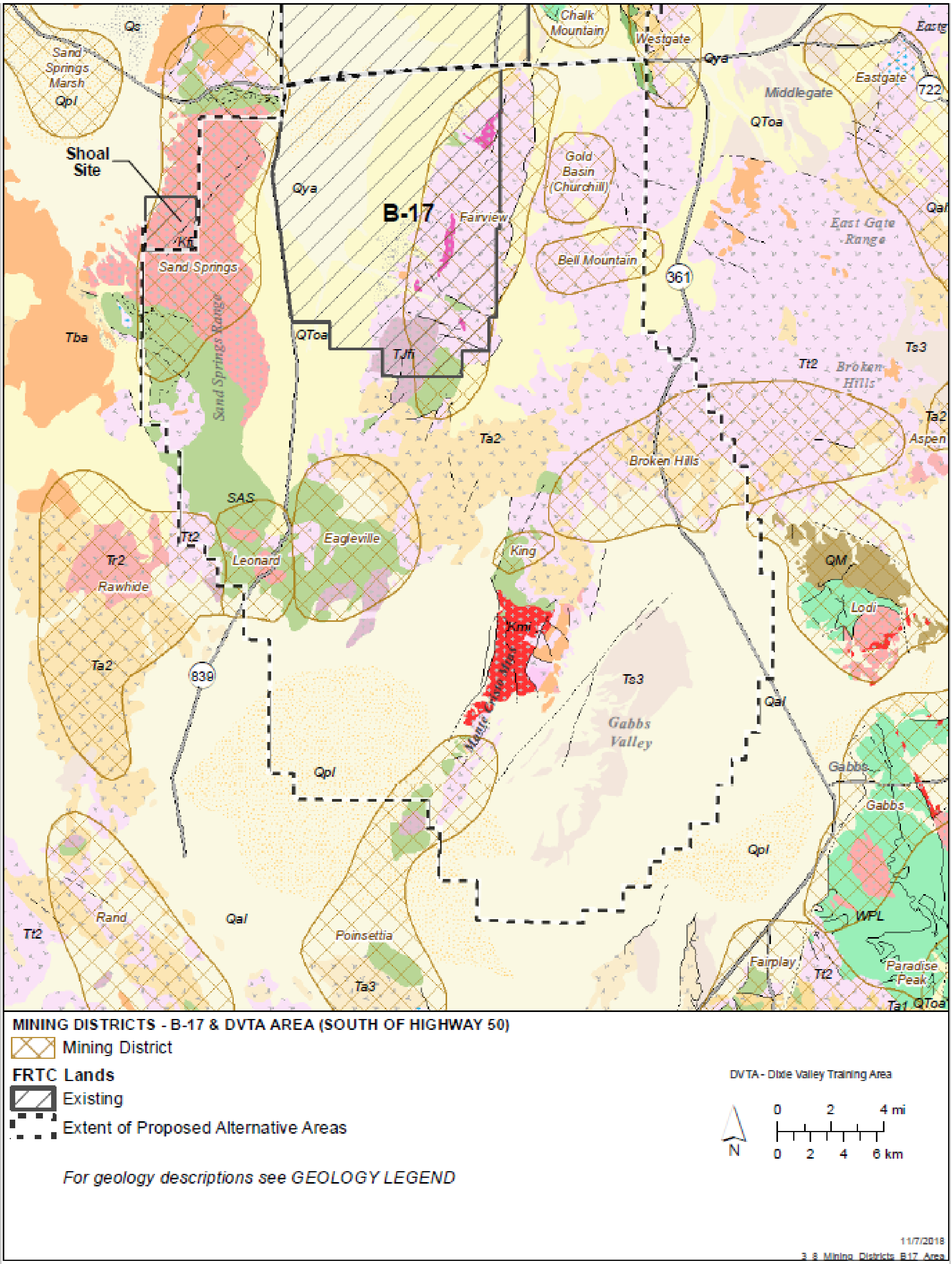


Figure 3.8: Mining Districts - B-17 & DVTA Area (South of Highway 50)

Identified Mineral Resources

Gold and silver.

3.3.2.2 Gold Basin District

The Gold Basin District, Churchill County, is located immediately east of the Fairview District in low volcanic hills.

History

Activity in this district occurred between 1920 and 1930, production is thought to have been limited, although no records have been preserved (Tingley, 1990). Tingley (1990) reports that after many decades without activity, a large number of mining claims were staked in this district in the late 1980s.

Geologic Setting and Mineral Deposits

The rocks outcropping the district are primarily ash-flow tuff, of rhyolitic composition, which are the eruptive products of the Tertiary-age Fairview Peak caldera collapse (Henry 1996). Additionally, felsic to intermediate intra-caldera dikes, and rhyolitic domes outside the caldera margins are present in the district (Henry 1996).

Mineralization in the western part of the Gold Basin district occurs along, or near the contact between intra-caldera dikes and the Fairview Peak tuff. Alteration of these rocks is minor, although the tuff is intensely silicified farther eastward (Henry, 1996). Tingley (1990) reports that development at the Gold Bug mine followed mineralization along a northwest striking, northeast dipping shear zone within ash-flow tuff which was kaolinized and silicified, sulfide minerals were identified in the silicified rock. Schrader (1947) noted that placer mining for gold and silver-minerals occurred in the district.

Identified Mineral Resources

Gold and silver.

3.3.2.3 Bell Mountain District

The Bell Mountain District, Churchill County, is located immediately east of the Fairview District, and south of the Gold Basin District in low volcanic hills.

History

Exploration was conducted by the Nevada Wonder Mining Co. between 1916 and 1919; however, ore of sufficient grade to mine at that time was not encountered (Schrader, 1947). There are records that in 1927 39 tons of ore with an average grade of 0.5 oz/ton gold and 16.4 oz/ton silver was produced from the property (A.L. Payne in Garside and Bonham, 1984). After many years of inactivity, Bell Mountain Mining Co. obtained the property in the late 1970's and commenced exploration for large-tonnage deposits that could be mined using heap-leaching methods (Tingely, 1990). The company was successful in defining over 2 million tons of material grading from 0.022-0.14 oz gold/ton and 1.0- 3.3 oz silver/ton, however the project did not proceed (Bonham, 1984).

There are current exploration activities in the district; these activities include: surface mapping, surface and underground sampling, geophysics, and drilling and sampling. Three gold-silver mineralized bodies have been defined based on drilling data. Review of Nevada’s 2018 Mine Directory indicates that a drilling project was conducted at the Bell Mountain Mine in 2017. The Bell Mountain Claims are within the proposed B-17 and DVTA withdrawal areas for Alternatives 1 and 2. The Bell Mountain Claims are not included in the proposed Alternative 3 B-17 withdrawal area.

Geologic Setting and Mineral Deposits

The rocks outcropping the district are primarily ash-flow tuff, of rhyolitic composition, which are the eruptive products of the Tertiary-age Fairview Peak caldera collapse (Henry 1996). Additionally, felsic to intermediate intra-caldera dikes, and rhyolitic domes outside the caldera margins are present in the district (Henry 1996).

Mineralization at the Bell Mountain Mine occurs along a northeast striking, moderately southeast dipping calcite vein. The vein extends for over a half mile and is as much as 50 ft wide. The vein is truncated on the west by a north-northwest-striking normal fault. Quartz partly replaces calcite but however, less completely than in the veins in the Fairview district. The vein contains native silver, cerargyrite, and possibly acanthite. The deposit is interpreted to have formed from supergene oxidation of a hypogene deposits of electrum, argentite, and possibly base metal sulfides and silver sulfosalts (A.L. Payne in Garside and Bonham, 1984).

Tingley (1990) reports that there was activity in the area in the 1980’s, exploring an east-west trending zone of silicification and stock-work quartz veining within the Tertiary ash-flow tuff. The zone is reported to be over 600 ft wide with manganese and iron-oxide staining.

Identified Mineral Resources

Gold and silver.

3.3.2.4 Sand Springs District

The Sand Springs District, Churchill County, encompasses most of the Sand Springs Mountains, a north-south trending range situated between the Fairview valley to the east and the Salt Wells Basin to the west. The major historic activity at Summit King Mine is located just outside of the proposed B-17 withdrawal.

History

Vein-hosted gold and silver mining was first established at Summit King in 1912, mining operations there continued until 1951 when the ore was spent. Total production was 20,895 oz of gold and 1,262,655 oz of silver with the major production occurring between 1940-1941 and 1948-1951 (Willden and Speed, 1974).

There is recorded production of tungsten from several smaller deposits in the district, these mines were active principally in the 1950’s. The largest tungsten mine in the Sand Springs district, the Red Ant, located in the southwestern part or the Sand Springs Range, east of Fourmile Canyon. This property produced 2,650 units of WO_3 (see Section 3.2.2.1 for discussion of units of WO_3) between 1941-47, 1954-56, 1961, and 1971-80 (Stager and Tingley, 1988).

Geologic Setting and Mineral Deposits

The Sand Springs range is composed predominately of a Mesozoic-age granitic pluton, the Sand Springs pluton. The pluton intruded Triassic-Jurassic metasedimentary units of the Sand Springs terrane. The metasediments are strongly deformed and faulted, but generally dip to the west, and run the length of the range (Satterfield, 2002). Tertiary-age rhyolite and andesite locally overlay the Mesozoic rocks. The pluton is intruded by numerous aplitic/pegmatitic dikes, as well as rhyolite and andesite dikes.

Vein -hosted gold and silver mineralization at the Summit King Mines is associated with a complex west-northwest striking fault system and associated fracture system. Mineralized veins occured most frequently in andesite, although it is also hosted in limestone and metasedimentary rocks. The ore frequently occurs in quartz veins 2-8 ft. wide, which were often heavily oxidized near the surface, some veins extended to a depth of 400 ft. Native gold, silver chloride, and acanthite were the primary ore minerals (Tingley, 1990).

In addition to the vein-hosted gold and silver, tungsten occurs in metasomatic deposits at the contact between the granitic pluton and the limestone. These irregular skarn replacement bodies have scheelite as the primary tungsten ore mineral, additionally scheelite is found in quartz veins cutting the skarn (Tingley, 1990).

Identified Mineral Resources

Vein hosted gold and silver, and minor tungsten in skarn.

3.3.2.5 Rawhide District

The Rawhide District, Mineral County, occupies a low range between Alkali Flat to the southeast, and the terminus of Rawhide Flats to the Northwest overlaps slightly the proposed B-17 withdrawal area. However, the most important mineral producing areas are located just outside of the boundary.

History

The first major discovery at Rawhide was in early 1907. Between 1908 and the early 1920’s, Rawhide produced about $1.5 million in gold and silver (Ross, 1961). Mining continued at Rawhide on a small scale up to 1943, but the years of highest production were between 1908 and 1918. Small amounts of placer gold were recovered from the pediment slopes in the district; this activity never occurred on a large scale, but placer exploration in the district continued up into the 1960's (Tingley, 1990).

In the early 1970’s there was renewed interest in the Rawhide District; Homestake Mining Co. and Getty Mines, Ltd. conducted extensive surface exploration as well as drilling in around the historic high-grade mines. In 1982, a subsidiary of the Kennecott Corp. acquired interest in the district and began a detailed exploration and development program. This work resulted in the definition of ore reserves totaling about 24 million tons grading 0.045 oz gold per ton and 0.47 oz silver per ton (Tingley, 1990).

In the early 1990’s The Denton-Rawhide gold mine began operation in the Rawhide District, which is adjacent to the proposed DVTA withdrawal boundaries. The mine currently is operated by Rawhide Mining LLC. Operations at the Denton-Rawhide facility include an open-pit mine and one or more leach pads. Based on information published in the NBMG 2016 report on mineral production, the mine produced 23,334 oz. gold and 147,316 oz. silver in 2015, and 17,927 oz. of gold and approximately 105,413 oz. of silver in 2016.

Geologic Setting and Mineral Deposits

Triassic-Jurassic basinal metasedimentary rocks of the Sand Springs terrane crop out on the eastern margins of the Rawhide District where they are intruded by Cretaceous granitic stocks and plutons (Tingley, 1990). The metasedimentary rocks are mainly deformed limestone and marble (Schrader, 1947).

Tertiary volcanic rocks underlie nearly all of the Rawhide District and are most important host to gold-silver mineralization in the district. These rocks are rhyolitic pyroclastic rocks; pumice rich tuff, and volcaniclastic rocks that have been cut by a series of rhyodacite porphyry plugs adjacent to a northwest trending zone of rhyolite vents. The volcanic rocks have been interpreted as a rhyolitic flow-dome complex aligned along a northwest trend (Tingley, 1990).

The silver-gold deposits mined during the early period of activity at Rawhide consisted of quartz veins up to 5 ft in width which occurred within wider zones of hydrothermally altered, kaolinized wall rock. The veins are largely replacement veins and irregular bodies along zones of sheeting, fracturing, and faulting (Tingley, 1990). Metallic mineralization within the veins consisted of cerargyrite, pyrite, native silver, native gold, and electrum in the oxidized zone; and argentite, proustite, pyargyrite, pyrite, gold, and electrum in the sulfide zone.

Significant hydrothermal alteration accompanies ore deposition including: silicification, kaolinization, and alunitization of the adjacent wall rock. Mineralization style is interpreted to be subaqueous hot-spring deposition based on the wide-spread hydrothermal alteration, brecciation, and stockwork veining present at many locations in the district (Tingley, 1990). The dominant gangue minerals in the veins are: adularia, alunite, jarosite, quartz, and calcite.

Identified Mineral Resources

Vein-hosted gold and silver.

3.3.2.6 Leonard District

The Leonard district, Mineral County, includes a small area south of Big Kasock Mountain in the southern Sand Springs Range. The Eagleville district is east of Leonard, and the Rawhide gold-silver district is west of Leonard. Important mines in the district are the Nevada Scheelite mine and other adjacent tungsten mines, and gold-silver prospects near the old camp of Sunnyside, about 1 mile southeast of Nevada Scheelite camp.

History

Tungsten ores were discovered at the site of the present Nevada Scheelite mine in 1926. During World War II, the district produced about 70,000 units of WO_3 (see Section 3.2.2.1 for discussion of units of WO_3) most of which came from the Nevada Scheelite mine. The Nevada Scheelite mine became one of the major tungsten producers in Nevada and was in operation almost continuously from the time of discovery until 1960 when it closed due to falling tungsten prices (Tingley, 1990). Operations resumed briefly between 1972 and 1976, and 1980 to 1982. Total tungsten production of the district is about 315,000 units of $W0_3$ (Stager and Tingley,1988).

Geologic Setting and Mineral Deposits

In the vicinity of the Nevada Scheelite Mine, the Cretaceous-age Nevada Scheelite pluton, which is granitic in composition, intrudes a structurally complex zone of Triassic-Jurassic metavolcanics and metasediments of the Sand Springs terrane. Metasediments present include a thick section, up to 500 ft, of limestone (Tingley, 1990). Additionally, there are Tertiary-aged, felsic intrusives and crystal-rich tuffs which intrude and blanket the Mesozoic metamorphic sequence (Satterfield, 2002).

Tungsten mineralization at the Nevada Scheelite Mine, occurs in skarn bodies at the contact between the granite and limestone beds. Scheelite occurs as small, disseminated crystals widely distributed in the skarn associated with garnet, epidote, diopside, wollastonite, quartz, calcite, and sulfide minerals. The sulfide minerals are pyrite, chalcopyrite, and molybdenite. The skarn zones are 2- 50 ft wide along the contact in an irregular zone about 1,800 ft long; drilling has shown the skarn zone to persist for at least 600 ft in depth (Tingley, 1990).

Vein-hosted gold and silver deposits at the Sunnyside Mine occur in small quartz veins which are hosted in a Mesozoic diorite porphyry. The veins are associated with Tertiary felsic dikes which intrude the porphyry. The veins contain free gold, horn silver, argentite, chrysocolla, and malachite in a quartz gangue (Schrader, 1947).

Identified Mineral Resources

Tungsten in skarn deposits, vein-hosted gold and silver.

3.3.2.7 Eagleville District

The Eagleville District, Mineral County, is located due east of the Leonard District in rugged east-west trending hills. To the south is Alkali Flat, to the north is Fairview Valley.

History

In 1882, mineral was discovered at what is now the site of the Eagleville mine. The Eagleville Mining Co. was formed and, between 1884 and 1895, about $28,000 worth of gold ore was shipped from the property (Schrader, 1947). In 1913, additional work was done on the property and ore worth $280,000 was reported to have been blocked out in the mine (Schrader, 1947). There are reports of recent exploration activity consisting of drilling in the district. Roughly 2,000 tons of barite have been produced from veins in the district.

Geologic Setting and Mineral Deposits

The Eagleville District is largely underlain by Triassic-Jurassic felsic intrusives with large carbonate inclusions of the Sand Springs terrane, and Triassic-Jurassic feldspar porphyry plutons. The Mesozoic rocks have been intruded by Tertiary rhyolite stocks (Satterfield, 2002).

Vein-hosted gold mineralization in the district is hosted in the Mesozoic intrusive rocks. The veins are oriented northwesterly and contain altered, brecciated meta-andesite, quartz, crystalline barite, fine-grained pyrite, and, in the oxidized portions, free gold (Tingley, 1990).

In addition to gold, barite was also produced from veins at Eagleville. The vein barite deposit is adjacent to but separate from the vein gold deposits. Barite was mined from one vein which crops out over 3,000 ft. along strike; the vein strikes northeast, is near-vertical, and is up to 8 ft. in thickness (Papke, 1984).

Schrader (1947) references several small copper and lead prospects and mines within the district which occur along the contact of limestone and granitic intrusive rocks.

Identified Mineral Resources

Gold and barite.

3.3.2.8 Poinsettia District

The Poinsettia District, Mineral and Nye Counties, occupies a northeast trending ridge, Fissure Ridge, within the proposed withdrawal area. The district is positioned between Gabbs Valley to the east and Alkali Flat to the west.

History

Tingley (1998) reports that the Poinsettia District has produced: mercury, gold, antimony, and copper. No exact records of production are available.

Geologic Setting and Mineral Deposits

Several prospects are located on the edge of the proposed withdrawal area, in the Black Hills and Fissure Ridge. In the Black Hills a Jurassic-aged, fine-grained granitic unit intrudes the basinal units of the Triassic-Jurassic aged Sand Springs Terrane. The mineralization appears to follow the intrusive contact.

Identified Mineral Resources

No verified production records.

3.3.2.9 King District

The King District, Mineral County, is located on the western side of the Monte Cristo Mountains above Alkali Flats. The district is located between the Broken Hills District to the east and the Eagleville District to the west.

History

Early prospecting of the area likely occurred around 1907 when the nearby camp at Rawhide became active. The first known activity with associated production was in 1926 when a small stringer of rich gold ore was discovered in an old shaft. Additional discoveries were made within the next two years and one car of gold ore was shipped from the district in 1927. Prospecting has been carried out in the district over the years since the original activity in 1926, but no additional production has been recorded. In 1989, the area was under claim by a Reno company, and exploration drilling had been carried out along the trend of the old mine workings (Tingley, 1990).

Geologic Setting and Mineral Deposits

The western slope of the Monte Cristo Mountains is underlain by Mesozoic metavolcanic rocks, mainly andesites, which have been intruded, in the mine area, by a Tertiary rhyolite dike. To the east, beyond the limits of the mining district, the older rocks are overlain by Tertiary rhyolite tuffs (Tingley, 1990).

The mines of the King District all occur along the sheared contact between the Mesozoic metavolcanic rocks and a silica-flooded Tertiary rhyolitic dike. The metavolcanic rocks are silicified and contain chlorite and epidote: while the rhyolite dike is fractured and contains iron- and manganese-oxides. The silicified rock along the contact contains disseminated sulfide minerals (Tingley, 1990). The rhyolite is up to 300 ft wide and heavily altered, it contained gold, silver, lead, and copper values in an iron-rich gossan (Wren, 1963). There were apparently pods of enriched ore within the oxidized shear zone that were rich enough to have been mined, however no large tonnage of ore was ever developed. Tingley (1990) observed that the recent activity in the area was exploring the potential for low-grade high-volume mining.

Identified Mineral Resources

Gold.

3.3.2.10 Broken Hills District

The Broken Hills district, Mineral County, includes the southern Broken Hills, a low range that defines the north end of Gabbs Valley, as well as small area on the east slope of the northern Monte Cristo Mountains.

History

By 1920, about $70,000 worth of silver-lead ore had been shipped from the property (Schrader, 1947). The silver-base metal mines of the district are credited with about $180,000 between 1935 and 1940. The total metallic production, through 1940 totals about $250,000 (Schrader, 1947).

Fluorite was discovered in the Monte Cristo Mountains on the west side of the district in 1922. Fluorite mining began in 1928 and continued until 1957; Baxter mined the property from 1928 through 1951 and Kaiser Aluminum and Chemical Co. operated from 1952 through 1957. During this time, nearly $6,000,000 worth of fluorspar was mined from the property (Ross, 1961).

Geologic Setting and Mineral Deposits

Rocks cropping out in the district consist mainly of Tertiary volcanic rocks of intermediate composition, chiefly rhyodacite to andesite flows, tuffs, and breccia. Rhyolite, crystal-rich quartz latite, and welded ash-flow tuffs cover parts of the district. Andesite and basalt dikes and irregular bodies intrude the volcanic rocks. The country rocks near these intrusions has been extensively hydrothermally altered (Tingley, 1990). A Triassic-Jurassic age granite crops out both north and south of the district (Schrader, 1947).

Silver-lead deposits in the Broken Hills Mine area occur in quartz veins which cut andesite. The deposits are associated with 6, or more, veins, which are contained in a zone of mineralization about 400 ft. wide. In general, the veins range up to about 2,000 ft in length, 9 ft. in width, and extend to a depth of at least 350 ft. (Tingley, 1990).

The principal producing veins, the Broken Hills veins and the Belmont vein, strike northwesterly and dip steeply to the west (Tingley, 1990). The veins are composed chiefly of hydrothermally altered andesite tuff breccia and minor quartz; the ore minerals mainly replace the altered wall rock. Oxide mineral present include gypsum, cerargyrite, cerussite, anglesite, limonite, plumbojarosite, and jarosite. Primary sulfides, consisting of argentiferous galena, jamesonite, pyrite, chalcopyrite, sphalerite, and rare molybdenite. Proustite and pyargyrite are reported in both oxide and sulfide zones (Schrader, 1947).

Fluorite mineralization occurs in the Monte Cristo Mountains in the western portion of the district. Fluorite veins occur in Tertiary andesitic rock and in rhyolite ash-flow tuff. Veins are localized in northeast-striking, northwest-dipping faults and shear zones and show characteristics of open-space filling. Fluorite forms botryoidal and drusy coatings, or veins, within the andesite and rhyolite tuff. The fluorite is mainly white, pale green, or lavender, and ranges from very fine-grained, layered aggregates to euhedral crystals (Tingley, 1990). The mineralized zone occurs in andesitic rocks and can be traced for about 2,000 ft. along strike, and 700 ft. down-dip; the vein averaged only 1.5 ft. in thickness (Archbold, 1966).

Identified Mineral Resources

Vein-hosted silver and lead, and fluorite.

3.3.3 B-20

Figure 3.9 displays the mining districts which occur within the proposed B-20 withdrawal area. The mining districts are discussed in the coming subsections.

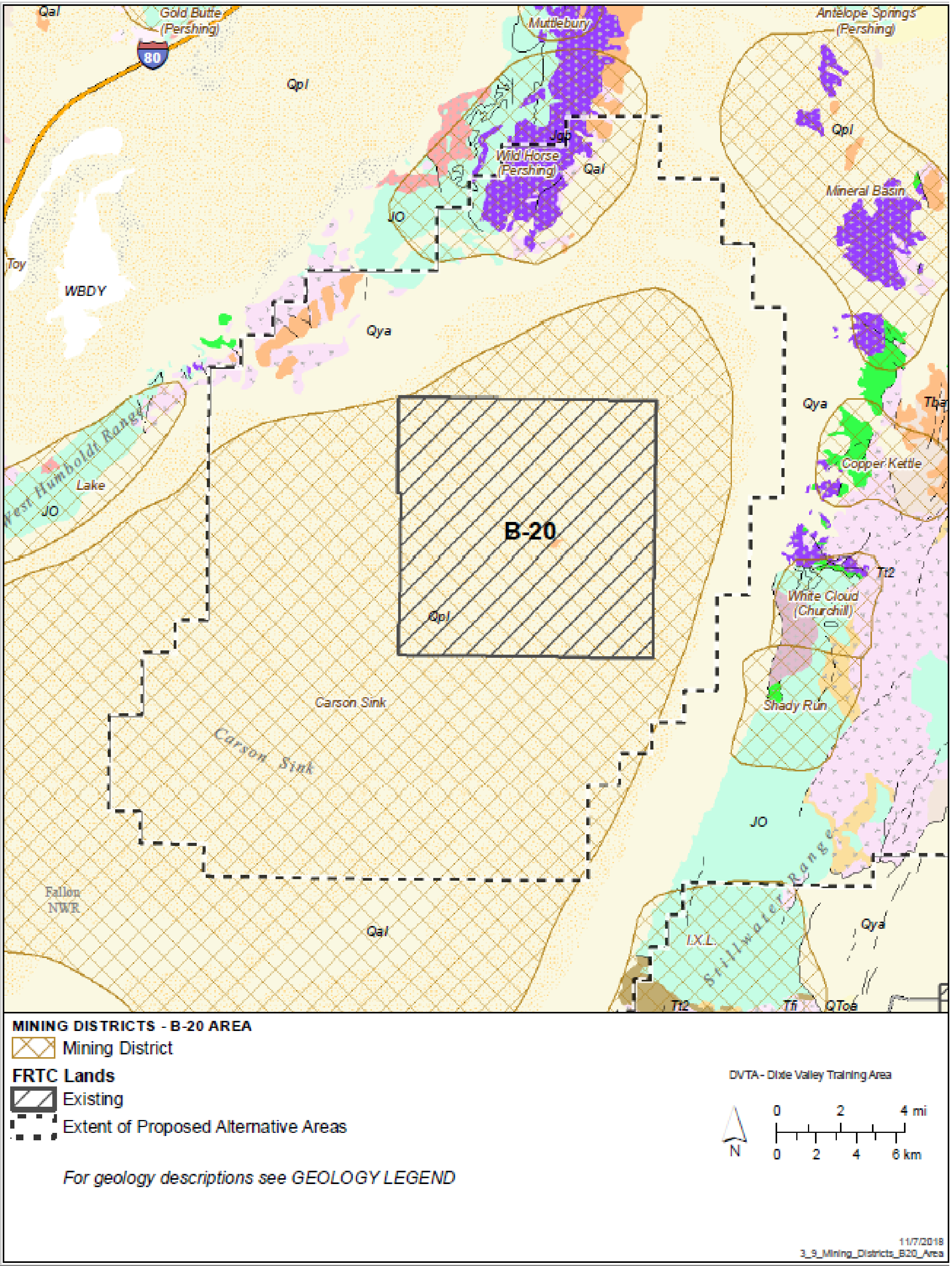


Figure 3.9: Mining Districts - B20 Area

3.3.3.1 Wild Horse District

The Wild Horse District, Pershing County, is located in the West Humboldt Range. The district is situated between the Carson Sink to the south and the Humboldt Sink to the north.

History

Production in this district did not commence until after World War I. Approximately 200 tons of scheelite-bearing skarn was mined from the tungsten-producing part of the district, approximately 46 tons of antimony were produced from the other mines in the district (Bonham and others, 1985).

Geologic Setting and Mineral Deposits

The West Humboldt Range in the vicinity of the district is comprised of Triassic-Jurassic aged metasedimentary rocks including: shale, argillite, sandstone, and minor limestone. These metasedimentary units are complexly folded and faulted, and have been intruded by Jurassic-age gabbroitic, and Cretaceous-age granitic plutons (Bonham and others, 1985). Tertiary-aged tuff, and basalt flows overlay the Mesozoic rocks on the eastern side of the range.

Antimony mineralization occurs within the district associated with northeast trending faults in the Jurassic- gabbro. The deposits are zones of iron-stained, argillized gabbro with lenses of quartz within the fault systems. Antimony ore minerals found at this location include: jamesonite and bindheimite, gangue minerals are quartz, pyrite, and iron oxides (Bonham and others, 1985).

Tungsten mineralization occurs within the district; however, it is located on the north-west side of the range, outside of the proposed withdrawal area. The tungsten occurs in scheelite-bearing skarn deposits which formed at the intrusive contact between the Triassic-Jurassic limestone and Cretaceous granite (Bonham and others, 1985). The deposits are in lens-shaped pods, up to 10 ft. long along the intrusive contact. In addition to scheelite, pyroxene, garnet, amphibolite, and epidote are the accessory minerals (Bonham and others, 1985).

Iron mineralization in the form of magnetite with lesser hematite occurs on the southeastern margin of the West Humboldt range. This mineralization is associated with the hydrothermally altered, Jurassic-aged Humboldt mafic complex. The Humboldt mafic complex is an extensive system of plutonic and volcanic mafic rocks exposed in the West Humboldt, Stillwater, Clan Alpine ranges, and in the Buena Vista Hills covering an area of approximately 445,000 ac (Johnson and Barton, 2000) . Numerous iron occurrences and deposits are hosted in the intensely scapolite-altered, fractured and brecciated mafic rocks of this complex.

Identified Mineral Resources

Antimony, tungsten, and iron.

3.3.4 DVTA

Figure 3.10 displays the mining districts which occur within the proposed DVTA withdrawal area. The mining districts are discussed in the coming subsections.

3.3.4.1 IXL District

The I.X.L District is located in Churchill County, in the central Stillwater Range, and encompasses drainages on both the east and west sides of the mountain range. The mines and prospects in the I.X.L. District are concentrated into two canyons: I.X.L Canyon, which drains to the east; and Cox Canyon which drains to the west.

History

In 1878, mining operations the deposits at Silver Hill in the upper part of I.X.L. Canyon commenced. Vanderburg (1940), estimated that by 1908, $20,000 worth of silver had been mined from deposits at Silver Hill in I.X.L. Canyon.

Papke (1979) reports that 1,900 tons of fluorite were mined from the Revenue mine in the upper part of Cox Canyon between 1942 and 1957.

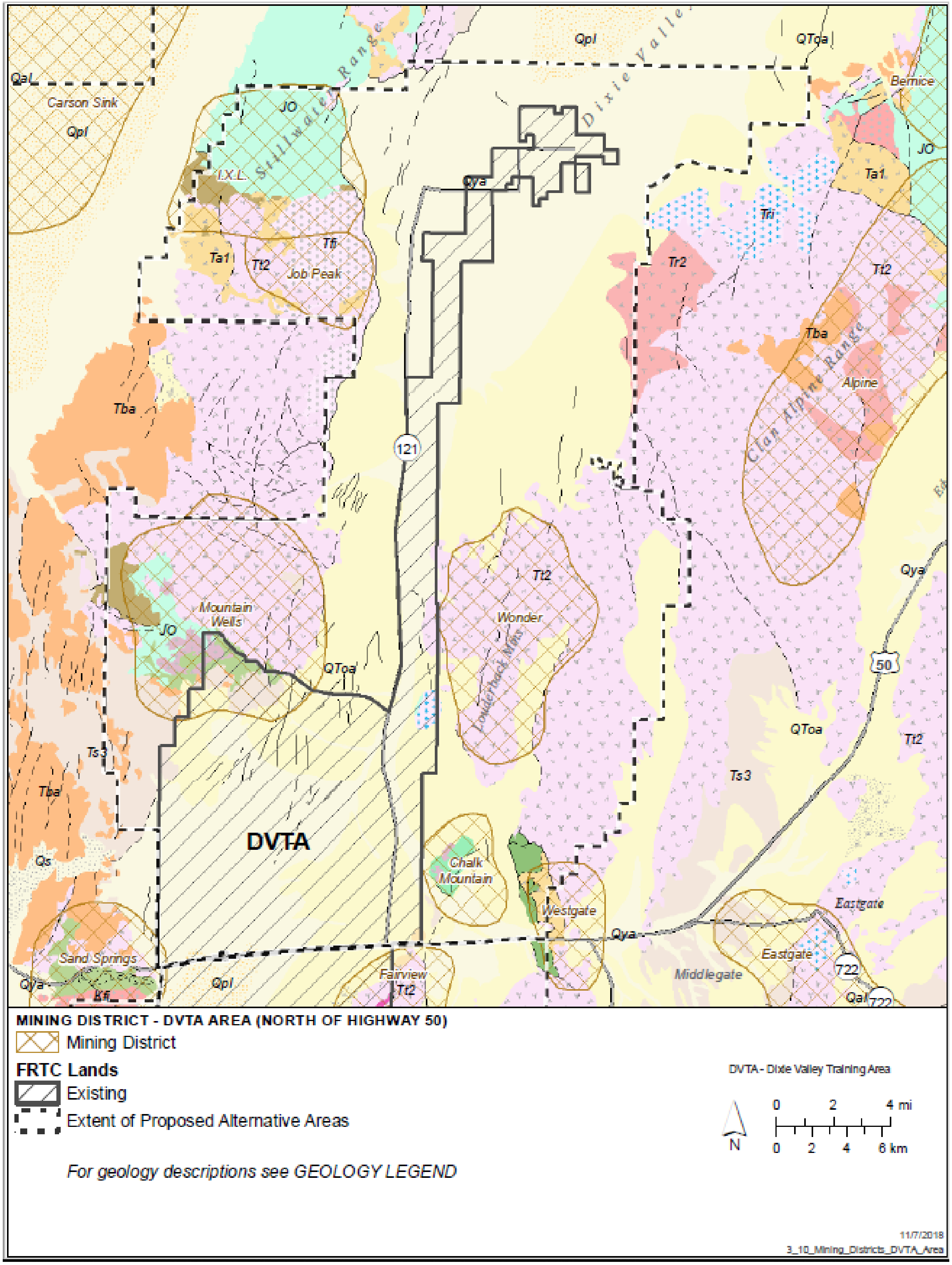


Figure 3.10: Mining Districts - DVTA Area (North of Highway 50)

Geologic Setting and Mineral Deposits

The central Stillwater Range is composed principally of a sequence of Mesozoic slate and phyllite of the Jungo terrane, which is locally interbedded with thin intervals of quartzite and limestone. Generally, this sequence dips to the east. The clastic sequence is intruded by Tertiary granitic rocks.

Folding and imbricated thrust faults have been mapped by Page (1965) in the Triassic slate and phyllite of the Stillwater Range. Page (1965) interprets these features along with brecciated shales to represent a thrust sheet which underlies the Stillwater Range. Page (1965) indicates that thrusting likely occurred in the Middle to Late Jurassic, and the granitic pluton was emplacement after thrusting ceased.

The mines and prospects in the I.X.L. District are concentrated into two canyons: I.X.L Canyon, which drains to the east; and Cox Canyon which drains to the west. The mines and prospects in I.X.L Canyon are localized near the contact between the limestone and quartzite interbeds and the intrusive granitic body in a roughly 3,000 ft. wide by 2.5-mile-long belt trending east. The mineralization along this contact appears to be skarn, or replacement-style. Silver has been mined from quartz and calcite veins of the Bonanza group. Additional skarn mineralization in the Black Prince mine, also in I.X.L. Canyon, is reported to consist of lead- zinc- and copper-sulfides, along with the gangue minerals magnetite, epidote, garnet, calcite, and quartz (Tingley, 1990).

The mineralization in lower Cox Canyon is low-grade silver, gold, lead, and copper in veins (Schrader, 1947). In the upper canyon there are several fluorite occurrences which are located in veins and breccia in a north-northeastward trending fault zone which cuts through slate and thinly bedded limestone (Papke, 1979).

Identified Mineral Resources

Silver and fluorite are the two dominant mineral resources present in the I.X.L. District.

3.3.4.2 Job Peak District

The Job Peak District, Churchill County, is located south of the I.X.L. District on the east side of the Stillwater Mountain range.

History

Limited information on this district exists.

Geologic Setting and Mineral Deposits

The Job Peak District is centered on a Tertiary granitic intrusive, the Freeman Creek pluton which intrudes older rhyolite, tuff, dacite and andesite, as well as the I.X.L. pluton. The Freeman Creek pluton itself is cut by numerous granite porphyry dikes (John, 1993).

John (1993) reports that hydrothermal alteration is pervasive throughout the early Tertiary rocks due to the nearby Stillwater caldera complex. However, no mineralization is reported to be associated with these zones of propylitic and argillic alteration (John, 1993).

Identified Mineral Resources

No record of mineral production.

3.3.4.3 Mountain Wells District

Also referred to as the La Plata District, the Mountain Wells District is located in Churchill County on the south eastern extent of the Stillwater Range. The District lies on the east side of the Stillwater Range, centered around southeast draining Elevenmile Canyon and La Plata Canyon.

History

This district saw significant growth in the 1860's, however, there is scant evidence to show that much ore was produced (Vandenburg, 1940). In 1864 a stamp mill was erected, however, it was soon dismantled and moved to another more promising district (Vandenburg, 1940). Fluorite was discovered in the district in 1939; however, there are no records of fluorite production (Tingley, 1990). More recent exploration in the 1980's has focused on tungsten and molybdenum in the skarn deposits (Tingley, 1990).

Geologic Setting and Mineral Deposits

The Mountain Wells District is comprised of metasedimentary and metavolcanic rocks from the Upper Triassic which have been intruded by a Cretaceous-Tertiary aged granitic pluton. Aplitic Tertiary dikes, as well as ash-flow tuffs, volcanics, and related sediments from the Stillwater Caldera complex are also present in the district (Tingley, 1990).

There is evidence of two periods of structural deformation recorded in the district. A Jurassic-Cretaceous aged compressional event which juxtaposed Triassic limestone above Triassic phyllite along a northeast-trending thrust fault. The younger event, occurring in the Cenozoic, records shortening along north-trending folds in the Tertiary sediments as well as extension along high-angled normal faults (Tingley, 1990).

Mineralization in this district is associated with the contact between the granitic pluton and the metasedimentary rocks, and the hydrothermal system developed from the emplacement of the numerous aplitic and andesitic dikes. Three broad categories of deposits are found in this district: molybdenum-tungsten-copper skarn, which is found at the intrusive-metasedimentary contact; silver-copper bearing quartz veins, which occur in shear zones; and fluorite, which is found in shear zones, which are spatially associated with aplitic dikes (Tingley, 1990).

The skarn deposits coincide with the irregular, northwest-trending contact between the granitic intrusive and the metasedimentary units. Numerous aplitic and andesitic dikes, trending northeast and northwest, intersect this contact which has been heavily-silicified and brecciated. Trace molybdenite, chalcopyrite, and scheelite have been found in this heavily-silicified contact zone.

The silver and copper-sulfides are found in large quartz veins, which cross-cut both the intrusive and metasedimentary rocks along northeast and northwest trends. These zones are up to several feet thick, and locally also contain molybdenite.

The fluorite occurs along the contact between aplite sills and dikes and the phyllite and limestone, which they intersect (Tingley, 1990).

Identified Mineral Resources

There are three deposit types identified in this district: molybdenum-tungsten-copper skarn, silver-copper bearing quartz veins, and fluorite. However, it is unclear if there has been appreciable production from any of these occurrences.

3.3.4.4 Wonder District

The Wonder District is located in Churchill County, on the east side of the Dixie Valley. The district encompasses the Louderback Mountains, which are a roughly north-south trending spur range off the Clan Alpine Mountains. None of the floor of the Dixie Valley is included in the district, however the Wonder Wash, an alluvial filled valley separating the Louderback from the Clan Alpine Mountains is included in the district.

History

Gold and Silver production in the Wonder District began in 1908. A 200-ton/day cyanide mill was constructed in 1911, which was kept active until 1919 when the ore was mined out (Schrader, 1947).

According to Schrader (1947) production from the district between 1911 and 1919 totaled over 69,000 oz of gold and 6,400,000 oz of silver.

As of 1987 Quade and Tingley (1987) report that a Vancouver based company had constructed leach pads and was extracting gold and silver using cyanide leaching.

Geologic Setting and Mineral Deposits

The exposed rocks in the Wonder District are primarily volcanic; the oldest of which are Oligocene-age andesite and basalt flows, which are overlain unconformably by a thick section of quartz-latite and rhyolite, known as the Wonder rhyolite. Schrader (1947) reports that the Wonder rhyolite is at least 2,000 ft thick and is intruded by numerous plugs, stock, and dikes of dacitic, rhyolitic, and andesitic compositions. The Wonder rhyolite is also heavily fractured and hydrothermally altered; steeply dipping, north to northwest-oriented faults and fractures appear to be the most important orientation for mineralization in the district (Schrader, 1947).

According to Schrader (1947) the majority of the gold-silver production from the Wonder District was mined from epithermal vein-systems within the Wonder rhyolite, the most important of which is the Nevada Wonder vein which was mapped extending for several miles north-northwest from the Wonder Mine. The majority of the veins are between 1- 40 ft. thick, and several are over 1,000 ft. deep. The veins are principally comprised of quartz and adularia, with thick sections of gouge at the contact with the country rock. Additional gangue minerals found in the vein systems are iron and manganese oxides, calcite, fluorite, and barite. The primary ore minerals are acanthite, ceragyrite, and silver-salt, gold occurs free and combined with acanthite (Schrader, 1947). Quade and Tingley (1987) report that in addition to gold and silver, copper, and lead were minor products associated with some of the veins.

Identified Mineral Resources

Gold and silver were mined from quartz veins in this district.

3.3.4.5 Chalk Mountain District

The Chalk Mountain District encompasses Chalk Mountain, an isolated north-northeast oriented range located on the east side of the Dixie Valley.

History

Dedicated activity in this district began after 1922, prior to which the district had attracted only sporadic interest. Peak activity in the district was between 1923 and 1929; however, accurate production records are not available, because much of the production was credited to the nearby Fairview District (Quade and Tingley, 1987). Through 1927, the Chalk Mountain mine is credited with 99 oz gold, 59,651 oz silver, and 861,355 lbs of lead (Vanderburg, 1940). Mining activity continued in this district until the 1950s (Quade and Tingley, 1987).

Geologic Setting and Mineral Deposits

Four major rock units outcrop in Chalk Mountain; folded limestone and dolomite of Triassic age, volcanic-derived sedimentary rocks of Triassic-Jurassic age, quartz porphyry which intrudes the older sedimentary units, and a granodiorite which intrudes the quartz porphyry (Quade and Tingley, 1987).

The northern half of Chalk Mountain is dominated by the quartz porphyry, which has been intruded by the younger granodiorite. The southern half of the range is principally the deformed Mesozoic sediments, there is an irregular, roughly east-west contact between the quartz porphyry and the Mesozoic sediments. Within the Mesozoic sediments there are several smaller intrusions of the granodiorite (Quade and Tingley, 1987).

The lead-silver mineralization present at Chalk Mountain occurs along a northeast-trending structure on the east-side of the range within the Mesozoic limestone. The deposits occur both as veins, and along preferential beds within the limestone. The ore minerals were reported as cerussite, anglesite, cerargyrite, wulfenite, vanadinite, and argentiferous galena (Vanderburg, 1940). The ore was reported to be porous and heavily oxidized (Schrader, 1947).

Numerous prospects on the west side of Chalk Mountain, appear to have investigated the contact between the carbonates and intrusives, however, they were not as productive as the east-side deposits.

Identified Mineral Resources

It is reported that lead and silver were mined from this district, although lead appeared to be the primary commodity. Schrader (1947) reports that ore could contain 60% lead and up to 60 oz./ton silver. Quade and Tingley (1987) report that samples taken from the dump contained gold and low silver along with very high lead, zinc, and arsenic. The same authors report variable values for silver from the prospects on the west-side.

3.3.4.6 Westgate District

The Westgate District, in Churchill County, is situated at the southern end of the Clan Alpine Mountains. This district overlaps parts of both the DVTA North, and B-17/DVTA South withdrawal areas, although the DVTA North withdrawal area contains the greater part. The majority of the district lies outside of the withdrawal areas; however, several important mineralized areas are within the DVTA North withdrawal area on the west and southwest side of the Clan Alpine range.

History

Very little is known about the history of this district. It was reported in 1923 that silver-lead-gold ores were produced in the area in 1915, but no further information was provided. Vanderburg (1940) reports that a mill was built in the district in 1939, which processed ores from nearby mines outside of the district.

Geologic Setting and Mineral Deposits

The southern extent of the Clan Alpine Mountains are composed of Triassic-Jurassic aged limestone and calcareous shale; Middle Jurassic quartz arenite and limestone, and Tertiary-aged rhyolitic tuff, and andesitic lavas.

Along the western edge of the mountain range Henry and others (2013) have mapped a recumbent syncline whose axis trends northwest. The axis of the syncline is composed of the calcareous quartz arenite, while the limbs are the older limestone and calcareous shale, both of these units are cut by valley parallel, west-dipping normal faults.

The eastern half of the range is composed of numerous Tertiary-aged felsic to intermediate volcanic rocks, which all dip moderately to the east.

On the western edge of the range, faults have dissected the limestone and calcareous shale units, aplitic dikes and quartz veins follow these faults creating zones of intense gossan. Schrader (1947) reports that the deposits, like Chalk Mountain, consist of lead and silver in veins and replacement bodies at the limestone-intrusive contact. Tingley (1990) reports having observed copper staining and some lead carbonates in these gossanous zones, however, remarks that mineralization is scant.

Identified Mineral Resources

Weakly mineralized lead and silver.

3.4 Known Occurrences- Industrial Locatable Minerals

The following presents a description of the occurrence of industrial locatable minerals that occur in the Study Area and are not included in Section 3.3.

3.4.1 Barite

Historical barite production occurred at one mining district in the Study Area. The Eagleville Barite Mine located in Eagleville District produced over 2,000 tons of barite from underground workings (Horton 1963). The Rat Barite Mine, also in the Eagleville district has past barite production. Tingley (1988) assessed the districts as having production/reserves of less than 25,000 tons of barite. There has been no recent exploration and/or production efforts associated with the Eagleville District or the Eagleville Barite Mine. No recent barite exploration and/or production activities in the Study Area are known (Muntean and others, 2017).

3.4.2 Diatomite

As of 2016, there is no reported exploration and/or production of diatomite within the Study Area (Muntean and others, 2017). Tingley (1998) reports diatomite is present in the Dead Camel Mountains near the Camp Gregory mining district. Diatomite lenses occur in tuffaceous sedimentary rocks of the Truckee Formation along the southern edge of the mountain range. Diatomite deposits also occur approximately three miles southeast of the Camp Gregory district in Tertiary lake sediments. Although these diatomite deposits have been known for years (Vanderburg, 1940) and are currently held by mining claims, there has been no reported activity for many years.

3.4.3 Fluorspar

Fluorspar is a mineral aggregate or mass containing enough fluorite to be of commercial interest, primarily in the chemical, metallurgical, and ceramic industries. The primary source of fluorspar is Fluorite. Most commercially significant fluorspar occurs in veins and irregular bodies, as replacement deposits and cavity fillings, although fluorite also occurs as a gangue mineral (USGS 1966).

Nevada was a relatively consistent producer of fluorspar from 1976 through 1991 from four mines. Production records indicate producing mines are located in Pershing, Nye, Lander and Mineral counties. Much of the fluorspar mined in Nevada was from replacement deposits and breccias in Paleozoic carbonate rocks (Davis, 2015). Historic production has occurred in the IXL Canyon, the Mountain Wells, and Broken Hills Districts within the proposed withdrawal areas. Demand for fluorspar and the price of fluorspar have decreased in recent years due to a number of factors (Davis, 2015) that include, inexpensive imports from Mexico and China, the ban on chlorofluorocarbons, and changes in steel processing methods. The reduction in fluorspar mining in Nevada is associated with changes in market demand, as opposed to depletion of reserves.

3.4.4 Gems and Semi-Precious Stones

Castor and LaPointe (2001) indicates there are several sites in which gemstone quality rock and semi-precious stone can be found in or near Study Area boundaries. Area or districts and the commodities identified include the following:

- Slate Mountain: Petrified wood and agate are located southeast of Fairview Range
- Broken Hills District: Gemstone quality andorite, boulangerite, cerussite, jamesonite, and owyheeite
- Rawhide mining district: Gemstone quality alunite and barite
- Chalk Mountain Mine: Gemstone quality descloizite, mcguinnessite, mimetite, and vanadinite
- Starfire Mine: Fire Opal

No records of production are available.

3.4.5 Gypsum

Review of Tingley's 1998 mineral inventory report indicated there were no gypsum occurrences noted in mining districts located within the Study Area. Gypsum has been observed in association with oxide replacement minerals in hydrothermally altered andesite tuff breccias in the Broken Hills mining district Schrader (1947). Information contained within the USGS MRDS indicates the presence of a gypsum-anhydrite prospect along the west boundary of the Carson Sink in the proposed B-20 withdrawal area.

3.4.6 Lithium

In Nevada lithium deposits occur as lithium-bearing clays (McDermitt Caldera), and lithium-enriched brines (Clayton Valley). Both of these deposits types occur in geological environments which are found within the Study Area, specifically closed, subsiding basins surrounded by felsic volcanic material.

A review of NBMG's 2016 annual report indicates Nevada was the only state to produce lithium in 2016 (Muntean and others, 2017). The only lithium producing area in Nevada is Clayton Valley which is not located within the Study Area. Lithium produced from the Clayton Valley is from lithium-enriched brines. Based on their locations, approximately 50 percent of the 19,040 new claims staked in 2016 were for lithium exploration. NBMG's 2016 annual mineral industry report does not document recent lithium exploration and/or production efforts in the Study Area (Muntean and others, 2017).

3.4.7 Sulfur

Sulfur is primarily used to make sulfuric acid, which in turn is used extensively in the fertilizer industry. Sulfur is also used in the chemical, paper products, and explosives industries (Nash, 1996). Volcanic centers, Miocene to recent in age, are most commonly associated with native sulfur deposits. Most economic sulfur occurrences in Nevada occur as fumarole-type deposits. These fumarole deposits precipitate sulfur on the surfaces of host-rock in vents, vesicle, breccia, and other open volcanic structures adjacent to volcanoes.

Papke and Castor (2003) Map 142 indicates there are no significant sulfur deposits within the Study Area. Sulfur occurrences within the Study Area are considered secondary deposits and are likely associated with metallic ore deposits. In these deposits, sulfur occurs as common accessory sulfide minerals in mercury and precious metal deposits. These sulfide mineral sources for sulfur are not the most favorable for development, as they require significant processing.

3.4.8 Zeolite

The occurrence of zeolites is documented in the Westgate District. According to Bennet and Hoke (1975), zeolites of the Westgate mining district were formed by alteration of volcanic ash deposited in a saline lake environment. No production records are available.

3.5 Known Leasable Resources

The following presents a description of the occurrence of leasable resources which occur within the Study Area.

3.5.1 Geothermal

Nevada is the second largest geothermal power producing state in the US after California with existing production capacity of approximately 717 megawatts (MW) (NDOM, 2017 and EIA, 2016).

Geothermal water not hot enough for electrical power generation may be used for general building heating, or for other purposes such as growing crops, dehydrating vegetables, as well as for climate control such as aquaculture, spas, recreational hot springs, and swimming pools. Such direct uses are developed in Nevada, primarily in urban areas.

A review of BLM and NBMG records indicate there are at least 27 operating geothermal power plants at 15 geothermal sites in the state of Nevada. As shown in Figure 3.11, ten of the operating geothermal power plants are located in the vicinity of the Study Area, indicating that significant geothermal resource potential exists within the Study Area. However, none of the producing sites are located within the proposed withdrawal area boundaries. The Don A. Campbell plant facilities are within 5 km of the proposed B-17 boundary. Other existing power plants are generally more than 20 km from the Study Area boundaries. The existing power plants in the Study Area vicinity are listed in Table 3.3 (NDOM, 2017) with the nameplate capacity in Megawatts (MW) and gross output in Megawatt-hours (MWH).

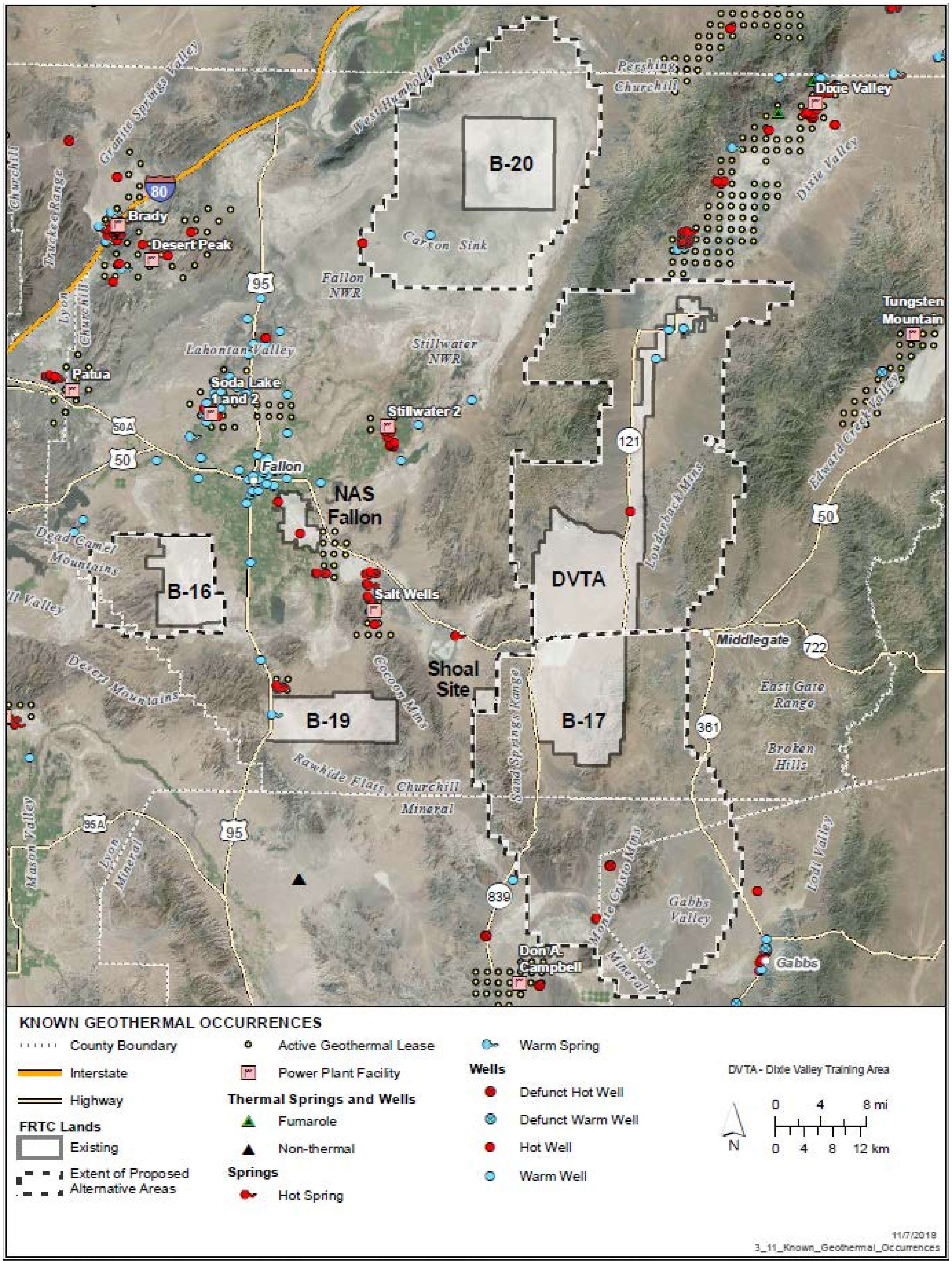


Figure 3.11: Known Geothermal Occurences

Table 3.3: Existing Geothermal Production in Study Area Vicinity

Power Plant	Year of Initial Operation	Name Plate Capacity (MW)	Gross Output (MWH)
Wabuska	1984	5.6	17,411
Desert Peak	1985	23	125,973
Soda Lake 1&2	1987	23.1	109,917
Dixie Valley	1988	64.7	531,212
Stillwater	1989	47.2	203,347
Brady	1992	26.1	90,460
Salt Wells	2008	23.6	132,258
Patua	2013	48	203,996
Don A. Campbell[1]	2013	40	425,842
Tungsten Mtn	2017	37	34,469

Notes: 1: Also known as Wild Rose and Wild Rose II.

The Wabuska geothermal area was a former direct use site utilized for space heating and aquaculture (NMBG, 2017). No other direct use sites are known in the Study Area vicinity.

3.5.1.1 Exploration Projects

There are more geothermal exploration and development projects in Nevada than in any other state. As of March 2012, Nevada had 70 geothermal exploration projects in various stages of development (Shevenell and Zehner, 2012). Nevada has seen a period of rapid growth in geothermal exploration and development within the past 15 years. Geothermal resource exploration and development is increasing and is expected to continue to increase in the future (Shevenell and Zehner, 2012). Grants from the Department of Energy, and the State of Nevada, as well as favorable regulations, and tax incentives stimulate geothermal and other renewable energy resource development in Nevada.

Table 3.4 provides a lists of geothermal power projects in the Study Area vicinity compiled from OpenEI Geothermal Projects List (http://openei.org/wiki/category/:Geothermal_Projects) and from NBMG 2016 Annual Report (NBMG, 2016). The estimated installed capacity, project type, and phase of the project are also included in the table. This list is likely an under-representation of the early stage geothermal exploration activities which are taking place in the Study Area vicinity.

Table 3.4: Geothermal Development Projects in the Study Area Vicinity

Project Name	Developer	Estimated Installed Capacity	Project Type	Previous Production	County	Project Phase[1]
Brady EHS	Ormat	22 MW	Enhanced Geothermal System	Produced Resource	Churchill	Phase 4
Frontier Observatory for Research in Geothermal Energy	USDOE	-	Enhanced Geothermal System	Unproduced Resource	Churchill	Research
Dixie Meadows	Ormat	15-20 MW	Conventional Hydrothermal	Unproduced Resource	Churchill	Phase3
New York Canyon	TerraGen	70 MW	Conventional Hydrothermal	Unproduced Resource	Pershing	Phase 3
Aurora	Gradient Resources	190 MW	Conventional Hydrothermal	Unproduced Resource	Mineral	Phase 2
Colado	Gradient Resources	60 MW	Conventional Hydrothermal	Unproduced Resource	Pershing	Phase 2
Fallon	Gradient Resources	50 MW	Conventional Hydrothermal	Unproduced Resource	Churchill	Phase 2
Desert Queen	Alterra Power	36 MW	Conventional Hydrothermal	Unproduced Resource	Churchill	Phase 2
McCoy	Alterra Power	80 MW	Conventional Hydrothermal	Unproduced Resource	Churchill & Lander	Phase 2
Upsal Hogback	Alterra Power	N/A	Conventional Hydrothermal	Unproduced Resource	Churchill	Phase 2

Notes: Phase 1 – Prospects
Phase 2 – Exploration
Phase 3 – Under Construction
Phase 4 - Operational

According to information published in NBMG's 2016 annual report (NBMG, 2016), BLM offered 22 parcels for geothermal exploration in 2016; leases for fourteen parcels totaling approximately 32,000 ac were sold. Figure 3.11 shows the active geothermal leases in the Study Area vicinity. Figure 3.11 shows that none of the land offered for lease was located within the proposed withdrawal area boundaries; however, some parcels were located adjacent to existing and proposed withdrawal areas. In 2016, Nevada Division of Minerals (NDOM) permitted 14 wells and 16 new geothermal wells were drilled. This is a reduction from previous years and has shown a steady decrease since a peak of 71 wells drilled in 2009 (NBMG, 2016).

3.5.1.2 Available Geothermal Direct Evidence Data

Direct exploration methods for geothermal systems include well and spring temperature data, temperature gradient data, shallow gradient data, and geochemical geothermometer data. The Nevada Bureau of Mines and Geology (NBMG, 2016) maintains a geothermal database and interactive map (https://web2.nbmg.unr.edu/NevadaGeothermal/) that includes these data sets derived from a variety of private and government funded projects dating back to the 1960s. In addition, well temperature data from 43 bore holes drilled to depths of 150 m (500 ft.) by the Navy in 2012 was provided for this assessment.

A geothermal cluster is defined as a geographic grouping of wells which have at least one known occurrence of thermal water (greater than 20°C), and /or appear to have a common source and could represent a continuous anomaly at depth. Springs, wells, and geothermal clusters within the withdrawal area are shown on Figure 3.12. Table 3.5 summarizes the geothermal data for the geothermal clusters in the vicinity of the withdrawal areas.

Geothermal gradients greater than 100 degrees Celsius per kilometer (°C/km) are shown as hot gradient holes on Figure 3.12. Springs and wells are considered hot if their temperature exceeds 37°C. The holes drilled by the Navy are labeled warm if the maximum temperature at 150 m is greater than 30°C, they are labeled hot if the temperature exceeds 50°C.

Table 3.5: Known Geothermal Cluster Summary Within the Proposed Withdrawal Areas

Geothermal Cluster	Thermal Springs and Wells		Gradient Holes		Geothermometer	
	No.	Max T °C (depth [m])	No.	Max Grad. (°C/km)	No.	Max. T (°C)
Fallon	-	-	10	98.3	-	-
Dead Camel Mountains	2	30 (219.5)	-	-	-	-
Lee Allen Hot Springs	10	96 (2)	5	94.6	5	192.9
Bell Flat	-	-	2	713	-	-
Gabbs	13	62.2 (0)	55	330	-	-
Dixie Valley	33	77.6 (500)	92	612	2	83.9
Carson Sink	-	-	15	136	-	-

The Fallon geothermal cluster encompasses the city of Fallon and extends west into the proposed B-16 withdrawal area. Gradient measurements are available from 10 holes within the existing and proposed B-16 withdrawal area with a maximum gradient of 98.3°C/km. The Dead Camel Mountains geothermal cluster is approximately 1 km west of the B-16 expansion area boundary. Temperature data is available from two wells.

The Bell Flat geothermal cluster is entirely within the proposed B-17 expansion area. Two hot gradient holes are present in Bell Flat with a maximum gradient of 713°C/km.

The Don A. Campbell geothermal power plant is on the west side of the Gabbs Valley geothermal cluster, outside of the proposed B-17 withdrawal area. Rawhide Hot Spring is within the B-17 expansion area and has a reported temperature of 62.2°C. Two hot temperature wells were drilled by Ormat Nevada, Inc. in the vicinity of Rawhide Hot Spring. Twelve hot gradient holes are present within the proposed B-17 withdrawal boundary. The highest gradient hole was 330°C/km. Several hot wells are present approximately 6 km southeast of the B-17 proposed withdrawal boundary with temperatures up to 68.3°C at a depth of 99 m near the town of Gabbs.

Area B-20 is largely within the Carson Sink geothermal cluster. Within the proposed B-20 withdrawal there are approximately 15 gradient holes with a maximum gradient of 136°C/km. There are five permitted wells and one warm well.

The southern portion of the Dixie Valley geothermal cluster includes much of the proposed DVTA withdrawal area. The northern portion of the Dixie Valley Geothermal cluster includes known geothermal occurrences at Dixie Hot Springs, Hyder Hot Springs, Dixie Valley Power Plant. Jersey Valley geothermal cluster within the adjoining Jersey Valley and hosts the Jersey Valley hot spring and Jersey Valley Power Plant. Within the DVTA there are nearly 100 gradient holes of which approximately 25 are hot gradient holes with maximum gradient 612°C/km. There are two exploration (EX) Gradient Hole anomalies (Pirouette Mountain and Elevenmile Canyon) that were drilled in the late 1970s by Hunt Energy Corp., as of 2012 the U.S. Navy Geothermal Program Office was exploring the projects for future development (Williams and Blackwell, 2012). Drill holes by the Navy encountered water temperatures up to 77.6°C at depths of 150 m located in the vicinity of the 612°C/km hot gradient hole.

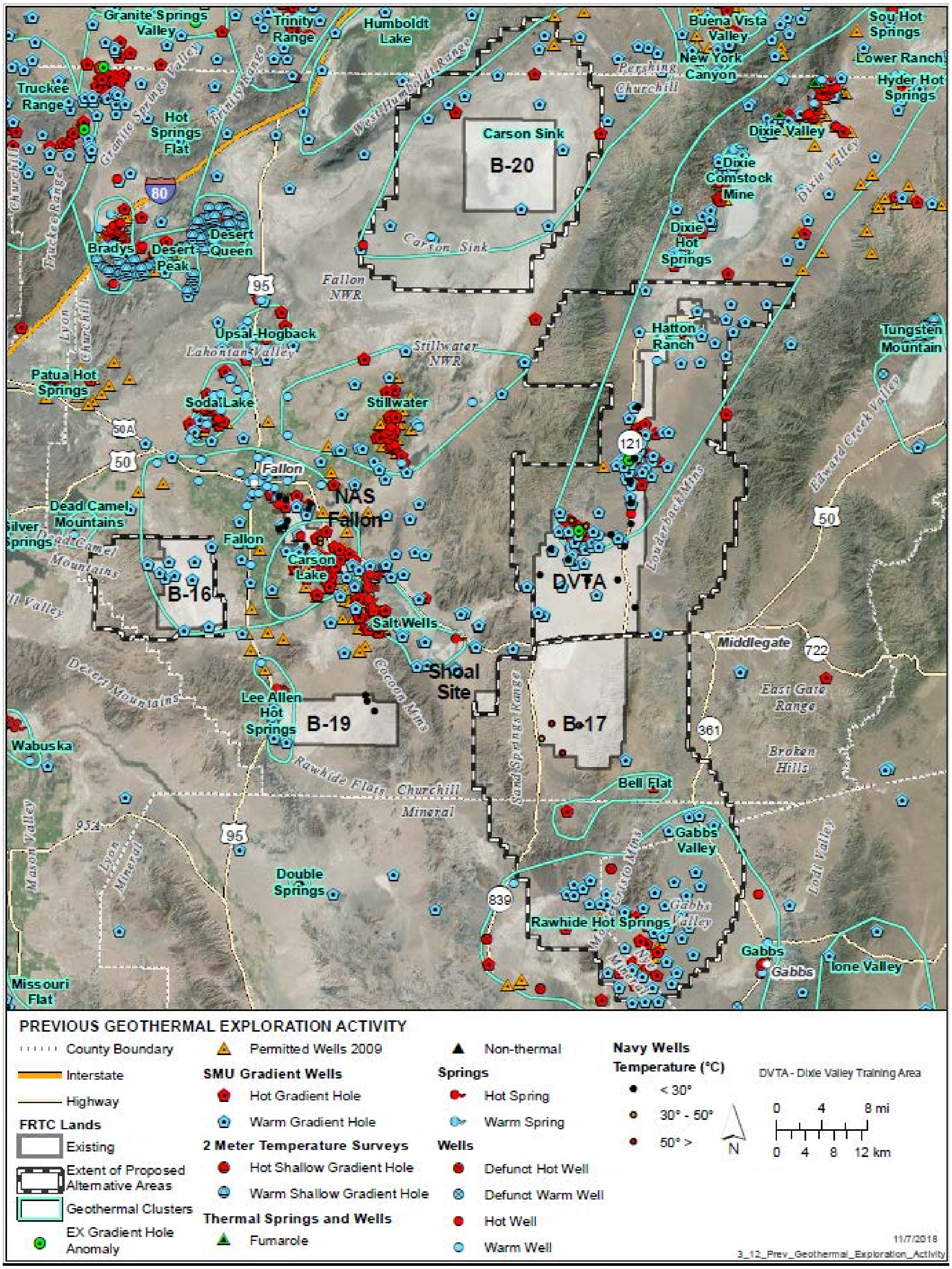


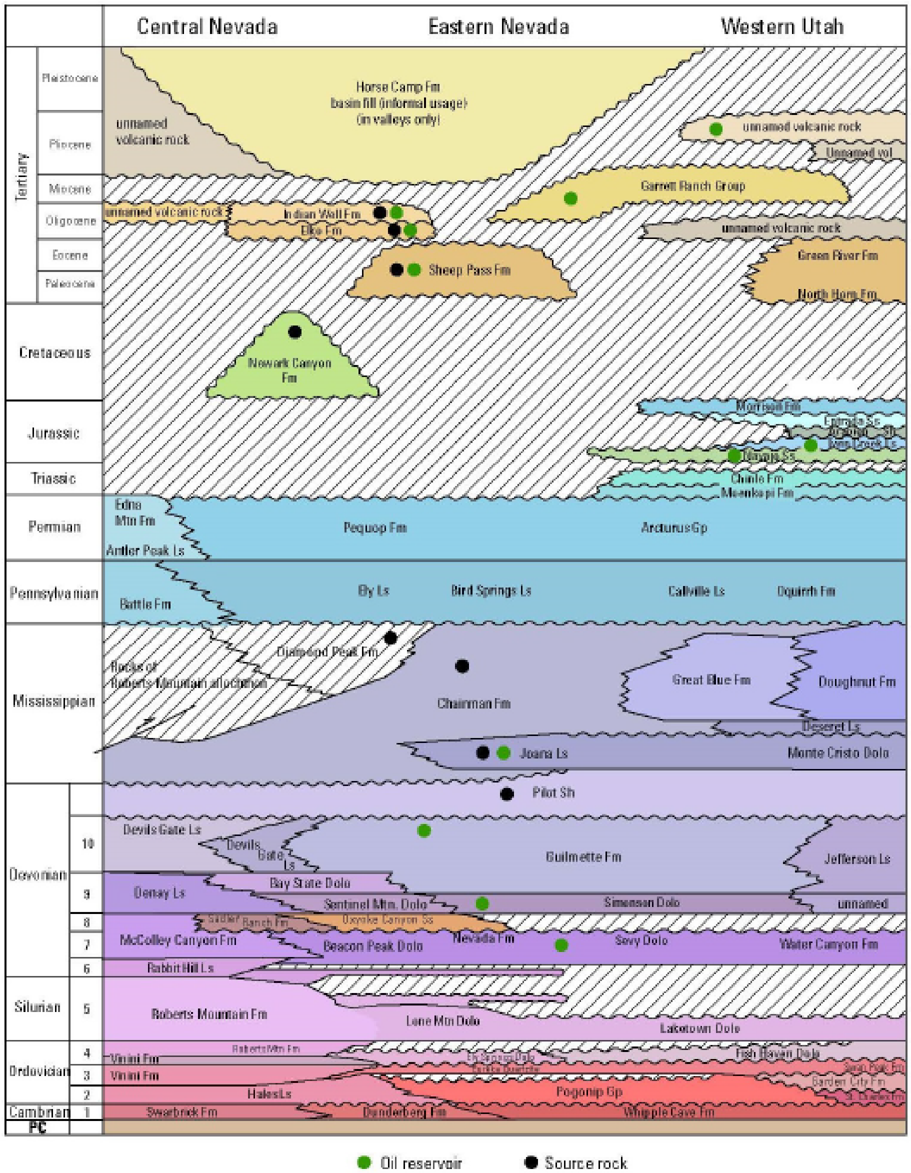
Figure 3.12: Previous Geothermal Exploration Activity

3.5.2 Oil and Gas

Nevada oil and gas production accounts for a very small fraction of the overall U.S. oil and gas production. NBMG (2016) reports that there are 64 actively producing wells in the state; average maximum production is approximately 90 barrels per day. Producing fields are primarily found to the east of the Study Area in Railroad Valley (Nye County) and northeast of the Study Area in Pine Valley (Eureka County). The only producing gas field in Nevada is located in the Kate Springs area of eastern Nye County.

Commercially viable accumulations of oil and gas require a hydrocarbon source rock, a migration pathway for generated hydrocarbons, a reservoir where hydrocarbons are accumulated and a trap or seal to contain the hydrocarbons. To date, all producing Nevada oil fields occur in Neogene basins where the combination of source rock burial, heating, and valley fill seals have resulted in oil generation and preservation, within the eastern Great Basin.

Figure 3.13 is a generalized section through the Great Basin of central Nevada, eastern Nevada, and Western Utah and identifies known hydrocarbon source and reservoir rocks (Anna and others, 2007). The most important hydrocarbon source rocks in the eastern Great Basin are the upper Devonian/Mississippian Pilot Shale and the Mississippian Chainman Shale. The early Mississippian-aged Joana Limestone has been identified as a potential source rock for hydrocarbons, however, no produced oil has been typed to the Joana Limestone (Anna and others, 2007). For the most part these formations occur to the east and southeast of the Study Area.



Anna and Others, 2007

GENERALIZED STRATIGRAPHIC SECTION ILLUSTRATING EASTERN GREAT BASIN PETROLEUM SOURCE AND RESERVOIR ROCKS

10/5/2018
3_13_Generalized_Strat_Column

Figure 3.13: Generalized Stratigraphic Section Illustrating Eastern Great Basin Petroleum Source and Reservoir Rocks

A query of the NBMG online Oil and Gas Well Search database in September 2018 indicates there are several historical wells within Study Area boundaries, as shown in Figure 3.14. Table 3.6 summarizes the historic oil and gas wells in the area, a count of holes within in the four withdrawal areas is included for reference. Almost all of the wells with oil and/or gas showings were drilled prior to 1985. Natural gas has been reported from seeps and water wells in the Study Area, including one near Soda Springs to the northeast of the proposed B-16 withdrawal area.

One well drilled in 2007 within the proposed B-17 withdrawal area, in the Gabbs Valley area, recorded an oil show, however, there are no production records associated with this well.

Table 3.6: Summary of Oil and Gas Wells in Area

Well Type	Count	No. In Target Area			
		B-16	B-17	B-20	DVTA
Oil Show	6	0	1	0	0
Gas Show	8	0	0	1	0
Oil & Gas Show	6	0	0	1	0
Dry Well	31	1	4	1	0
Total	**51**	**1**	**5**	**3**	**0**

There is one authorized oil and gas lease in the B-17 (Alternative 3) withdrawal area (Gabbs Valley). There are also authorized oil and gas leases southeast of the Study Area in Esmeralda County. Three oil and gas wells were permitted in 2016 and only one well was drilled. In January 2016, one oil and gas well was permitted west of the Study Area in Churchill County. The well location was southeast of Fallon.

A review of NBMG information indicates there were no Federal oil and gas leases in effect for 2015 and 2016 in Lyon County. There were two competitive leases and three noncompetitive leases in effect in Churchill County in 2016. There were no competitive leases and one noncompetitive lease in effect in 2016 in Mineral County. In 2016, seven competitive and two noncompetitive oil and gas leases were in effect in Pershing County. The greatest number of Federal leases was in effect in Nye County. These leases primarily are located in the eastern portion of the Nye County away from the Study Area.

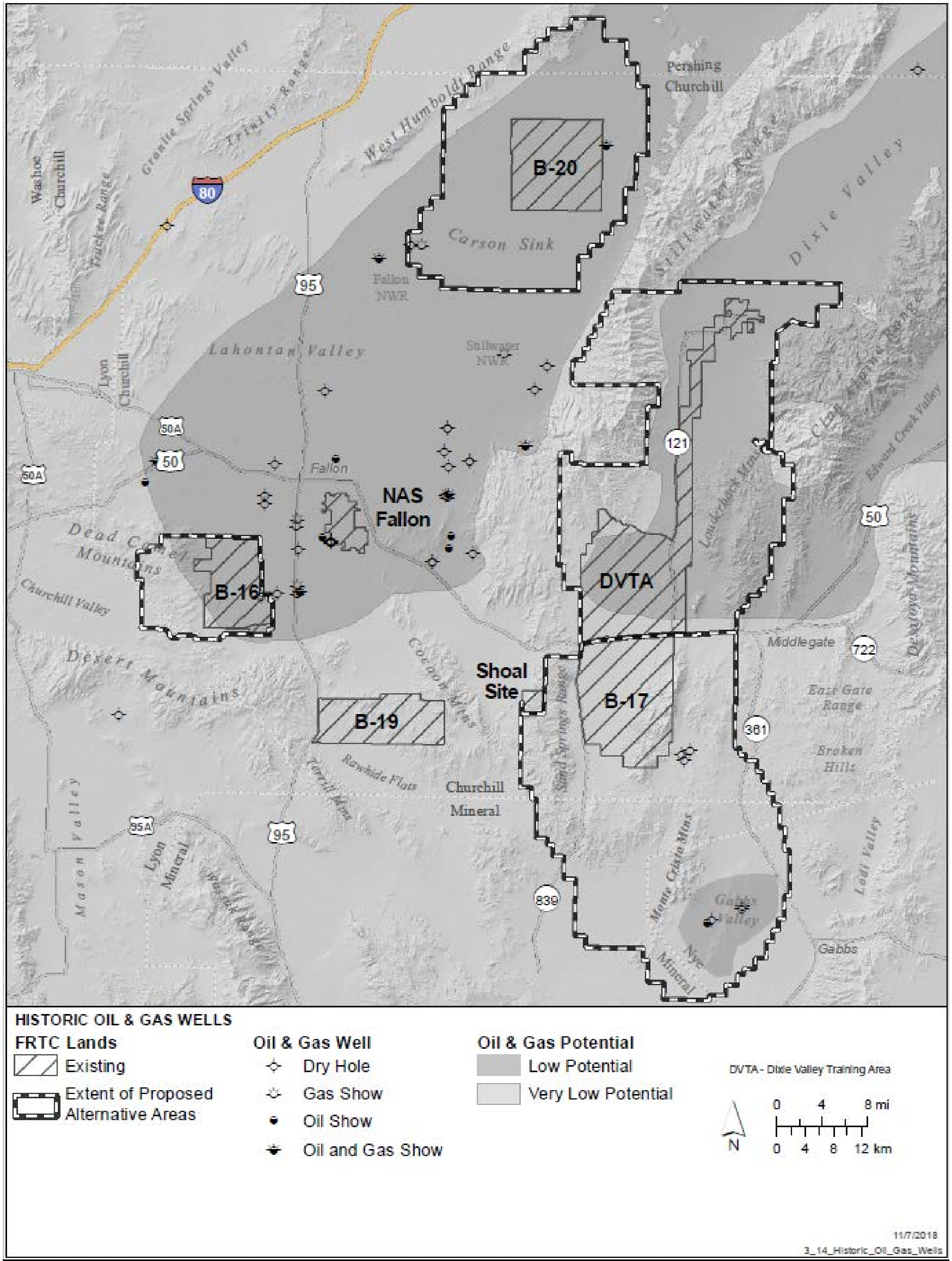


Figure 3.14: Historical Oil and Gas Wells

3.5.3 Oil Shale

Oil shale has been reported in the Elko Formation (Mississippian). The Vinini Formation (Ordovician), Woodruff Formation (Devonian), Sheep Pass Formation (Eocene), and the Elko Formation (Eocene-Oligocene) are also potential sources of oil shale (Anna and others, 2007). However, these formations likely do not extend west into the Study Area. NBMG records contain no information regarding exploration, or production, of oil shale deposits within or adjacent to existing and/or proposed withdrawal areas.

3.5.4 Native Asphalt

No native asphalt production or occurrences are reported in the Study Area, or elsewhere, in Nevada.

3.5.5 Coal

There are no commercial coal deposits in the State of Nevada and only a few reported occurrences of coal in southern Nevada. Garside and Papke (1980) concluded that Nevada contains only minor occurrences of poor-quality coal in low-tonnage deposits that would be difficult to mine.

The only coal occurrence of note is found in Nye county, approximately 60 miles south of Fallon. Coal was produced in limited quantities from the Lewis Coal mine in the early 1900s, with no production beyond 1920. Review of NBGM and BLM records indicate no coal is currently leased within the Study Area (BLM, 2012). Furthermore, there are no reported coal occurrences within the Study Area (Tingley, 1998).

3.5.6 Phosphate

No phosphate production or occurrences are reported within the Study Area. According to Papke and Castor (2003), known Nevada phosphate deposits primarily exist in Elko County.

3.5.7 Potash

Potash primarily is mined from large evaporite potash beds containing sylvite or carnallite which have not, thus far, been discovered in the Study Area. These deposits are typically associated with thick beds of halite and are the result of continuing evaporation of water after halite has precipitated from the water. The playa lakes within the Study Area are geological environments potentially suitable for this type of deposit. Potash can also be produced by processing minerals such as alunite or kalinite which are also sources of aluminum. Papke and Castor (2003) report minor production of kalinite, but grades were too low to sustain production.

3.5.8 Sodium Minerals

The Huck Salt mine is Nevada's only commercial Salt producer, actively mining from the Fourmile Flat playa located south of U.S. Route 50 approximately four miles west of existing and proposed DVTA withdrawal areas and approximately four miles northeast of the existing B-19 withdrawal area in Salt Wells Basin. Mining began near Fourmile Flat in 1863. The locally-owned Huck Salt mine currently extracts evaporite (salt and borax) deposits from the dry lake bed surface for commercial purposes (de-icing roads and for water softeners). Another playa, Eightmile Flats, is located in the Salt Wells Basin west of the Sand Springs Range.

Huck Salt produced 19,110 tons of salt in 2016 (Perry and Visher, 2017) at their Churchill County operation, which is outside of the Study Area. This salt is primarily used for de-icing roads (USGS, 2003). There is also records of Salt being mined from the large playa in Carson Sink. Existing and proposed B-20 withdrawal areas are located in the Carson Sink basin. Although there is potential for mining of salt from playas within and adjacent to the Study Area, there is no current production of salt.

3.6 Known Saleable Mineral Deposits

The following presents a description of the known saleable mineral deposits, which occur in the Study Area.

3.6.1 Clay Minerals

According to Papke and Castor (2003), the Some Tuesday area in Churchill County had an insignificant past production of clay materials. Information obtained via NBMG's searchable mining district file database indicates the Some Tuesday clay (kaolinite) mine is located in the Dead Camel Mountains within the proposed B-16 withdrawal area. This location is approximately one-mile east of the Churchill and Lyon County line. The Some Tuesday clay mine is no longer in operation.

3.6.2 Aggregate, Sand, and Gravel

Aggregate is produced from natural deposits of sand and gravel, and from selected quarried materials that are mined and processed to meet material gradation requirements. According to the Carson City BLM, there are no commercial aggregate and/or sand and gravel mining operations within or adjacent to Study Area boundaries. However, numerous (historical and active) small scale sand and gravel quarries and borrow pits exist within the Study Area. A number of these features are administered by BLM and other governmental agencies such as NDOT. Extracted material typically is used for local purposes including road base material, concrete additive, and other construction related uses. Local sand and gravel mining efforts generally occur at alluvial channel or terrace deposits, or in basin fill sediments in proximity to communities or along highways roads. Review of BLM LR2000 records indicates there are five NDOT borrow pits located within the Study Area. The locations of the borrow pits are summarized in Table 3.7 below and shown in Figure 3.15.

Table 3.7: Summary of Study Area NDOT Borrow Pits

Township	Range	Section	County	Ac	Physical Location	Withdrawal Area
21 N	34 E	22	Churchill	41	NA	Alternative 1 DVTA
18 N	34 E	9	Churchill	60	Dixie Valley	Alternative 1 DVTA
13 N	35 E	3	Nye	---	---	---
14 N	35 E	34	Nye	80	NA	Alternative 3 B-17
16 N	35 E	5	Churchill	---	---	---
17 N	35 E	32	Churchill	160	U.S. 50 / Westgate	Alternative 1 DVTA
16 N	33 E	18	Churchill	40	Scheelite Road	Alternative 1 DVTA

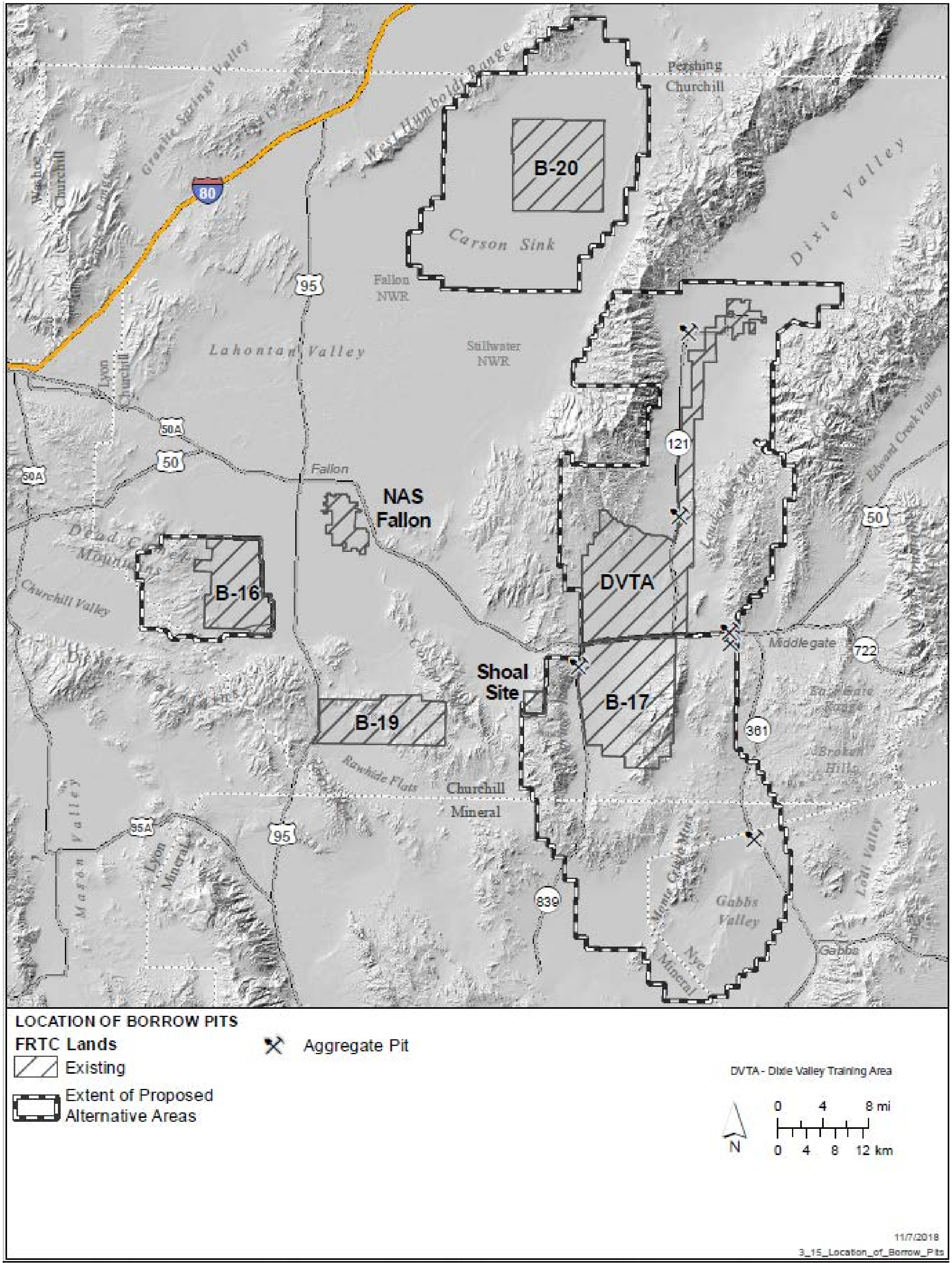


Figure 3.15: Location of Borrow Pits

Review of USGS MRDS indicates six borrow pits were located along U.S. 50 between Middlegate and just west of Summit Pass in Churchill County.

3.6.3 Clay

Clay deposits form in a variety of rock types and geologic settings. Clay deposits in Nevada are primarily found in hydrothermally altered rocks or in fine-grained, clastic, lacustrine sedimentary rocks and deposits. Clay deposits are also derived from hydrothermal weathering of glassy volcanic ash and tuffs (Nash, 1996).

According to NBMG's 2016 annual mineral industry report, Nevada has never been a large clay producer; the state's 2016 clay production only accounts for 0.35% of domestic production, approximately 100,447 tons in 2015 (NMBG 2016). There are no significant clay mining operations within or adjacent to Study Area boundaries. Papke and Castor (2003) reported that there was a small historic clay mine in the Some Tuesday area of the Dead Camel Mountains within the proposed B-16 withdrawal area. This location is approximately one-mile east of the Churchill and Lyon County line.

3.6.4 Pumice & Cinder

Pumice and cinder are used in abrasives, lightweight cement aggregate and concrete building blocks. There are several documented occurrences and former mines outside the Study Area. Cinder is actively being produced from the Cinderlite Rock mine in Carson City County to the west of the Study Area; however, pumice currently is not produced in Nevada. Papke and Castor (2003) indicate there are no current or historical pumice, pumicite, or cinder operations within, or adjacent, to Study Area boundaries.

3.6.5 Building, Ornamental & Specialty Stone

Building stone was historically mined in the Gabbs Valley Range, near the south DVTA/B-17 withdrawal areas; however, there is no current production. Review of NBMG's 2016 annual report and Papke and Castor (2003) indicate there is not significant dimension/building/ornamental stone and/or landscape rock produced within or adjacent to Study Area boundaries.

3.6.6 Petrified Wood

Middle Miocene aged petrified wood occurs southeast of Slate Mountain between Fairview Range, the Sinkavata Hills and Bell Flat, and in the Middlegate, Rawhide, and Gabbs areas Mustoe (2015). This area is located within the proposed B-17 withdrawal area. Although there likely are other occurrences of petrified wood throughout the Study Area, none are considered significant.

4.0 ASSESSMENT OF MINERAL AND ENERGY RESOURCE POTENTIAL

As stated in Section 1.0 of this Report, the Mineral Potential Classification System used in this assessment is as defined in BLM Manual 3031 (BLM, 1985):

- **Level of Potential:**
  - O = No Potential: The geologic environment, the inferred geologic processes, and the lack of mineral occurrences do not indicate potential for accumulation of mineral or energy resources.
  - L = Low potential: The geologic environment and inferred geologic processes indicate a low potential for accumulation of mineral resources.
  - M = Moderate potential: The geologic environment, the inferred geologic processes, and the reported mineral or energy occurrences or valid geochemical/geophysical anomaly indicate moderate potential for the accumulation of mineral resources.
  - H = High potential: The geologic environment, inferred geologic processes, the reported mineral or energy occurrences and/or valid geochemical/geophysical anomaly, and the known mines or deposits indicate high potential for the accumulation of mineral or energy resources. The “known mines and deposits” do not have to be in the area that is being classified but have to be within the same type of geologic environment.
  - ND = Potential not determined: Mineral and energy resource potential not determined due to a lack of useful data. This notation does not require a level-of-certainty qualifier.
- **Level of Certainty:**
  - A = The available data are insufficient and/or cannot be considered as direct or indirect evidence to support or refute the possible existence of mineral or energy resources within the respective area.
  - B = The available data provide indirect evidence to support or refute the possible existence of mineral or energy resources.
  - C = The available data provide direct evidence but are quantitatively minimal to support or refute the possible existence of mineral or energy resources.
  - D = The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral and energy resources.

The mineral potential classification system is shown in tabular form in Table 4.1.

Table 4.1: Mineral Potential Classification System

<table>
<tr><td rowspan="4">Increasing Potential >>></td><td rowspan="3">ND
Unknown Potential</td><td>H/A
High Potential</td><td>H/B
High Potential</td><td>H/C
High Potential</td><td>H/D
High Potential</td><td rowspan="3">O/D
No Potential[1]</td></tr>
<tr><td>M/A
Moderate Potential</td><td>M/B
Moderate Potential</td><td>M/C
Moderate Potential</td><td>M/D
Moderate Potential</td></tr>
<tr><td>L/A
Low Potential</td><td>L/B
Low Potential</td><td>L/C
Low Potential</td><td>L/D
Low Potential</td></tr>
<tr><td colspan="6">Increasing Certainty >>></td></tr>
</table>

Notes:

1 - Not commonly used and only in special circumstances

Source - Based on BLM Manual 3031 (1985), Illustration 3

The Mineral Potential Classification System addresses the potential for the presence or occurrence of a mineral concentration. The classification system does not require an estimate of the economic significance, or the commercial viability, of the concentration. It should be noted that the BLM uses the shortened term “mineral potential” to include both mineral and energy resource potential.

The following assessment is based on previously published information including previous assessment, historical mine records, national geochemical, and geophysical data sets. No direct field investigation was executed as part of this assessment.

4.1 Locatable Minerals

The following presents the mineral potential classification for metallic and industrial locatable minerals. The information used to evaluate the mineral potential is summarized here to clarify the rationale used to determine potential. The discussion is organized with respect to locatable commodities and the potential occurrences as it pertains to specific areas within each of the withdrawal areas.

4.1.1 Mineral Potential of Metallic Locatable Minerals

The following sections present mineral potential classifications for metallic locatable minerals. Table 4.2 presents a summary of the mineral production and the mineral potential classification for locatable minerals in each withdrawal area.

Table 4.2: Summary of Metallic Locatable Resources

Withdrawal Area	Location	Approximate Active Unpatented Claim Listings per Location	Mineral Resource	Deposit Type	Recorded Production	Resource Potential	Certainty Level	Comments
B-16	Camp Gregory District	8	Au, Ag	Epithermal	N/A	Moderate	B	Defined by permissive geologic relationships, Mihalasky (2001)
B-17	Rawhide District	751	Au	Epithermal	17,927 oz. in 2016	High	D	Defined by historic and current production
			Ag	Epithermal	105,413 oz. in 2016	High	D	Defined by historic and current production
	Leonard District	9	W	Pluton-Related	4,995,900 lbs.	High	D	Defined by historic production
			Au, Ag	Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships
			Cu	Pluton-Related	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships, single element anomalies
	Eagleville District	68	Au	Pluton-related	28,000 USD	High	D	Defined by historic production
			Ag	Pluton-Related, Epithermal	N/A	Moderate	B	Defined by Mihalasky (2001)
			Cu, Pb	Pluton-related	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships, single element anomalies
	King District	20	Au	Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships
			Cu, Mo	Pluton-Related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships
	Broken Hills District	146	Ag, Pb	Epithermal	250,000 USD	High	D	Defined by historic production
			Cu, Mo, Zn	Pluton-Related	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships
	Poinsettia District	36	Au, Hg, Sb, Cu	Pluton-related	N/A	Moderate	B	Defined by mineral occurrences, permissive geologic relationships
	Monte Cristo Prospect	4	Cu	Pluton-related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships
B-17/DVTA	Westgate District	22	Pb, Ag, Au	Pluton-related	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships, Mihalasky (2001)
			Cu	Pluton-related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships
	Sand Springs District	17	Au	Epithermal	20,895 oz.	High	D	Defined by historic production
			Ag	Epithermal	1,262,655 oz.	High	D	Defined by historic production
			W	Pluton-related	42,029 lbs.	High	D	Defined by historic production
			Cu	Pluton-related	N/A	Moderate	B	Defined by single element anomalies, permissive geologic relationships
	South Sand Springs Prospect	0	Au, Ag	Pluton-Related, Epithermal	N/A	Moderate	B	Defined by Mihalasky (2001)
	Fairview District	70	Au	Epithermal	48,000 oz.	High	D	Defined by historic production
			Ag	Epithermal	4,700,000 oz.	High	D	Defined by historic production
			Cu, Mo, Pb, Zn	Pluton-related	N/A	High	C	Defined by mineral occurrence, permissive geologic relationships
	Slate Mountains Prospect	0	Au, Ag	Pluton-Related, Epithermal	N/A	Moderate	B	Defined by Mihalasky (2001)
	Gold Basin District	25	Au	Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships
	Bell Mountain District	400	Au	Epithermal	19.5 oz.	High	D	Defined by historic production
			Ag	Epithermal	639.6 oz.	High	D	Defined by historic production
DVTA	I.X.L Canyon District	0	Ag	Pluton-related, Epithermal	20,000 USD	High	D	Defined by historic production, permissive geologic relationships
			Au	Pluton-Related, Epithermal	N/A	Moderate	B	Defined by Mihalasky (2001)
			Pb, Zn, Cu	Pluton-related, Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships, single element anomalies
			W	Pluton-related	N/A	Moderate	C	Defined by permissive geological relationships, single elements anomalies
	Job Peak District	0	Cu, Mo	Pluton-related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships
	Mountain Wells (La Plata) District	0	Mo, W, Cu	Pluton-related	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships, single element anomalies
			Ag	Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships, single element anomalies
			Au	Pluton-Related, Epithermal	N/A	Moderate	B	Defined by Mihalasky (2001)
			Zn	Pluton-Related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships

Withdrawal Area	Location	Approximate Active Unpatented Claim Listings per Location	Mineral Resource	Deposit Type	Recorded Production	Resource Potential	Certainty Level	Comments
	Wonder District	11	Au	Epithermal	69,000 oz.	High	D	Defined by historic production
			Ag	Epithermal	6,400,000 oz.	High	D	Defined by historic production
			Pb	Pluton-Related, Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships
			Cu	Pluton-Related, Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships
	Chalk Mountain District	26	Pb	Pluton-related	861,355 lbs.	High	D	Defined by historic production
			Ag	Pluton-related	59,651 oz.	High	D	Defined by historic production
			Au	Pluton-related	99 oz.	High	D	Defined by historic production
			Cu	Pluton-related	N/A	High	C	Defined by mineral occurrences, single element anomalies, permissive geological relationships
			Zn	Pluton-Related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships
B-20	Wild Horse District	9	W	Pluton-related	200 tons of ore	High	D	Defined by historic production
			Sb	Pluton-related	46 tons	High	D	Defined by historic production
			Cu, Mo	Pluton-related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships
			Pb, Zn	Pluton-related	N/A	Moderate	C	Defined by single element anomalies, permissive geologic relationships
			Fe	Pluton-related, Epithermal	N/A	High	C	Defined by mineral occurrences, permissive geologic relationships

4.1.1.1 Gold and Silver

Nevada is a major metallic mineral producer. According to NBMG's 2016 annual mineral industry report, Nevada gold production accounted for 81 percent of total U.S. gold production and 5.5 percent world gold production in 2016. Based on information obtained from NBMG and NDOM, there are no recent active producing mines in the Withdrawal Area. The Denton-Rawhide Mine is located immediately adjacent to (within one mile), and southwest of, the proposed Alternative 1 DVTA withdrawal boundary in Mineral County and is the only active gold and silver mine in the vicinity of the Withdrawal Area. The Denton-Rawhide Mine reported gold production approximating 0. 3 percent of the State's total reported gold output in 2016. It should be noted that all gold production in the Study area is associated with volcanic hosted epithermal deposits.

The potential for gold and silver production across northern Nevada, including much of the Study Area, has been evaluated by many authors. Mihalasky (2001) presents a model of the potential for volcanic and sedimentary rock-hosted gold and silver deposits throughout Nevada. The model presented by Mihalasky (2001) evaluated potential by determining conditional relationships between measured indicators and known conditions, using a weight of evidence modeling method. Factors used to predict mineral potential were structural, geochemical, geomagnetic, gravimetric, lithologic, and lithotectonic data. Figure 4.1 and Figure 4.2 present the findings of Mihalasky (2001) for Volcanic Hosted Gold and Silver exploration areas and favorable Sedimentary Rock Hosted Gold and Silver Deposits, respectively. The higher the posterior probability score, the greater the mineral potential.

Based on the BLM 3031 classification criteria, the Mihalasky (2001) findings are too broad to support a mineral potential rating higher than a M/B. We evaluated historic mining activity on a district scale (Section 3.3) to support mineral potential classification. Figure 4.3 and Figure 4.4 present the mineral potential classification for gold and silver, respectively. Mineral potential rankings were defined as follows:

- H/D: Mining districts with documented historical production.
- H/C: Mining districts with documented mineralization, but no production.
- M/B: Areas rated as having high gold and silver potential based only on Mihalasky (2001).

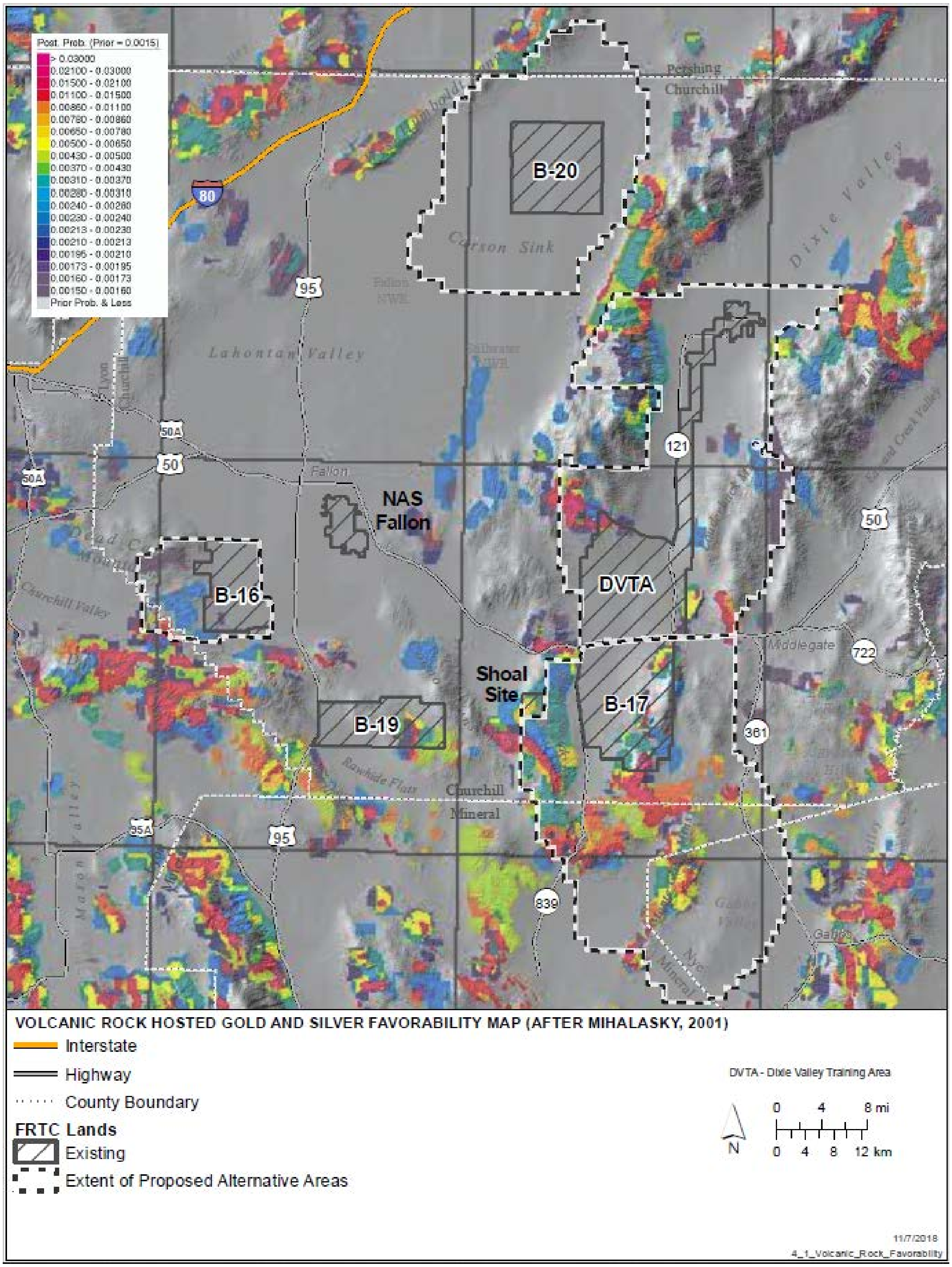


Figure 4.1: Volcanic Rock Hosted Gold and Silver Favorability Map

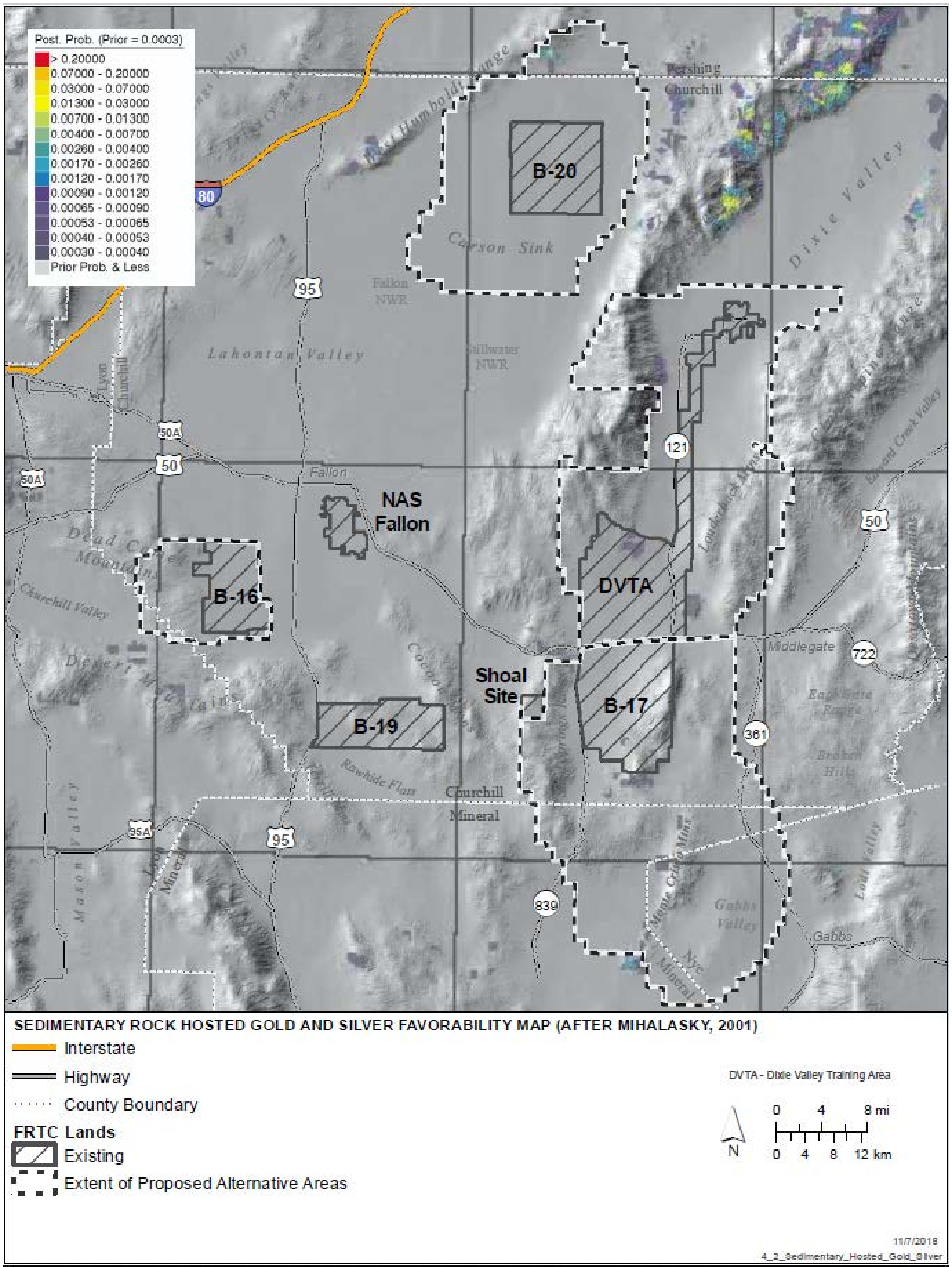


Figure 4.2: Sedimentary Rock Hosted Gold and Silver Favorability Map

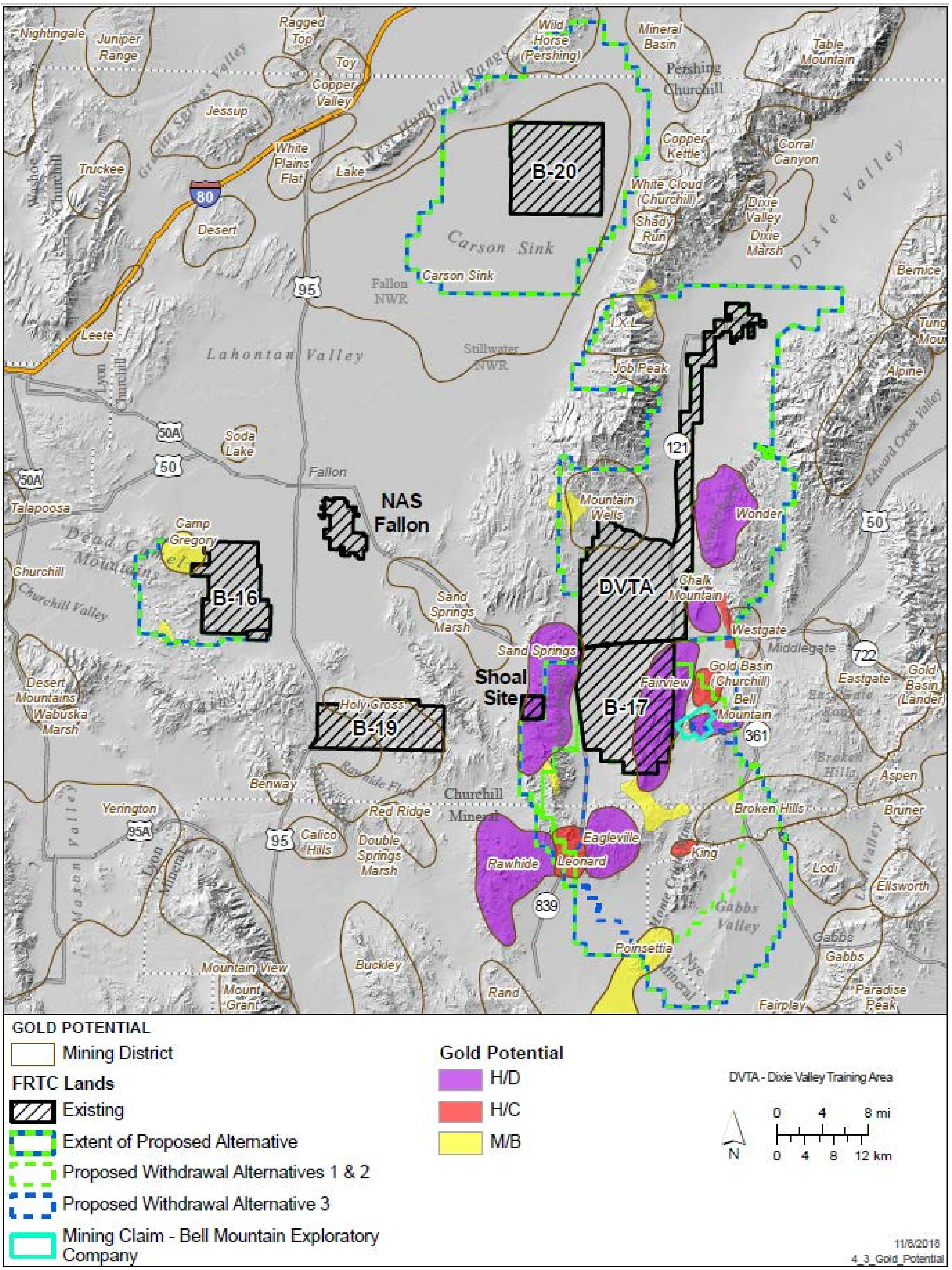


Figure 4.3: Gold Potential

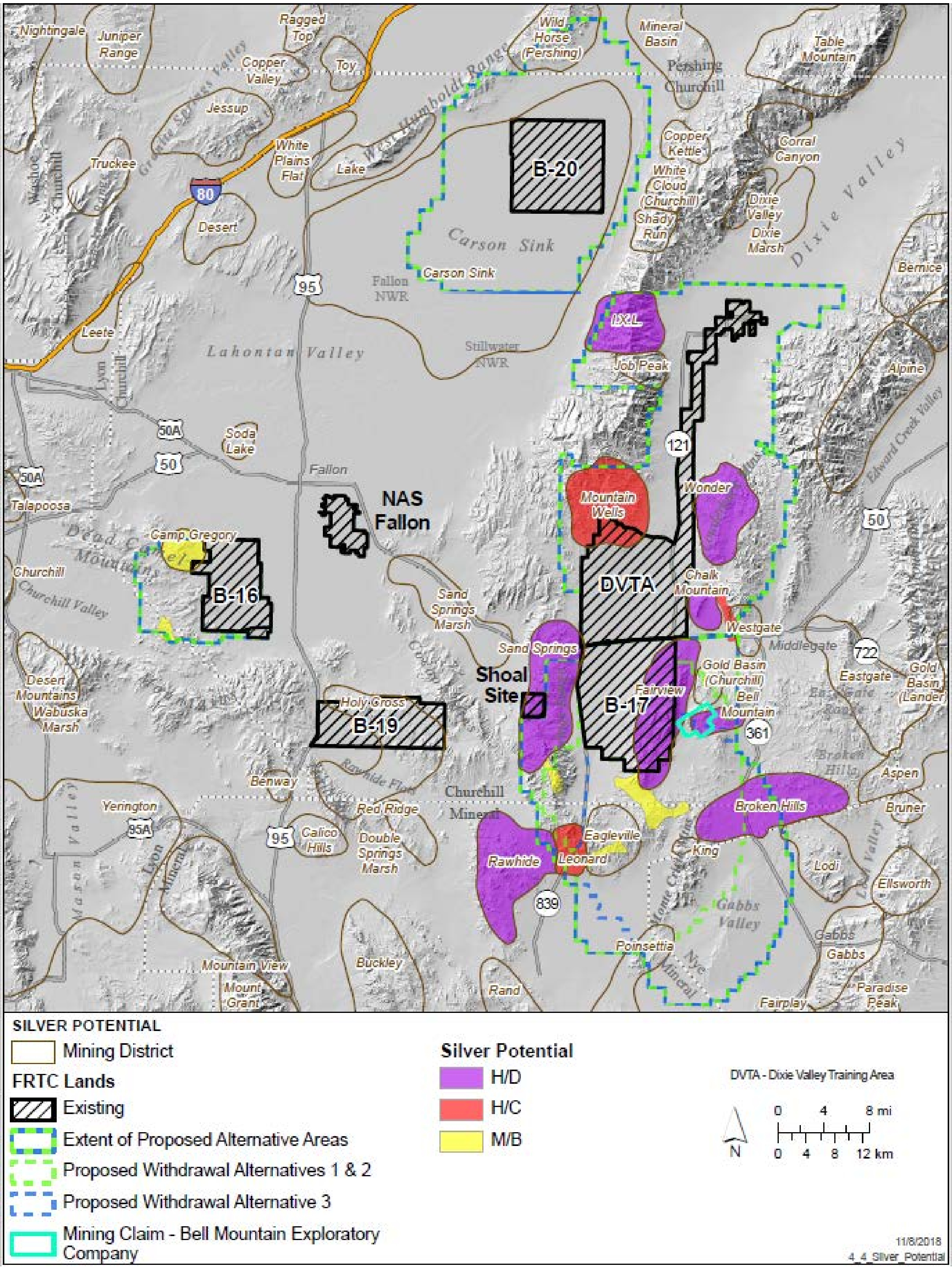


Figure 4.4: Silver Potential

4.1.1.2 Copper

According to the 2016 NBMG annual report, Nevada copper production was dominated by two mines both located outside the Study Area (Muntean and others, 2017). Exploration for copper was focused in the Yerington district in Lyon County. No reported exploration efforts were reported for counties located within the Study Area. There is no documented copper production in the Study Area; however, numerous districts in the Study Area contain reported occurrences of copper bearing minerals.

Copper mineralization is typically associated with plutons. Types of pluton-related copper deposits include porphyry, skarn and polymetallic. Since copper mineralization is closely associated with plutons, the location of Jurassic, Cretaceous and Tertiary intrusive rocks in the Study Area is a key factor in determining copper potential. This analysis relied on Singer (1996) to delineate tracts permissive of pluton-related deposits.

Figure 4.5 presents the mineral potential classification for copper. Mineral potential rankings were defined as follows:

- H/C: Mining districts with documented mineralization, but no production.
- M/C: Basins upgradient of anomalously high copper concentrations from NURE/PLUTO dataset.
- M/B: Tracts permissive of Pluton-Related Deposits from Singer (1996).

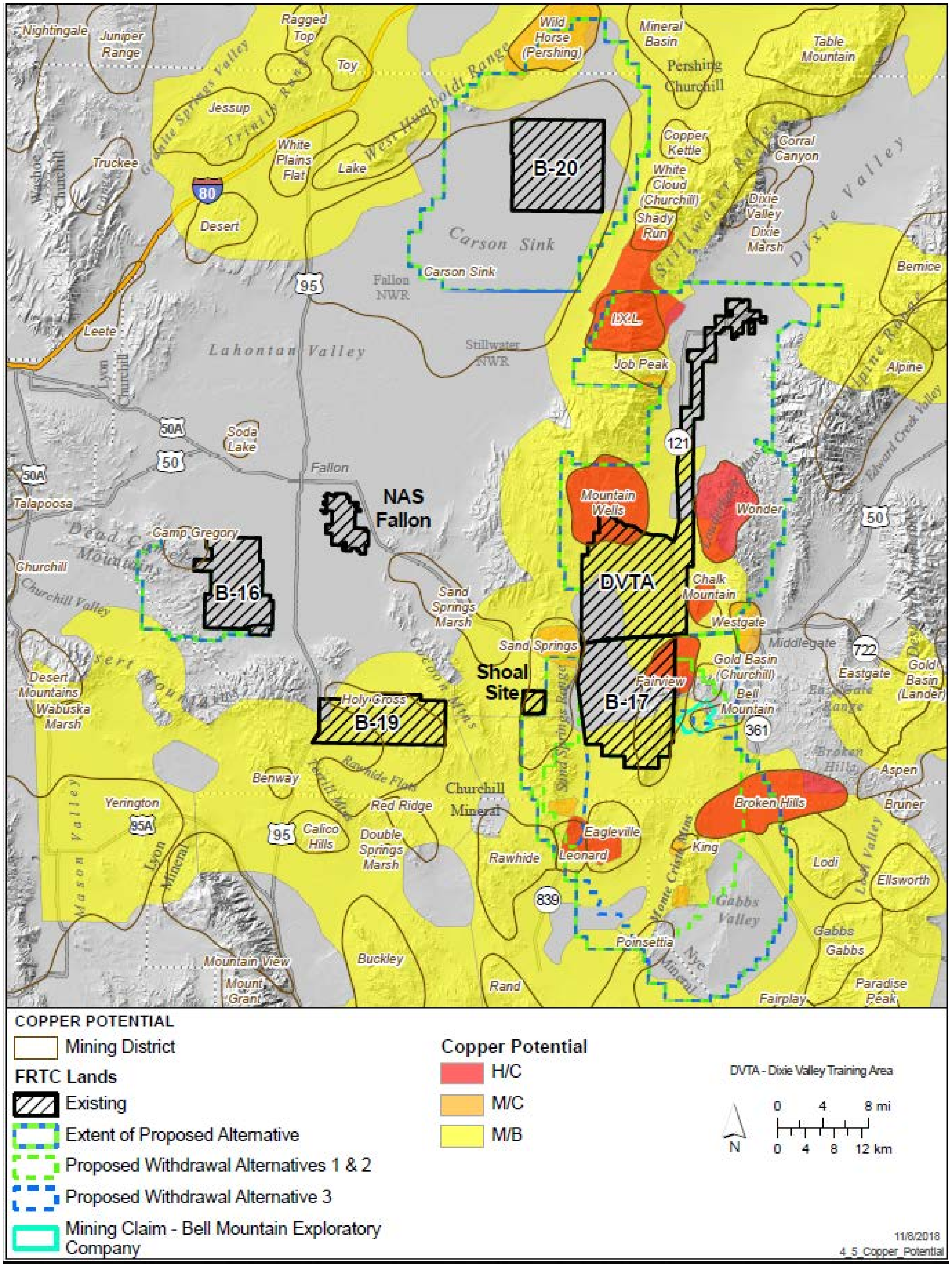


Figure 4.5: Copper Potential

4.1.1.3 Molybdenum

Molybdenum is typically produced as an associated mineral rather than a primary mineral of interest. The only reported molybdenum production in Nevada in 2016 was from the KGHM's Robinson copper mine which produced 493,010 lbs (224 tons) of by-product molybdenum (Muntean and others, 2017). No indications of past molybdenum production in the Study Area were noted in the document reviewed.

Molybdenum mineralization is associated with plutons and is strongly associated with copper. Types of pluton-related molybdenum deposits include porphyry, skarn and polymetallic. Molybdenum mineralization is closely associated with plutons, therefore, the location of Jurassic, Cretaceous and Tertiary intrusive rocks in the Study Area is a key factor in determining molybdenum potential. This analysis relied on Singer (1996) to delineate tracts permissive of pluton-related deposits.

Figure 4.6 presents the mineral potential classification for molybdenum. Mineral potential rankings were defined as follows:

- H/C: Mining districts with documented mineralization, but no production.
- M/C: Basins upgradient of anomalously high molybdenum concentrations from NURE/PLUTO dataset.
- M/B: Tracts permissive of Pluton-Related Deposits from Singer (1996).

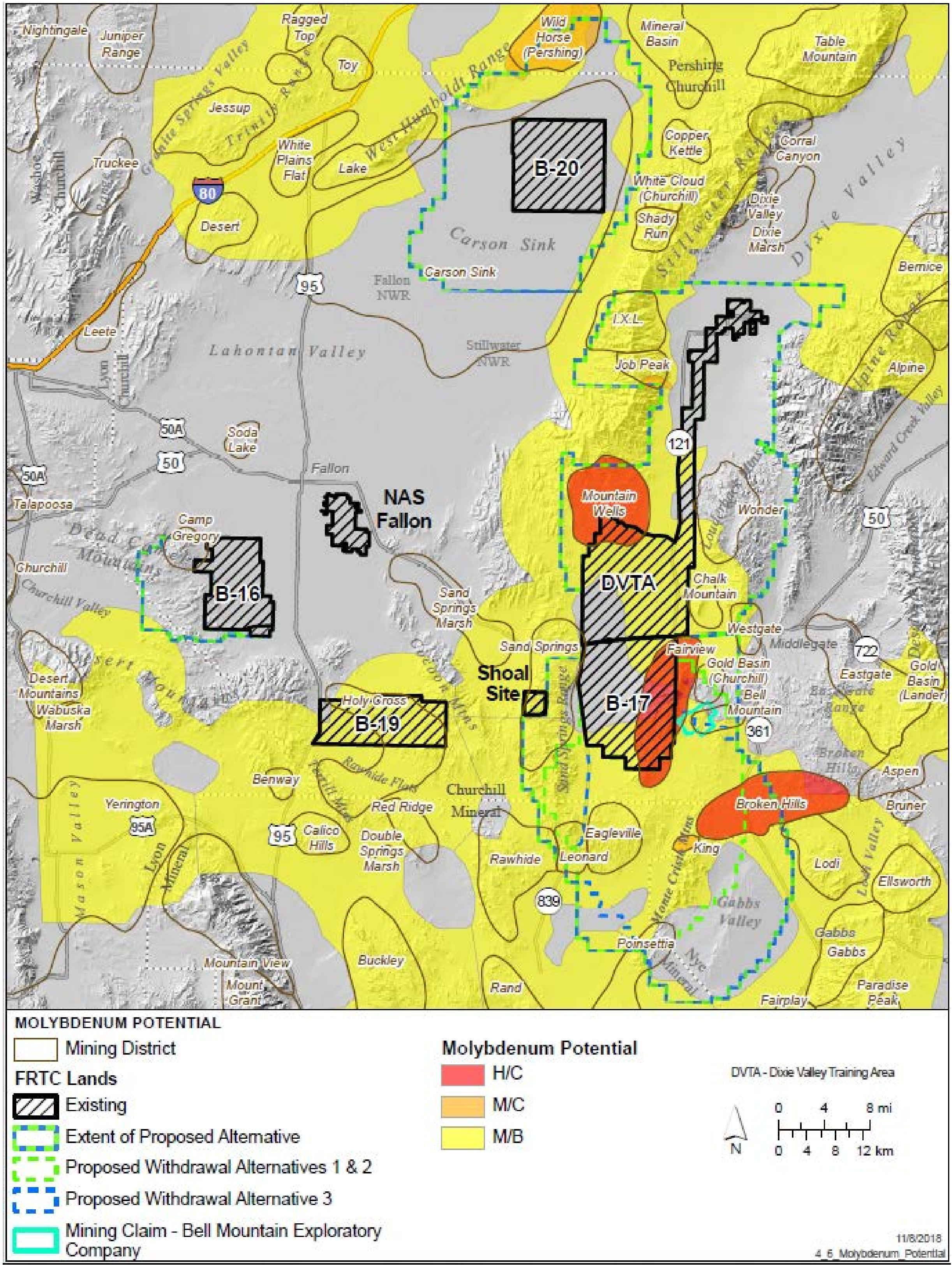


Figure 4.6: Molybdenum Potential

4.1.1.4 Lead and Zinc

Lead and Zinc are commonly found in association with deposits of more economically important minerals, such as gold, silver, and copper, but can be an important byproduct. The principal ore mineral of lead is galena (lead sulfide), but anglesite (lead sulfate), and cerussite (lead carbonate) are also significant. The principal ore mineral of zinc is sphalerite (zinc sulfide). Historical lead production occurred in the Chalk Mountain and Broken Hills Districts. No historical production of zinc production is documented in the Study Area.

Since lead and zinc mineralization is closely associated with plutons, the location of Jurassic, Cretaceous and Tertiary intrusive rocks in the Study Area is a key factor in determining lead and zinc potential. This analysis relied on Singer (1996) to delineate tracts permissive of pluton-related deposits.

Figure 4.7 and Figure 4.8 presents the mineral potential classification for lead and zinc, respectively. Mineral potential rankings were defined as follows:

- H/D: Mining districts with documented historical production.
- H/C: Mining districts with documented mineralization, but no production.
- M/C: Basins upgradient of anomalously high lead or zinc concentrations from NURE/PLUTO dataset.
- M/B: Tracts permissive of Pluton-Related Deposits from Singer (1996).

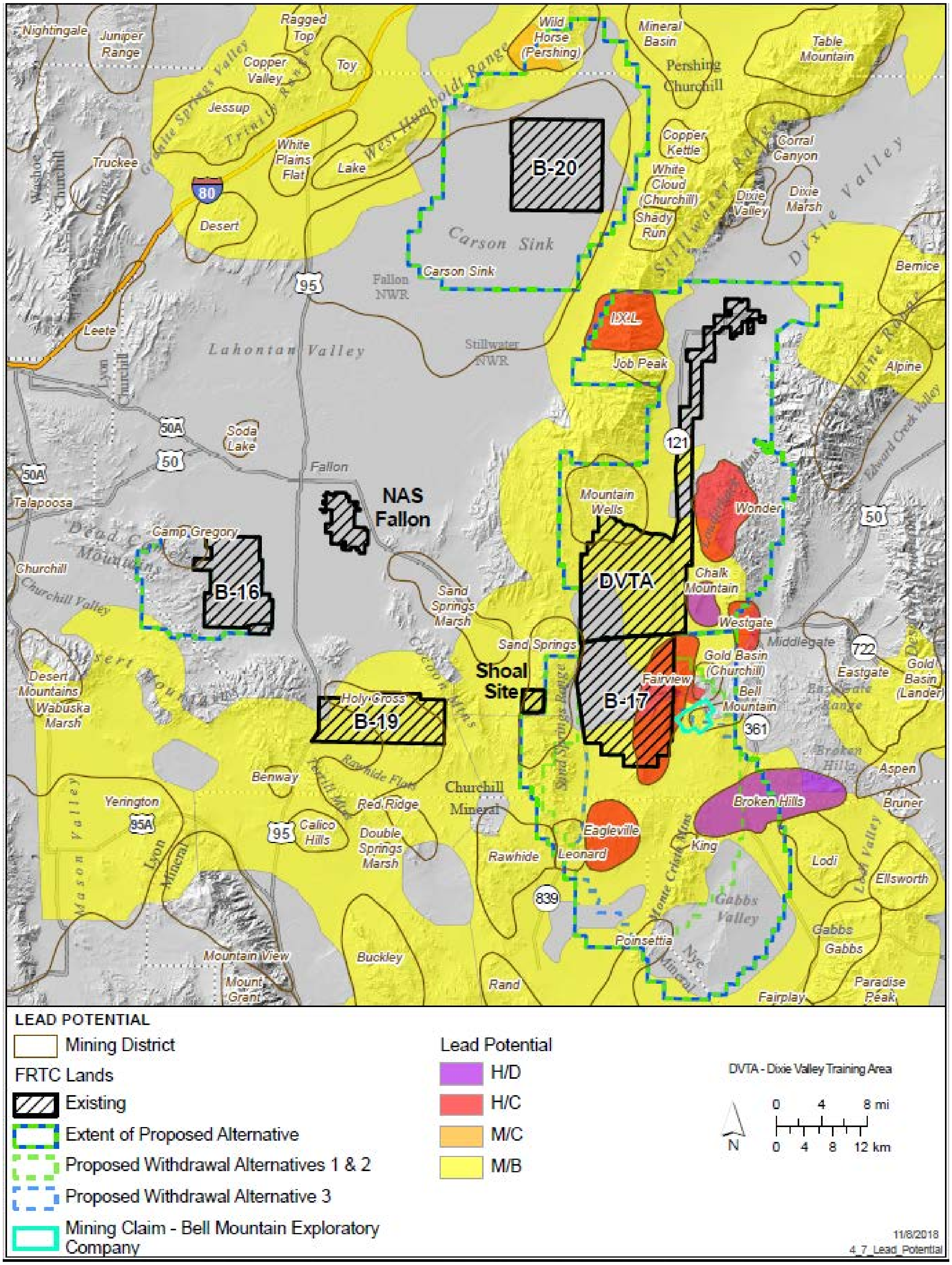


Figure 4.7: Lead Potenital

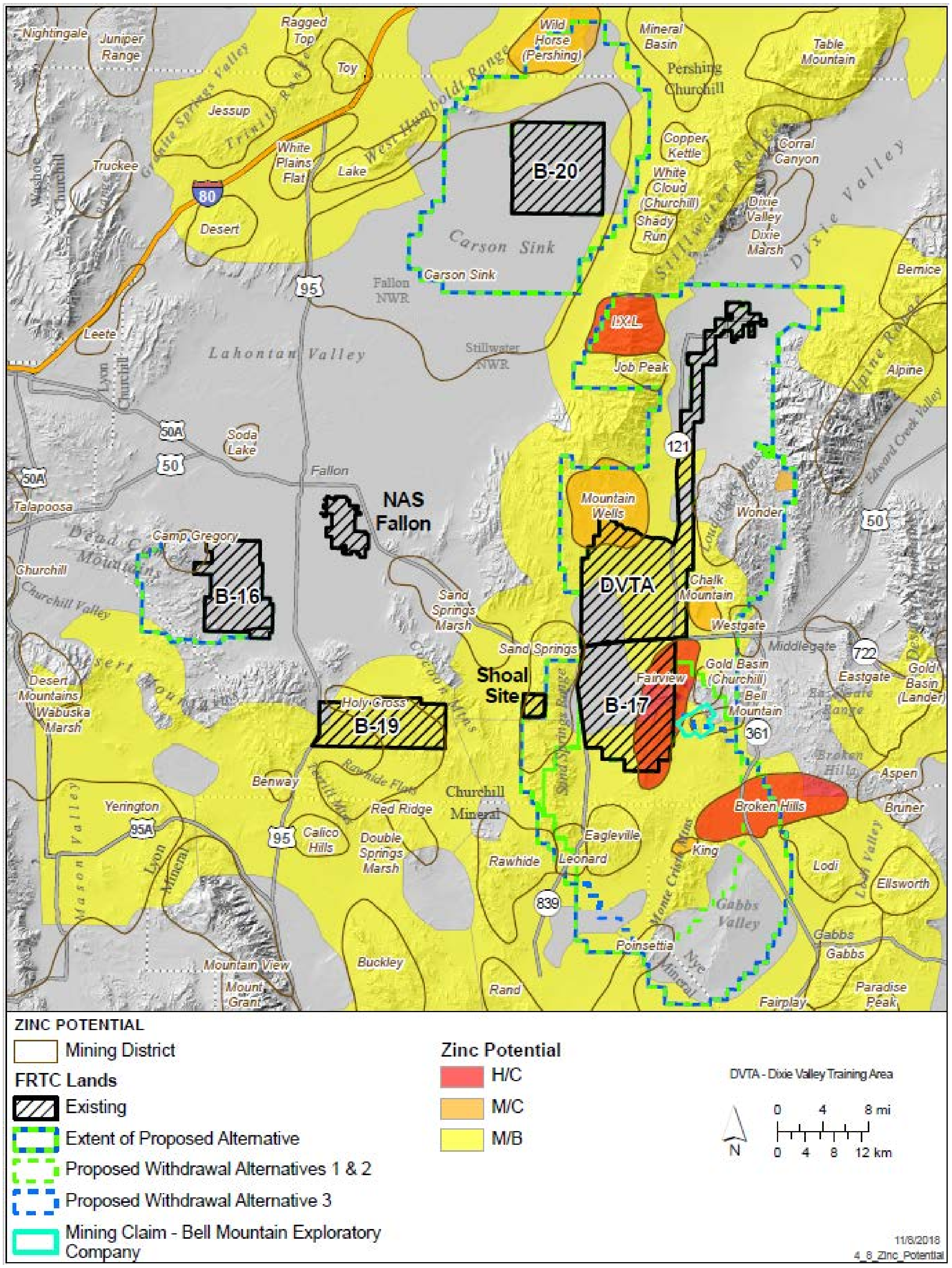


Figure 4.8: Zinc Potential

4.1.1.5 Tungsten

Nevada has had significant tungsten production from skarn and vein deposits in the past (Tingley 1998), but little, if any, is currently produced. China has dominated the tungsten market for several decades which has tended to depress the price and limit exploration.

Tungsten skarn deposits in the Study Area are typically found where carbonates within Triassic-Jurassic basinal sediment sequences of the Sand Springs or Jungo terranes are intruded by granitic intrusive bodies. Scheelite is the dominate ore mineral (Stager and Tingley, 1988). Tingley (1998) identified several districts in which tungsten is considered a significant mineral resource. Noted districts located within the Study Area include the Leonard, Fairview, Eagleville, and Sand Springs districts. The Leonard district is assessed as having production/reserves greater than 100,000 units of WO_3 (see Section 3.2.2.1 for discussion of units of WO_3) while the Fairview, Eagleville, and Sand Springs were assessed as having production/reserves less than 10,000 units of WO_3.

Other areas of interest include the Wild Horse, Chalk Mountain and Mountain Wells districts. Samples obtained in the northern portion of the Wild Horse district (near the northern proposed B-20 withdrawal area) yielded anomalous tungsten values (Willden and Speed, 1974). Samples obtained from the west side of Chalk Mountain in the Chalk Mountain district yielded low to moderate tungsten values; however, the values were consistent (Tingley, 1990). Prospecting for tungsten was active in the Mountain Wells (La Plata) district during the 1970s and 1980s. Extensive prospecting and some mining has been done in the vicinity of the deposits discussed above; however, their relatively small size and low grade makes them difficult to mine profitably.

Figure 4.9 presents the mineral potential classification for tungsten. Mineral potential rankings were defined as follows:

- H/D: Mining districts with documented historical production.
- H/C: Mining districts with documented mineralization, but no production.
- M/C: Basins upgradient of anomalously high tungsten concentrations from NURE/PLUTO dataset.
- M/B: Areas with potential skarn (i.e., Igneous pluton in contact with Mesozoic sedimentary rocks).

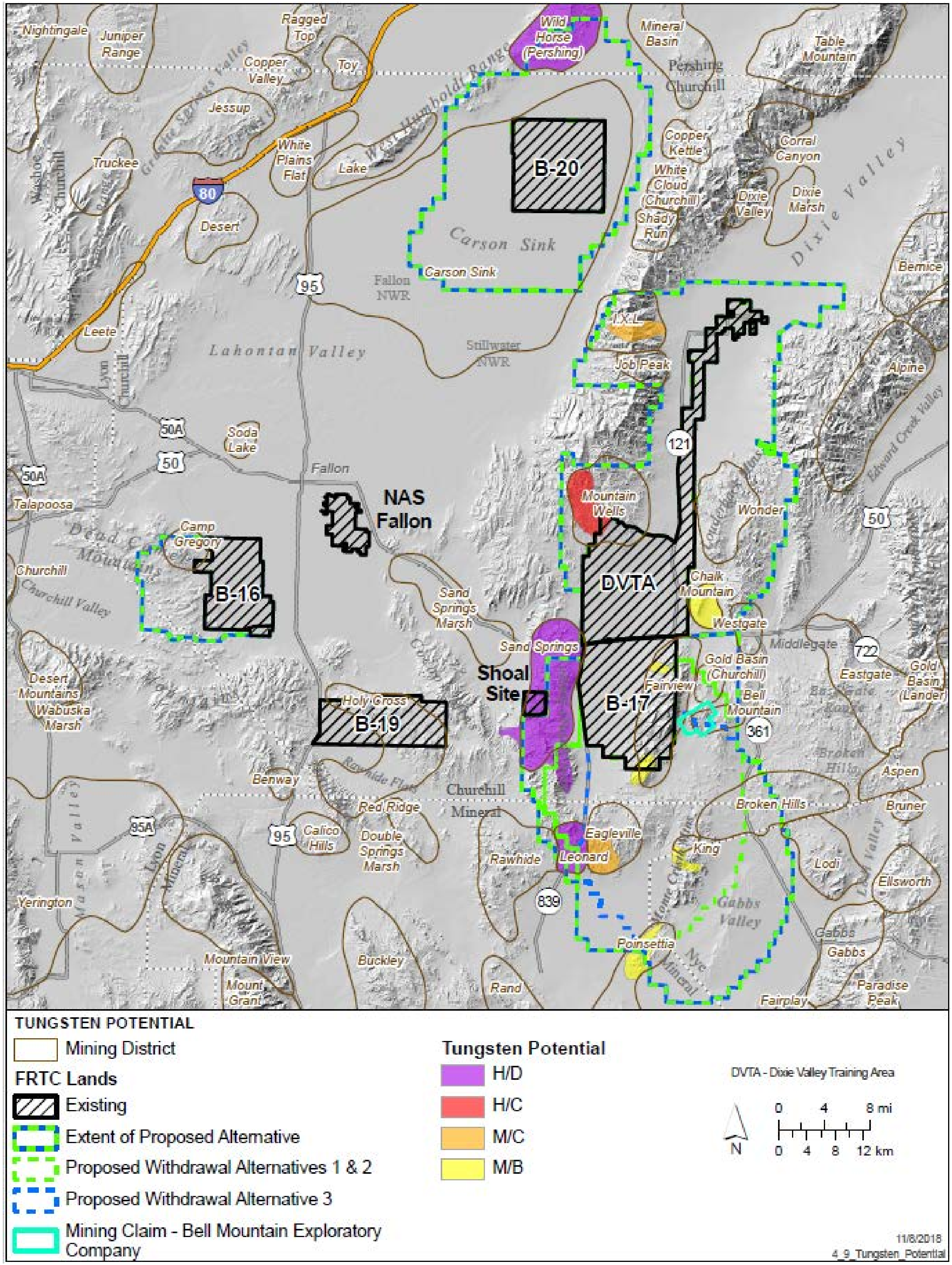


Figure 4.9: Tungsten Potential

4.1.1.6 Uranium

The primary source of uranium is uraninite, a constituent of granitic rocks and pegmatites. It also is found in high temperature hydrothermal veins associated with sulfide minerals and metallic ore deposits.

There is no reported uranium exploration, or production, in, or adjacent, to the Study Area (Muntean and others, 2017). Regional equivalent uranium geophysics surveys do not show any anomalous concentrations of uranium. Based on this assessment, the uranium mineral potential classification is M/B for all granitic plutons.

4.1.1.7 Additional Locatable Metals

Metals such as beryllium, antimony, arsenic, iron, and manganese, are known to occur within the Study Area (Tingley 1998). These metals are not actively explored; antimony, arsenic, and mercury occur with many of the precious metals and are considered to be deleterious elements.

Iron mineralization in the form of magnetite with lesser hematite occurs on the southeastern margin of the West Humboldt range in the proposed B-20 withdrawal area. This mineralization is associated with the hydrothermally altered, Jurassic-aged Humboldt mafic complex. The Humboldt mafic complex is an extensive system of plutonic and volcanic mafic rocks exposed in the West Humboldt, Stillwater, Clan Alpine ranges, and in the Buena Vista Hills covering an area of approximately 445,000 ac. Numerous iron occurrences and deposits are hosted in the intensely scapolite-altered, fractured and brecciated mafic rocks of this complex including historic mines in the Mineral Basin mining district, located several miles north of the proposed B-20 withdrawal area.

4.1.2 Mineral Potential of Industrial Locatable Minerals

The following subsections present mineral potential classifications for industrial locatable minerals. Table 4.3 presents a summary of the mineral production and the mineral potential classification for industrial locatable minerals in each withdrawal area.

Table 4.3: Summary of Industrial Locatable Resources

Withdrawal Area	Location	Mineral Resource	Deposit Type	Recorded Production	Resource Potential	Certainty Level	Comments
Near B-16	Near Camp Gregory District	Diatomite	Lacustrine	N/A	High	C	Defined by mineral occurrences and permissive geologic environment
	Lahontan Valley	Lithium	Lithium-bearing clay and Lithium-enriched brines	N/A	Moderate	A	Defined by permissive geologic environment
B-17	Broken Hills District	Fluorspar	Epithermal	6,000,000 USD	High	D	Defined by historic production
	Broken Hills District	Andorite, Boulangerite, Cerussite, Jamesonite, and Owyheeite	Pluton-related	N/A	High	C	Defined by occurrence
	Eagleville District	Barite	Pluton-related	2,000 tons	High	D	Defined by historic production
	Rawhide District	Alunite and Barite	Epithermal	N/A	High	C	Defined by occurrence
	King District	Fire Opal	Epithermal	N/A	High	C	Defined by occurrence
	Sand Springs & Poinsettia districts	Lithium	Lithium-bearing clay and Lithium-enriched brines	N/A	Moderate	A	Defined by permissive geologic environment
B-20	Carson Sink District	Lithium	Lithium-bearing clay and Lithium-enriched brines	N/A	Moderate	B	Defined by geochemical data and permissive geologic environment
DVTA	I.X.L Canyon District	Fluorspar	Epithermal	1,900 tons	High	D	Defined by historic production, permissive geologic environment
	Mountain Wells (La Plata) District	Fluorspar	Epithermal	500 tons	High	D	Defined by historic production
	Chalk Mountain District	Descloizite, McGuinnessite, Mimetite and Vanadinite	Pluton-related	N/A	High	C	Defined by occurrence
	Westgate District	Zeolites	Epithermal	N/A	High	C	Defined by occurrence
	Southern Dixie Valley	Lithium	Lithium-bearing clay and Lithium-enriched brines	N/A	Moderate	A	Defined by permissive geologic environment

4.1.2.1 Barite

Barite is a common mineral in many mineralized areas. It occurs usually as gangue mineral in hydrothermal veins, and is associated with ores of silver, lead, copper, cobalt, manganese, and antimony. It is found in veins in limestone, can be a cement in sandstone, and occasionally, as a sinter by waters from hot springs (Klein and Hurlbut, 1985). Barite was produced from the Eagleville District.

Figure 4.10 presents the mineral potential classification for barite. The mineral potential classification for barite are as follows:

- H/D: Mining districts with documented historical production (Eagleville District).
- H/C: Mining districts with documented mineralization, but no production (Wonder District).
- M/B: Districts with production of gold and silver from hydrothermal mineralization.

4.1.2.2 Diatomite

Diatomite is a near pure sedimentary deposit consisting almost entirely of silica originating from single-celled aquatic algae. Tingley (1998) reports diatomite is present in the Dead Camel Mountains near the Camp Gregory mining district. The diatomite occurs as lenses tuffaceous sedimentary rocks of the Truckee Formation along the southern edge of the mountain range.

Mineral potential rankings for diatomite are defined as follows:

- H/D: Geologic Units with documented production.
- M/B: Appropriate geologic environment for accumulation of diatomite (lacustrine deposits – playa lakes).

4.1.2.3 Fluorspar

Fluorspar is a common and widely distributed mineral. Usually found in hydrothermal veins in which it may be the chief mineral or as a gangue mineral with metallic ores, especially lead silver. Historic production has occurred in the IXL Canyon, the Mountain Wells and Broken Hills Districts.

Figure 4.11 presents the mineral potential classification for fluorspar. Mineral potential rankings were defined as follows:

- H/D: Mining districts with documented historical production.
- H/C: Mining districts with documented mineralization, but no production.
- M/B: Mining districts with metallic ores (i.e., all other mining districts in Study Area).

4.1.2.4 Gypsum

Gypsum is a common mineral widely distributed in sedimentary rocks, often as thick beds. It frequently occurs interstratified with limestones and shales and is usually found as a layer underlying beds of rock salt, having been deposited there as one of the first minerals to crystallize on the evaporation of salt waters. Occurs also as lenticular bodies or scattered crystals in clays and shales and as gangue minerals in metallic veins (Klein and Hurlbut, 1985).

There were no gypsum occurrences noted in mining districts located in the Study Area. Gypsum has been observed in association with oxide replacement minerals in hydrothermally altered andesite tuff breccias in the

Broken Hills mining district Schrader (1947). Although gypsum occurs as a hydrothermal alteration mineral, it is not commercially exploited from these types of deposits. Consequently, areas of hydrothermal alteration are not including as potential gypsum resources. Figure 4.12 presents the mineral potential classification for gypsum. Playa lakes, which potentially have the correct geologic environment for gypsum deposits, are assigned a mineral potential classification of M/B.

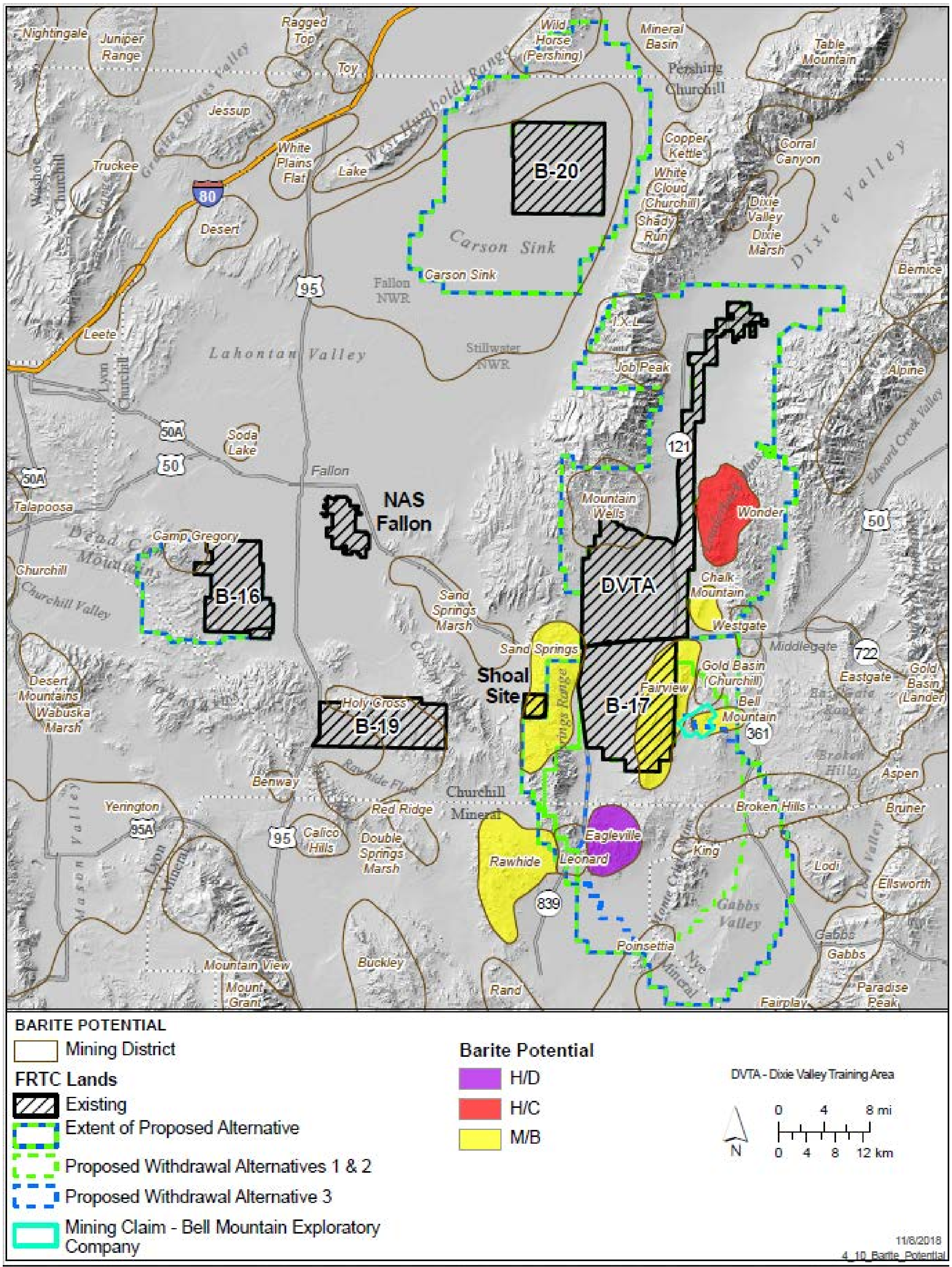


Figure 4.10: Barite Potential

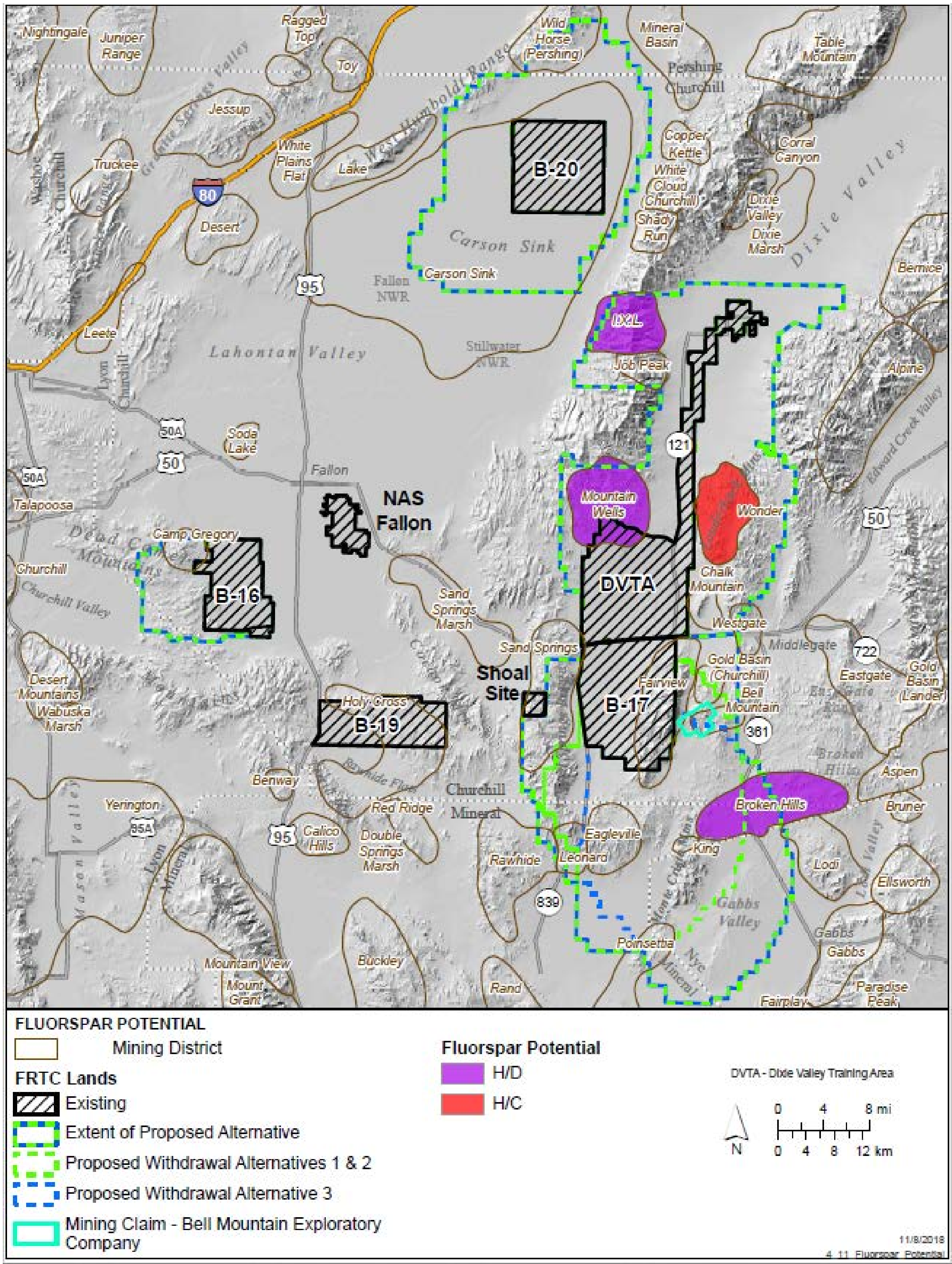


Figure 4.11: Fluorspar Potential

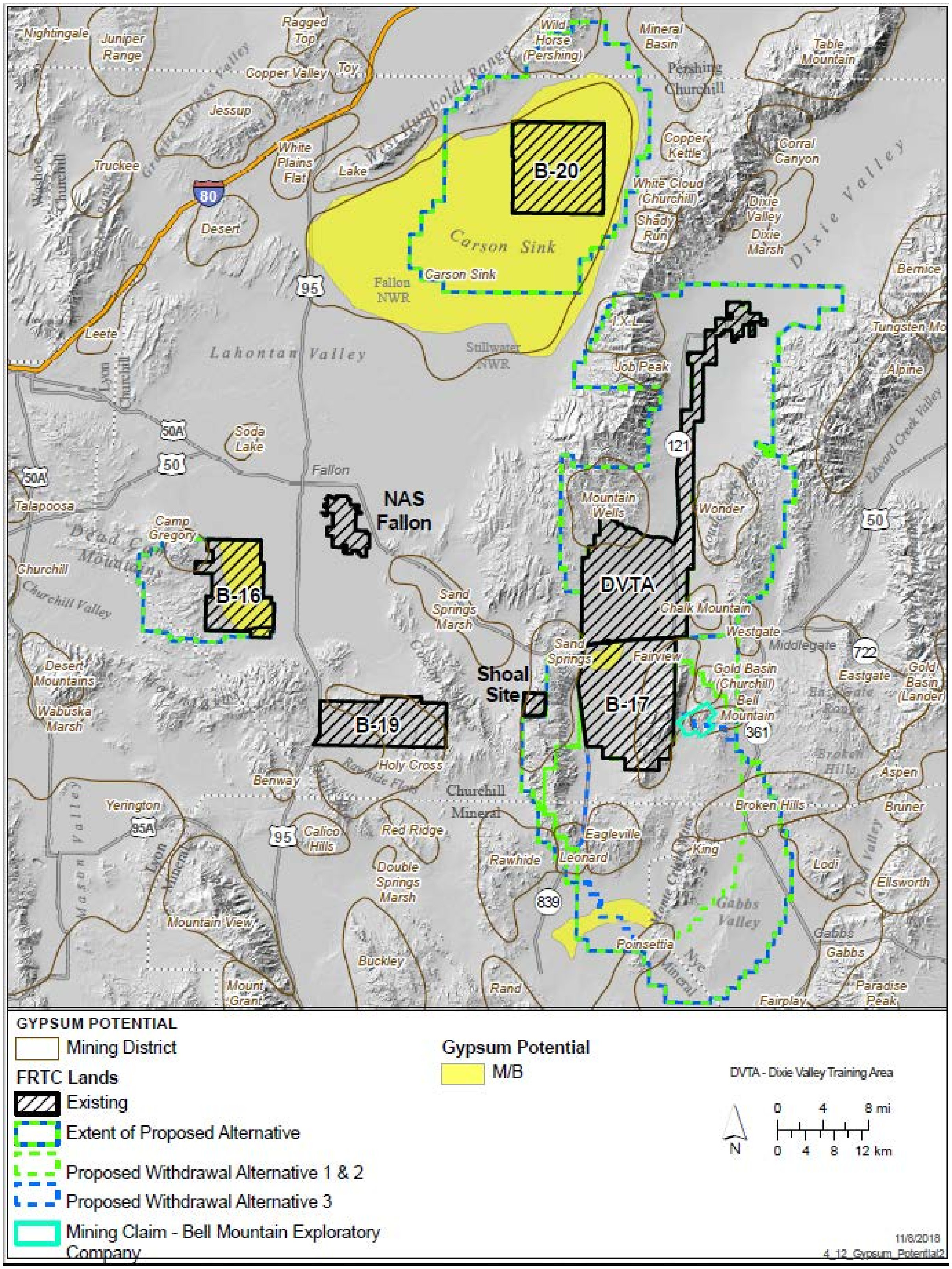


Figure 4.12: Gypsum Potential

4.1.2.5 Lithium

As discussed in Section 3.2.3, lithium mineralization in Nevada occurs in two forms: 1) lithium-bearing clay deposits; and 2), lithium-enriched brines. At present, the only domestic lithium production occurs outside of the Study Area in the Clayton Valley, located in Esmerelda County in west-central Nevada, where lithium is produced from lithium-enriched brines.

4.1.2.5.1 Lithium-Bearing Clay

As discussed in Section 2.5.2.1 Golder calculated the threshold value for anomalous lithium in playa samples to be 326.66 ppm. No sample within the Study Area from any of the geochemical datasets presented in this study: Davis (1976), Bohannon and Meier (1976), and NURE/PLUTO) exceeds this value. One sample from the PLUTO data set located in Dixie Valley, roughly 30 miles north of the DVTA, exceeded the threshold with a Li concentration of 450 ppm.

Vine (1980) published a classification system for assessing lithium anomalies in which lithium concentrations (in rocks and sediments) in the range of 100-300 ppm “may warrant further search,” while lithium concentrations (in rocks and sediments) in the range of 300-1,000 ppm “warrants further search.”

The NURE and PLUTO data sets include fourteen localized silt/float/soil samples which exceed the 100 ppm threshold for “may warrant further search” (Vine 1980). Eight of the samples, returning lithium values between 111 ppm and 150 ppm, are located near the southern margin of the Carson Sink playa, which covers the proposed B-20 withdrawal area. Two samples, returning lithium values in the 125 ppm to 200 ppm range, were identified in the Sand Springs Marsh playa, located centrally between the NAS Fallon, DVTA, B-19, and B-16 areas.

Although not supported by NURE, PLUTO or historical analytical results, playas in the north-western corner of B-17 and in the Poinsettia area, near the southern limit of the alternative area, have permissive geological setting.

Figure 4.13 displays the geographical distribution of mineral potential for lithium-bearing clays. Golder has interpreted the Vine (1980) classification scheme into the following mineral potential categories:

- M/C: Playas, which contain a soil sediment sample exceeding the 326.66 ppm threshold for anomalous lithium, between 300-1,000 ppm Li defined as Vine (1980) as “warrants further search.”
- M/B: Playas, which contain a soil sediment sample between 100-300 ppm, or “may warrant further search,” as per the classification of Vine (1980).
- M/A: Permissive geological settings (Playas).

4.1.2.5.2 Lithium-Enriched Brine

The correlation between lithium concentrations at the surface of playas and lithium concentration of the brines beneath is poorly understood. Vine (1980) explains that, “in the course of evaporation of a lake to dryness, and the subsequent lowering of the water table below the sediment surface, any concentration of lithium in the waters is apparently leached from the surface sediment without leaving a significant trace. Common surface clays, carbonates, sulfates and chlorides do not necessarily retain enough lithium to show an anomaly. Stable lithium clays or other lithium minerals probably form only under special conditions not generally found at the surface of the playa.” As a result, even playas with known lithium-enriched brines in their subsurface may lack elevated lithium concentrations at the surface (Vine, 1980).

For this reason, groundwater data was incorporated into the potential assessment for lithium-enriched brines. In addition to lithium content, the ratio of lithium to chloride is particularly important when assessing the potential to evolve a lithium brine from ground water. Waters with a relatively high (> 0.001) Li:Cl ratio have the potential to concentrate to lithium resources even if they possess a relatively low lithium content (Vine, 1980). Vine (1980) created a matrix based on the lithium content and the Li:Cl ratio of groundwater to roughly classify the potential for lithium brine deposits. Golder applied this classification scheme to groundwater geochemical data obtained from NBMG's online Great Basin Groundwater Geochemical Database (GBGGD). The classified wells were plotted geographically and mineral potential and certainty classifications were designated based on the distribution of well geochemical data. Figure 4.14 displays the geographical distribution of mineral potential for lithium-enriched brines.

Golder has interpreted the Vine (1980) classification scheme into the following mineral potential categories:

- H/C: Playas, which contains wells whose Li:Cl ratio is > 0.003, and Li content is >1 ppm, Vine (1980) classifies these waters as, "Has major resource potential."
- M/C: Playas, which contains wells whose Li:Cl ratio is between 0.003 and 0.001, and Li content is >1 ppm, Vine (1980) classifies these waters as, "Has minor resource potential."
- M/B: Playas which contains wells whose Li:Cl ratio is between 0.001 and 0.0003, and Li content is >1 ppm, Vine (1980) classifies these waters as, "Warrants further search."
- M/A: Playas as this is the correct geological environment for Li brine deposits.

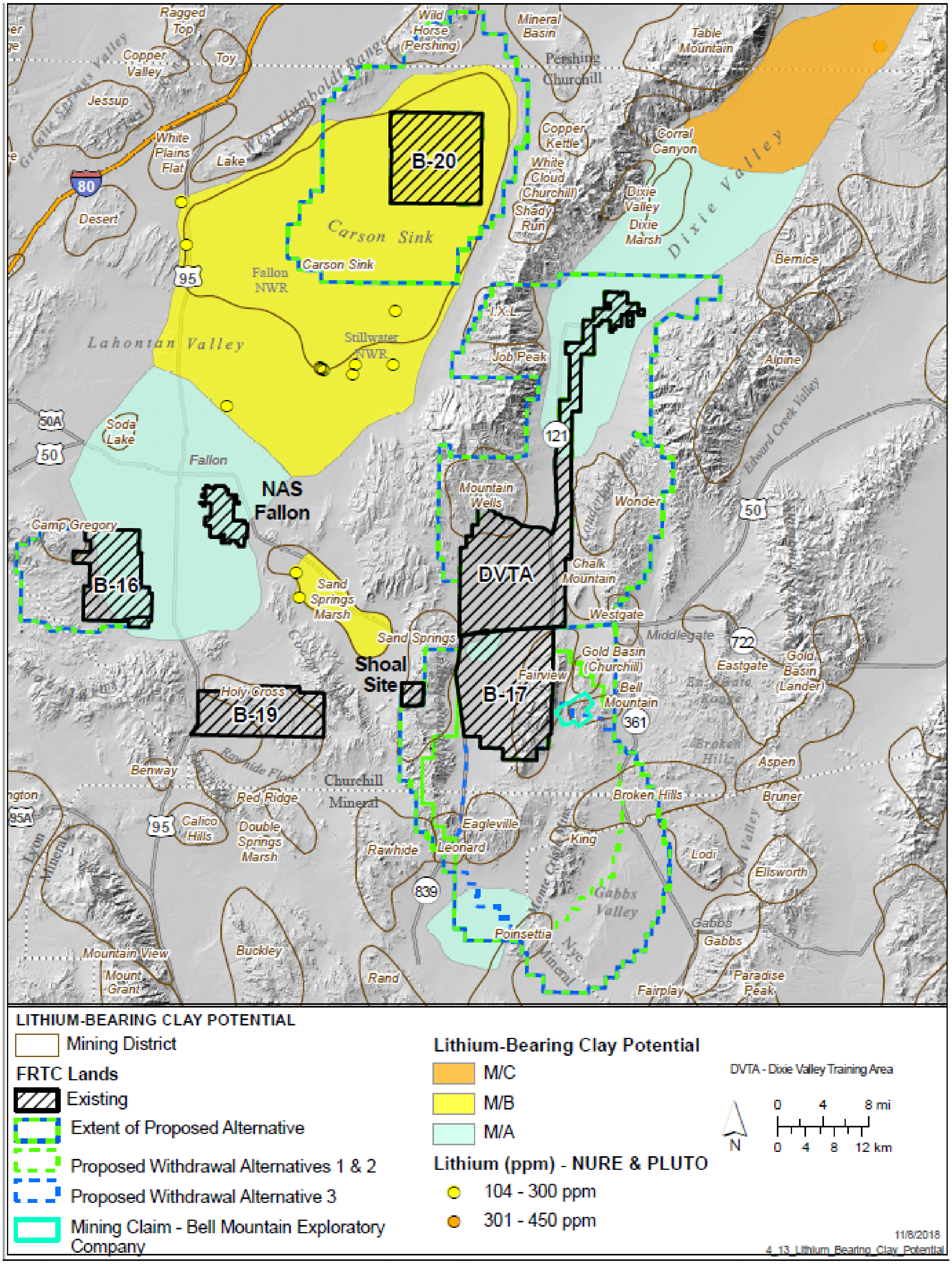


Figure 4.13: Lithium-bearing Clay Potential

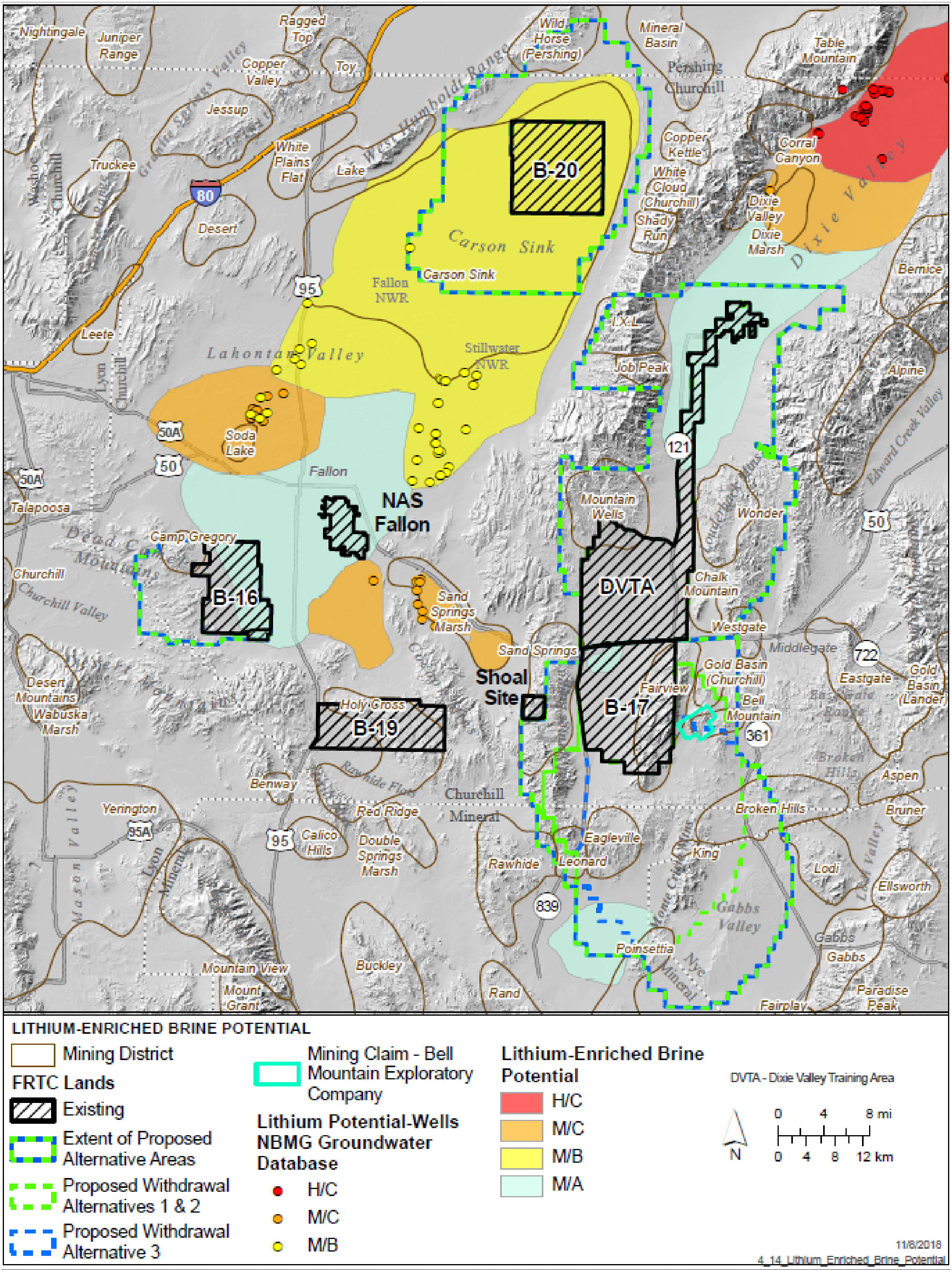


Figure 4.14: Lithium-Enriched Brine Potential

4.1.2.6 Sulfur

Papke and Castor (2003), indicate there are no significant sulfur deposits within the Study Area. Sulfur occurrences within the Study Area are considered secondary deposits and are likely associated with metallic ore deposits. Sulfur occurs in these deposits as common accessory sulfide minerals in mercury and precious metal deposits. These sulfide mineral sources for sulfur are not the most favorable for development, as they require significant processing. Most sulfur is produced as a result of fossil fuel processing (USGS, 2013). The mineral potential classification for sulfur is L/D.

4.1.2.7 Zeolites

Zeolites are a group of hydrous silicate minerals the show close similarities in composition, association and mode of occurrence. Zeolites of purest quality and of commercial interest most commonly occur in volcanic tuffaceous and sedimentary rocks in closed lacustrine basins (Tingley and others, 1998). The occurrence of zeolites in altered volcanic ash deposits is documented in the Westgate District. No production of zeolites is documented in the Study Area. The zeolite mineral potential classification for all volcanic ash deposits (i.e., Tuffs) is M/B.

4.2 Leasable Minerals

The following subsections present mineral potential classifications for leasable minerals. Table 4.4 presents a summary of the mineral potential classification for leasable minerals in each withdrawal area.

Table 4.4: Summary of Leasable Resources

Withdrawal Area	Location	Mineral Resource	Resource Potential	Certainty Level	Comments
B-16	Range Front	Geothermal	High	B	Permissive geologic relationships. Faulds, 2017.
	Dead Camel Mountains	Geothermal	Low	B	Non-permissive geologic relationships.
	---	O&G	Low	C	Defined by Anna and others, 2007
	---	Oil Shale	Low	D	Defined by Anna and others, 2007
	---	Asphalt	Low	C	Defined by Anna and others, 2007
	---	Coal	Low	D	Defined by Tingley, 1998
	---	Phosphate	Low	B	Defined by Papke and Castor, 2003
	Non-Playa	Potash	Low	B	Defined by Papke and Castor, 2003
	Non-Playa	Sodium Minerals	Low	D	Defined by lack of production
	---	Sulfur	Low	D	Defined by Papke and Castor, 2003
B-17	Gabbs Valley, Bell Flat, Rawhide Hot Spring	Geothermal	High	D	Nearby occurrences. Direct Evidence. Permissive geologic relationships. Faulds, 2017.
	Fairview/Stingaree Valleys	Geothermal	High	B	Permissive geologic relationships. Faulds, 2017.
	Sand Springs Range, Monte Carlo Mtns.	Geothermal	Low	B	Non-permissive geologic relationships.
	Gabbs Valley	O&G	Low	C	Defined by historic oil well
	---	Oil Shale	Low	D	Defined by Anna and others, 2007
	---	Asphalt	Low	C	Defined by Anna and others, 2007
	---	Coal	Low	D	Defined by Tingley, 1998
	---	Phosphate	Low	B	Defined by Papke and Castor, 2003
	Non-Playa	Potash	Low	B	Defined by Papke and Castor, 2003
	Non-Playa	Sodium Minerals	Low	D	Defined by lack of production
	---	Sulfur	Low	D	Defined by Papke and Castor, 2003
B-20	West Stillwater Range Front/Carson Sink	Geothermal	High	C	Nearby occurrences. Permissive geologic relationships. Faulds, 2017.
		Geothermal	Moderate	B	Nearby occurrences. Faulds, 2017
	Carson Sink	O&G	Low	C	Defined by Anna and others, 2007
	---	Oil Shale	Low	D	Defined by Anna and others, 2007
	---	Asphalt	Low	C	Defined by Anna and others, 2007
	---	Coal	Low	D	Defined by Tingley, 1998
	---	Phosphate	Low	B	Defined by Papke and Castor, 2003
	Carson Sink	Potash	Moderate	B	Defined by Papke and Castor, 2003
	Non-Playa	Potash	Low	B	Defined by Papke and Castor, 2003
	Carson Sink	Sodium Minerals	Moderate	D	Defined by historic production
	Non-Playa	Sodium Minerals	Low	D	Defined by lack of production
	---	Sulfur	Low	D	Defined by Papke and Castor 2003

Withdrawal Area	Location	Mineral Resource	Resource Potential	Certainty Level	Comments
DVTA	Range Front West side Dixie Valley	Geothermal	High	D	Nearby occurrences. Direct Evidence. Permissive geologic relationships. Faulds, 2017.
	Northwest Louderback Mtns.	Geothermal	High	C	Direct Evidence. Permissive geologic relationships. Faulds, 2017.
	East Dixie Valley	Geothermal	Moderate	C	Permissive geologic relationships. Faulds, 2017.
	Stillwater/Clan Alpine Ranges	Geothermal	Low	B	Non-permissive geologic relationships.
	---	O&G	Low	C	Defined by Anna and others, 2007
	---	Oil Shale	Low	D	Defined by historic oil well
	---	Asphalt	Low	C	Defined by Anna and others, 2007
	---	Coal	Low	D	Defined by Tingley 1998
	---	Phosphate	Low	B	Defined by Papke and Castor, 2003
	Non-Playa	Potash	Low	B	Defined by Papke and Castor, 2003
	Non-Playa	Sodium Minerals	Low	D	Defined by lack of production
	---	Sulfur	Low	D	Defined by Papke and Castor, 2003

4.2.1 Geothermal

Geothermal systems within the Study Area are amagmatic and lack an upper crustal magmatic heat source (Faulds and others, 2017). Instead, the high thermal gradients result from crustal and lithospheric thinning associated with right lateral trans-tensional displacement along the Walker Lane shear zone and basin-and-range extension (Kreemer and others, 2012). Heat flow gradients vary within the Great Basin with heat flow of 100 milliwatts per square meter (mW/m^2) characteristic of the northwest part of Nevada and less than 60 mW/m^2 in the central and eastern parts of the state. These areas have been referred to respectively as the Battle Mountain heat flow high and Eureka low (Tingley and others, 1998). Heat flow outside of the Great Basin are generally less than 30 mW/m^2.

Sites suitable for geothermal power production are generally characterized by high crustal heat flow, and fractured (permeable) bedrock which allows deep circulation of water. Productive high-temperature geothermal systems capable of electric generation are generally require temperatures more than 150°C at depths less than 3,000 m. Binary power plants use a second working fluid with a much lower boiling point than water that is heated by the geothermal waters and can produce power at temperatures below 150°C.

Several test projects are underway such as the Frontier Observatory for Research in Geothermal Energy (FORGE) Projects conducted near the Fallon, NV and Milford, UT, and the Newberry Demonstration Project in Oregon which are testing enhanced geothermal systems (EGS). EGS induces permeability of the system through hydraulic fracturing. This new technology has the potential to allow economic development of large areas of high heat flow in Nevada to geothermal development. However, the current focus of geothermal development in Nevada is on conventional geothermal systems. Therefore, this assessment focuses on the identification of settings that could host conventional geothermal systems characterized by high permeability bedrock, and deep circulating reservoirs.

Many of the power producing amagmatic geothermal systems in Nevada have surface expressions such as hot springs or fumaroles. Faulds and others (2011) inventoried the structural settings of more than 400 known geothermal systems in the extensional terrain of the Great Basin. Of the known systems, 39% are blind (i.e., no surface hot springs, fumaroles, and so forth). Researchers believe that a large percentage of the undiscovered geothermal resources are blind-systems owing to the greater degree of difficulty in identifying them (Faulds and others, 2017). Most of the known blind systems have been discovered through regional gradient drilling programs (e.g., Desert Peak), or by accident during drilling of agricultural wells, e.g., Stillwater, or mineral exploration wells, such as at McGinness Hills, Tungsten Mountain, and Blue Mountain (Faulds, 2017).

Considerable research into the structural controls on the location of blind geothermal systems in the Great Basin has been carried out over the past 15 years (Coolbaugh and others, 2002; Faulds and others, 2004, 2006, 2011, 2017; Faulds and Hinz, 2015; and Fossen and Rotevatn, 2016). In general, favorability for geothermal systems is related to high heat flow, and high permeably. Productive geothermal systems require high permeability to form a reservoir and allow circulation of water with a large volume of hot rock. The tensional and trans-tensional structural setting of the western Great Basin, and its active seismicity produce favorable, fractured bedrock conditions.

A systematic attempt to identify "blind" geothermal systems has recently been introduced into geothermal exploration. The concept, which is borrowed from oil exploration, is termed geothermal play "fairways" (Faulds and others, 2017). In this context a "fairway" is an area of high geothermal favorability whose boundaries are generated through a modeling process which integrates geologic, geochemical, and geophysical parameters. A play is a geothermal resource target.

Faulds and others (2017) applied the “fairways” methodology to a transect measuring 400 km east-west, and 240 km north-south that includes the proposed withdrawal areas. A detailed geothermal potential map was produced from this study which incorporates ten major parameters: 1) structural setting, 2) recency of faulting, 3) Quaternary fault slip rates, 4) regional geodetic slip rates, 5) slip and dilation tendency (i.e. orientation with respect to the stress field) of Quaternary faults, 6) earthquake density, 7) gravity data, 8) magneto-telluric data, where available, 9) temperature gradient data; and 10), geochemistry from springs and wells. These parameters were weighted and combined to develop the geothermal favorability map (Figure 4.15). Quaternary faults from the NBMG (2016) database have been overlain on the map.

The first seven parameters of this methodology assess permeability. As mentioned previously the permeability of the entire Study Area is high, reflecting the high geodetic strain rates, historical and Quaternary faults, and steep gravity gradients.

Locally favorable permeability conditions are based on the type of structures and slip kinematics. Certain structural settings are known to be associated with geothermal systems: horse-tail fault terminations, step-overs or relay ramps, fault intersections, and accommodation zones (Faulds and Hinz, 2015). Faulds and others (2017) compiled 375 favorable structural settings in their Study Area based on an evaluation of published reports, fault databases, aerial photographs, seismic reflection profiles, and gravity data. The highest ratings for local permeability were along a north-northest trending belt from Hawthorne to Battle Mountain which includes the Don A. Campbell, and Dixie Valley geothermal plants. This trend generally follows the central Nevada seismic belt, a region that has experienced several large historical earthquakes (Caskey and others, 2004).

Geophysical magneto-telluric (MT) methods, where available, have been found useful to identify zones of low resistivity upwellings that could signify shallowing heat sources and large-scale permeability. Reconnaissance MT surveying in the Great Basin has suggested such features were diagnostic of high temperature geothermal systems and could be used as a sub-regional indicator of geothermal potential (Wannamaker and others, 2007, Siler and others, 2014, Stanley, and others, 1976).

The Study Area has numerous known geothermal systems, a high geothermal gradient (Blackwell, 2010), a high geodetic strain rate (Kreemer, 2012), and a history of recent faulting. The following sections provide an assessment of the geothermal potential of the proposed withdrawal areas. The assessment is based on a review the available direct evidence discussed in Section 3.4 (well temperatures, temperature gradient, geochemical geothermometer) and additional assessment of the structural setting that may contribute geothermal favorability. The geothermal favorability assessment from Faulds and others (2017) is also reviewed for this assessment.

The following bullets present the geothermal potential classification system, potential rankings are defined as follows:

- H/D: Productive geothermal systems within 20 km along a continuation of similar geology setting. Or temperature gradient or well temperatures suggestive of productive temperatures at shallow depths with favorable structural settings.
- H/C: Temperature gradient or well temperatures which suggest productive temperatures at shallow depths, within favorable structural settings, with a productive geothermal systems more than 20 km along a continuation of similar geology setting.

- H/B: Continuation of known or indicated favorable geologic setting but lacking well data or temperature gradient.
- M/C: Temperature gradient and well data indicative of relatively low thermal gradients within a range front or otherwise favorable geologic setting.
- M/B: Within range front or otherwise favorable geologic setting but lacking well data with temperature gradient.
- L/B: Withdrawal areas occupied by mountain ranges.

4.2.1.1 B-16

There are no active geothermal fields, or geothermal exploration projects within the proposed B-16 withdrawal area, and no known geothermal leases are present in this area. Ten warm gradient geothermal gradient holes were completed in the B-16 area and four of the holes in the north half of the existing B-16 withdrawal area have gradients greater than 90°C/km and are relatively high gradient holes. These were drilled in an area with late-Quaternary (<15,000 yrs) en echelon faults that could represent step-overs or relay ramps. Faulds and others (2017) map (Figure 4.15) also shows this area as having high potential.

Faulds and others (2017) shows a large area of high potential in the southeast corner of the proposed B-16 withdrawal that appears to be associated with a favorable structural setting.

The east B-16 region is assigned a geothermal potential of H/B. The potential is located mainly along the range front area in the eastern and central portions of the proposed withdrawal area. The western half of the proposed B-16 withdrawal area is occupied by the Dead Camel Mountains and is assigned a geothermal potential of L/B (Figure 4.16).

4.2.1.2 B-17

The proposed B-17 expansion area includes the Gabbs Valley and Bell Flat geothermal clusters discussed in Section 3.5.1. The Don A. Campbell geothermal power plant is approximately 5 km southwest of the proposed withdrawal boundary. There are numerous indications of high thermal gradients in the southern half of the proposed B-17 withdrawal area including: gradient holes with gradients up to 713°C/km, defunct hot wells, the Rawhide Hot Spring with a temperature up to 62.2°C, and nearby hot wells at the town of Gabbs. The structural setting is favorable along the east and west sides of the Monte Cristo Mountains where historical (1954 Fairview Peak earthquake) and late Quaternary faults traces are mapped.

Geothermal exploration data for the northern half of the proposed B-17 withdrawal area is lacking. However, the structural setting continues to be favorable along the historical faults on the east side of Slate Mountain and Fairview Peak and the late-Quaternary faults on the east side of Aplite Ridge and the Sand Springs Range. Older Quaternary faults along the west side of Fairview Peak and along the southwest and east range front of the Bell Mountains, could provide structural targets as well.

Faulds and others (2017) (Figure 4.15) indicates high potential near the Don A. Campbell power plant and moderate to high potential along the east and west range fronts of the Monte Cristo Mountains, Slate Mountain, and Fairview Peak, along the east range front of Aplite Ridge and the Sand Springs Range, and the east and southwest range fronts of the Bell Mountains.

The proposed B-17 withdrawal area is determined to have geothermal potential of H/D in its southern half and geothermal potential of H/B in its northern half (Figure 4.16).

4.2.1.3 B-20

The proposed B-20 withdrawal area is within the Carson Sink geothermal cluster defined by thermal gradient holes with gradients up to 136°C/km, as discussed in Section 3.5.1. There are no geothermal power plants, active projects or geothermal leases within the proposed withdrawal area boundary.

The east side of Carson Sink forms the western range front of the Stillwater Range which is host to the New York Canyon geothermal project approximately 15 km north of the proposed B-20 withdrawal, and the Stillwater power plant 20 km south of the B-20 proposed boundary. The late-Quaternary, Eastern Carson Sink fault zone generally separates the extremely broad and deep Carson Sink from the prominent west front of the Stillwater Range. The western range-front of the Stillwater range provides a continuous favorable geologic setting from New York Canyon and the Stillwater plant and is considered an area with high geothermal potential. This zone is along the margin of the proposed B-20 withdrawal boundary. Faulds and others (2017) geothermal favorability map (Figure 4.15) shows a zone of high geothermal potential along the east margin of the B-20 boundary.

The structures which create locally favorable conditions at the Stillwater power plant appear to be spatially associated with historical faults scarps which ruptured during the 1954 Rainbow Mountain earthquake. These fault scarps extend from the Stillwater plant area, north into the middle of the Carson Sink on the B-20 proposed withdrawal area where they become widely distributed with numerous faults segments orientated north-south, northeast, and northwest. This broadly distributed fault zone occurs within the southern and western B-20 area, and is identified as a zone of high geothermal favorability (Faulds and others, 2017).

The Upsal Hogback project and the Soda Lake power plant are approximately 18 km and 30 km respectively southwest of the proposed B-20 boundary within the Carson Sink and provide evidence that mid-basin settings can also be favorable for geothermal power production within the Study Area.

The Desert Queen project and the Desert Peak power plant are 20 km and 30 km, respectively, southwest of the proposed B-20 boundary on the west margin of the Carson Basin.

The proximity to known geothermal systems with analogous geologic settings, and favorable structural settings along the east margin and the southwest portion of the proposed B-20 result in a geothermal potential rating of H/C. Areas outside the favorable structural settings are assigned a geothermal potential M/B (Figure 4.16).

4.2.1.4 DVTA

Known geothermal resources exist adjacent to the proposed DVTA withdrawal area. To the north the Dixie Hot Springs has a large contiguous lease block that extends north along the eastern front of the Stillwater range to the Dixie Valley Power plant. A similar geologic setting extends south along the west side of Dixie Valley past exploration areas at Elevenmile Canyon and Pirouette Mountain and several hot gradient holes with gradients greater than 300°C/km. A well drilled by the Navy in 2012 encountered temperatures of 76.6°C at a depth of 500 feet in the Pirouette Mountain area.

The range front fault along the west side of Dixie Valley ruptured during the1954 Dixie Valley Earthquake. Fault scarps from this and other late Quaternary seismic events extend from the Dixie Valley power plant south to the Elevenmile Canyon area.

The east range front of the Stillwater Range from the proposed northern DVTA boundary to Elevenmile Canyon is considered to have high geothermal potential due to the presence of known geothermal systems along this fault zone, numerous hot gradient holes, the recency of faulting and the favorable structural setting (Faulds and others, 2017) (Figure 4.15). The east range front of the Stillwater Range is assigned a geothermal mineral potential H/D (Figure 4.16).

A set of unnamed, northeast trending, Quaternary faults extends along the east side of the Dixie Valley, along the northwest front of the Louderback Mountains. A hot gradient hole with a gradient of 348°C/km is present at the fault termination at the eastern boundary of the proposed DVTA. Gradient holes further north along the west range front of the Clan Alpine Range have low temperature gradients. The northeast side of the Louderback Mountains are identified as having high geothermal favorability (Faulds and others, 2017) (Figure 4.15). However, no direct evidence is available to support the existence of a geothermal resource on the northwestern side of the Louderback Mountains; therefore, the northwest front is assigned a geothermal potential H/C (Figure 4.16).

There is limited exploration data available for the proposed DVTA area south of Elevenmile Canyon. The available temperature gradient data shows gradients as high as 87°C/km, but they are generally less than 60°C/km. The historical fault scarps present in the northern B-17 proposed withdrawal area extend into the south end of the DVTA on the east side of the valley and provide a favorable structural setting, however the lack of direct evidence of high thermal gradients has led to the assignment of a geothermal potential M/C (Figure 4.16).

Areas in the proposed DVTA withdrawal area occupied by the Stillwater Mountains are assigned a geothermal potential L/C (Figure 4.16).

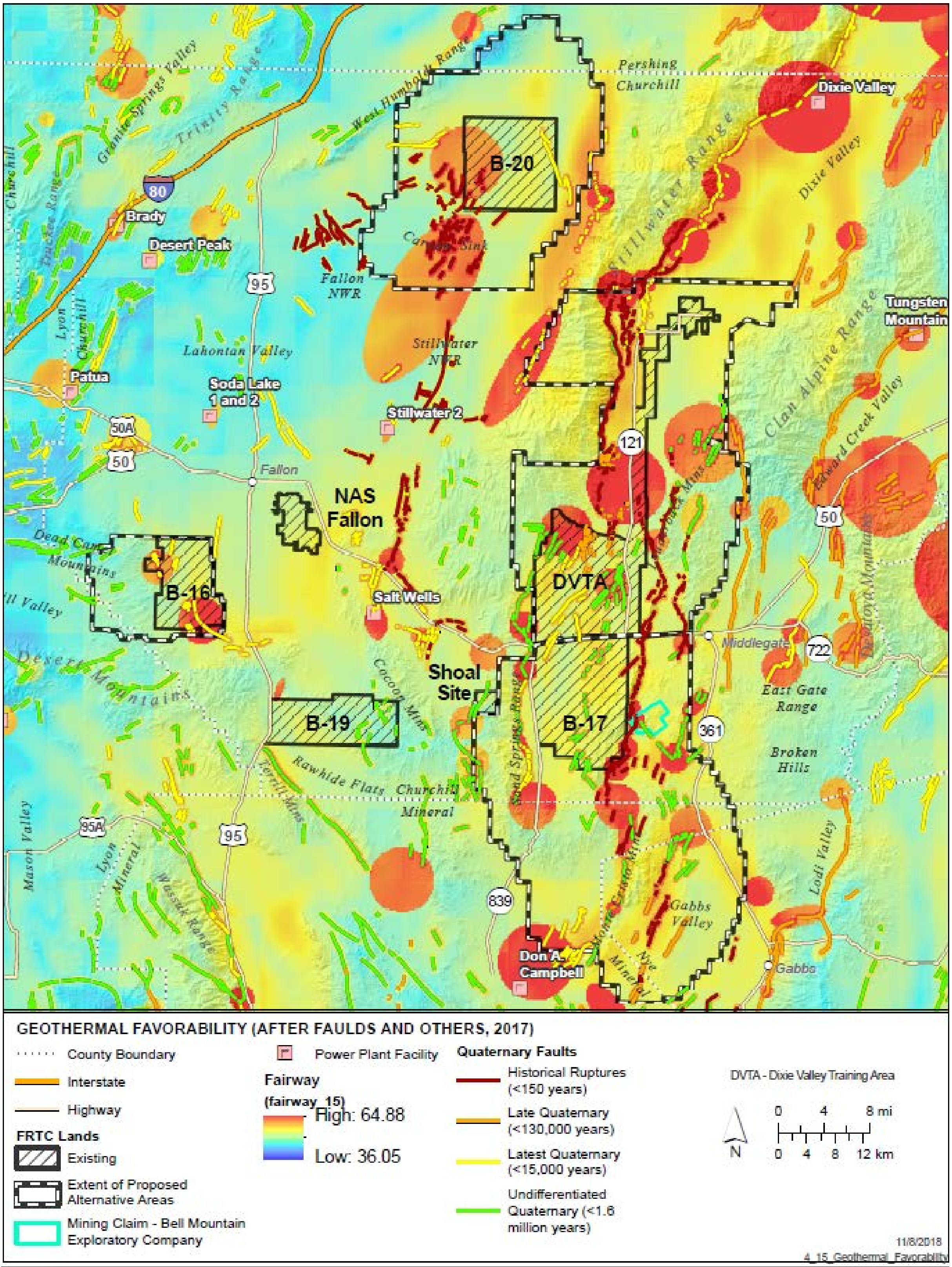


Figure 4.15: Geothermal Favorability

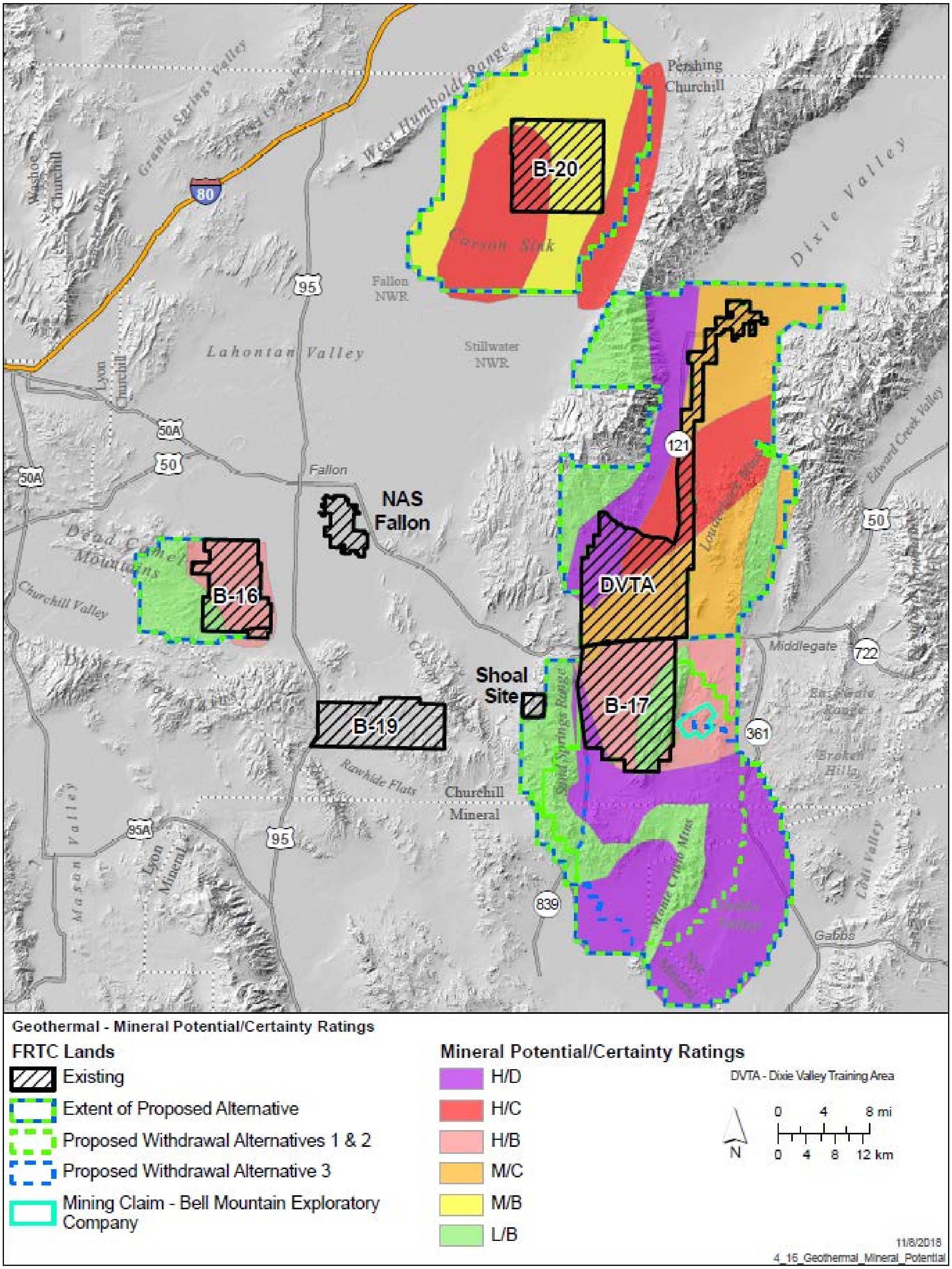


Figure 4.16: Geothermal Potential Assessment

4.2.2 Oil & Gas

According to NBMG's 2016 annual report, oil primarily is produced in two areas of the state, to the east of the Study Area in Railroad Valley (Nye County) and northeast in Pine Valley (Eureka County). Limited exploration has occurred in and adjacent to the Study Area. Within the Study Area oil and gas has been detected; however, no production has been reported. A statewide assessment of the qualitative petroleum potential of Nevada (Garside and Hess, 2011), attempted to outline areas of petroleum potential across the state. The Study Area falls within an area of low or no potential, as shown in Figure 4.17.

Commercially viable accumulations of oil and gas require a hydrocarbon source rock, a migration pathway for generated hydrocarbons, a reservoir where hydrocarbons are accumulated and a trap or seal to contain the hydrocarbons. To date, all producing Nevada oil fields occur in Neogene basins where the combination of source rock burial, heating, and valley fill seals have resulted in oil generation and preservation.

Barker and others (1995) identified two hypothetical oil plays in western Nevada, which are reasonable models for oil potential within the Study Area. One hypothetical play assumes that Permian-Triassic rocks in some ranges have the potential for petroleum generation and that Permian to Triassic sandstones and limestones, alluvial fans on the margins of ranges, or fractured volcanic rocks have the porosity to act as reservoirs. Traps may be formed by drag folds and truncation related to Fencemaker thrust sheets or by displacement of normal fault blocks. This play was considered by the BLM to have very limited potential due to small volume of source rocks.

According to the BLM's Carson City District MRPR (2013), a more likely scenario for oil production in the Study Area would involve heating organic-rich Neogene basin fill sediments, which have produced shows but no recoverable oil or gas, by geothermal convection, shallow intrusions, or heat flow along basin faults near graben boundaries. Oil and gas released from the fill sediments may then be trapped by interfingered lacustrine beds, or by altered volcanic tuffs or flows, or by normal faults. This scenario has been explored, but no production has been recorded (Barker and others 1995).

The mineral potential classification for oil and gas in the Study Area is L/C due to lack of favorable source rocks, and a history of Tertiary plutonism and deformation inconsistent with hydrocarbon production (Figure 4.18).

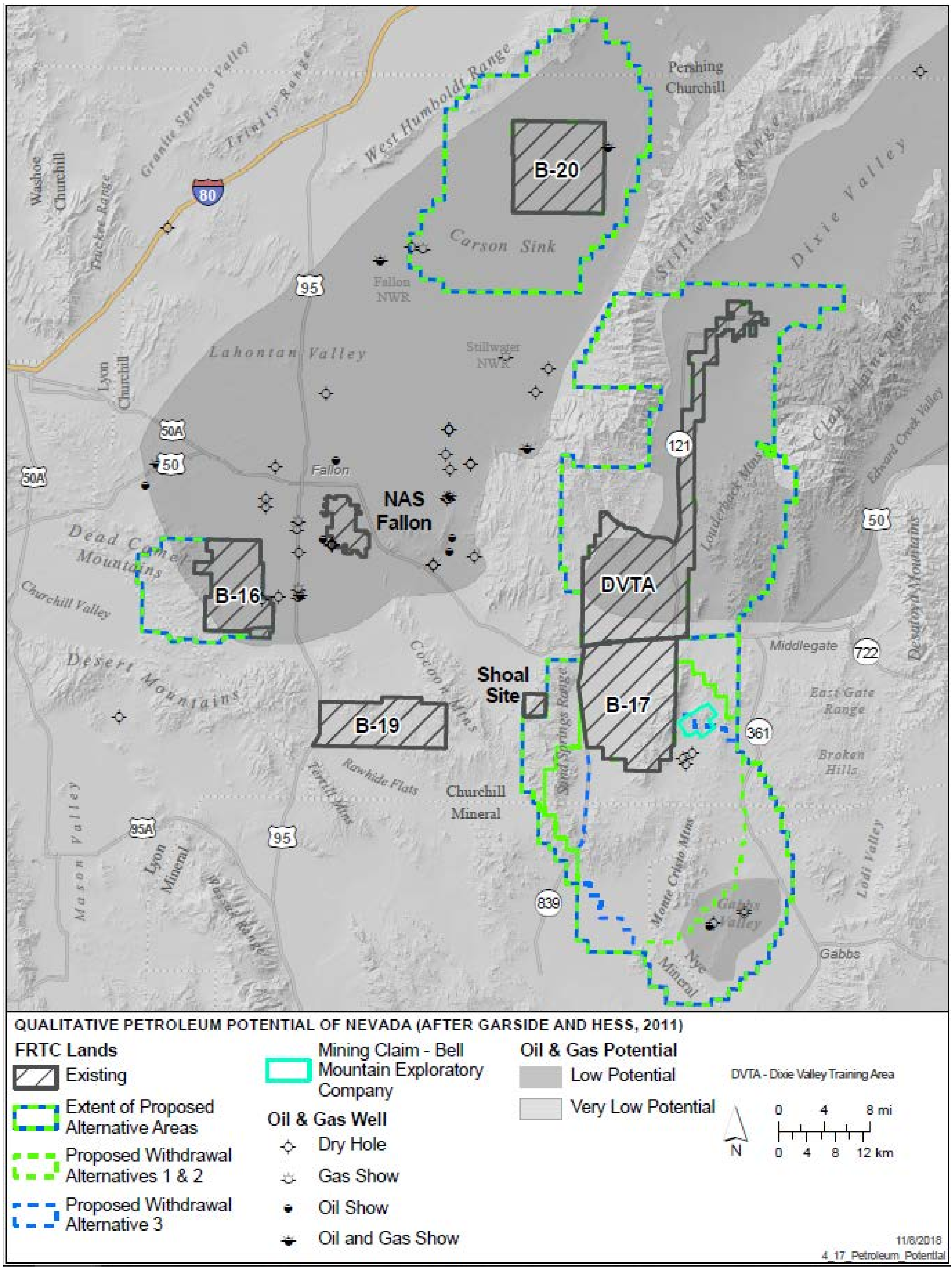


Figure 4.17: Qualitative Petroleum Potential of Nevada

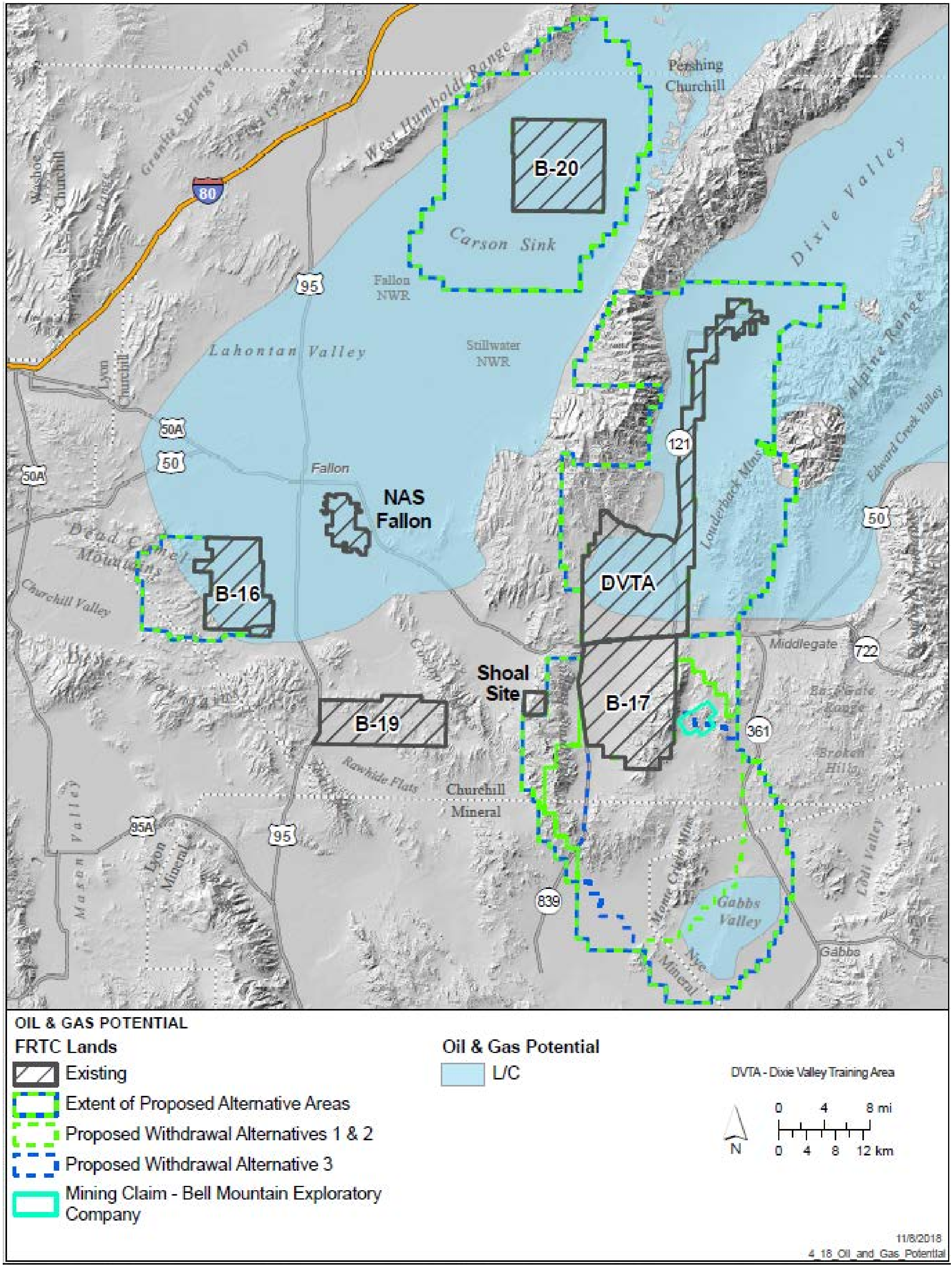


Figure 4.18: Oil and Gas Potential

4.2.3 Oil Shale

A review of NBMG records did not yield information regarding exploration or production of oil shale deposits within or adjacent to the existing and/or proposed withdrawal areas comprising the Study Area. Oil shale has been reported in the Chainman Formation (Mississippian), Vinini Formation (Ordovician), Woodruff Formation (Devonian), Sheep Pass Formation (Eocene), and the Elko Formation (Eocene-Oligocene) (Anna and others, 2007). These formations are for the most part located to the east of the Study Area, where Paleozoic miogeoclinal sediments were transported along regional thrust faults.

Within the Study Area there are sedimentary sequences which include minor shales and mudstones (Sand Springs Terrane, Jungo Terrane); however, these terranes have been subjected to geologic histories inconsistent with the production of oil. The mineral potential classification for Oil Shale in the Study Area is L/D due to geological history of plutonism and deformation inconsistent with hydrocarbon production (Figure 4.19).

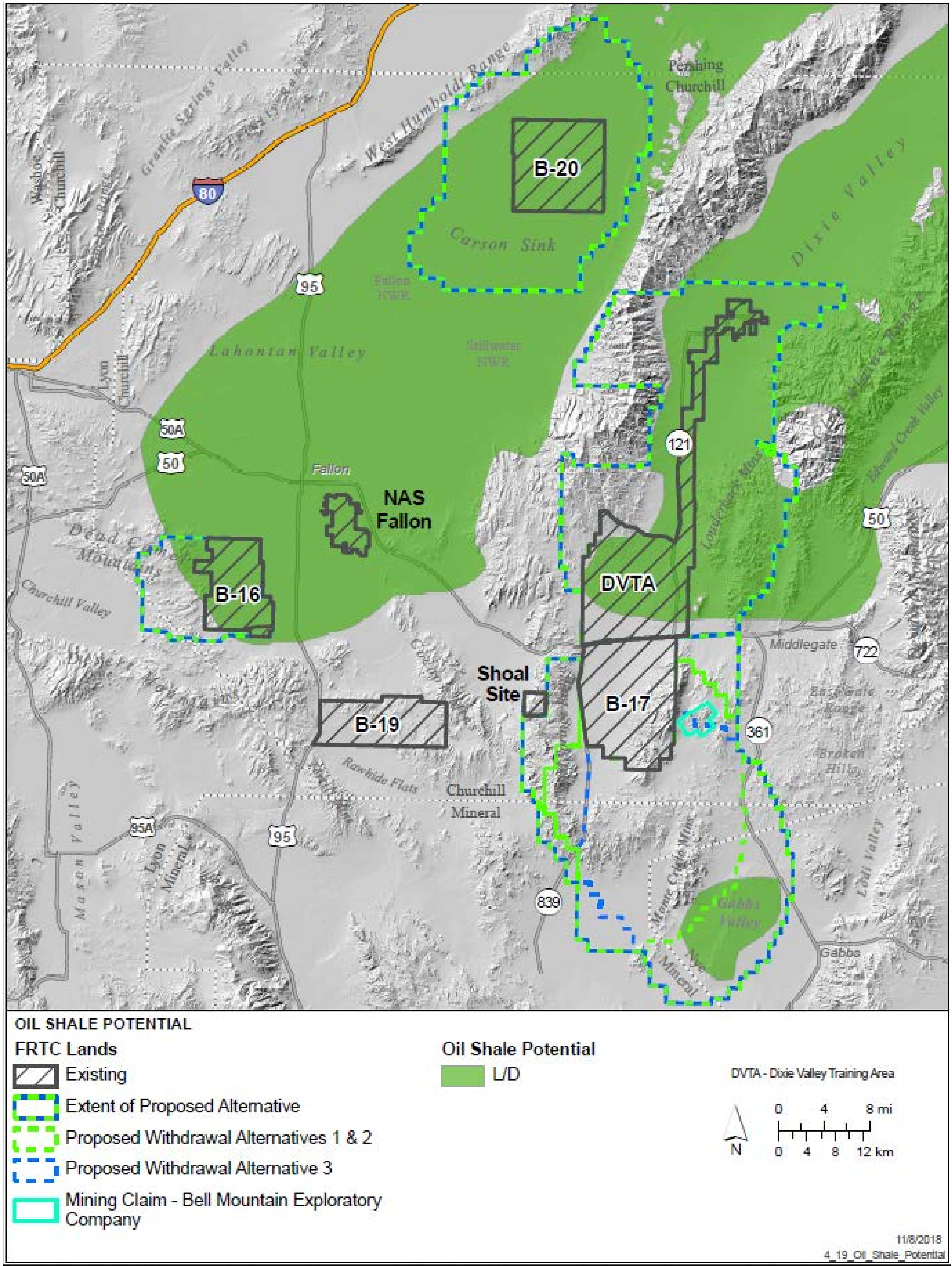


Figure 4.19: Oil Shale Potential

4.2.4 Native Asphalt

Potential for native asphalt development has not been widely studied; however, the geologic setting suggests less than favorable conditions for formation of native asphalt deposits within the Study Area. The mineral potential classification for native asphalt is L/C.

4.2.5 Coal

There are no commercial coal deposits in the State of Nevada and few reported occurrences of coal in southern Nevada. Garside and others (1980) concluded that Nevada contains only minor occurrences of poor quality coal in low tonnage deposits that would be difficult to mine.

Review of NBGM and BLM records indicate coal is not currently leased within the Study Area. Furthermore, there are no reported coal occurrences within the Study Area (Tingley, 1998).

The mineral potential classification for coal in the Study Area is L/D due to the unfavorable geologic environment for the formation of economic coal deposits.

4.2.6 Phosphate

No phosphate production or deposits are reported within the Study Area. According to Papke and Castor (2003), known phosphate deposits primarily exist in Elko County. However, significant production has not occurred. The mineral potential classification for phosphate is L/B.

4.2.7 Potash

Potash primarily is mined from large evaporite potash beds containing sylvite or carnallite which have not been discovered in the Study Area to date. These deposits are typically associated with thick beds of halite which result from continued evaporation of water after halite has precipitated from the solution. The playas within and adjacent to the Study Area are plausible geological environments for both minerals. Potash can also be produced by processing minerals such as alunite, or kalinite, which are additional sources of aluminum. Evaporation of brines used for lithium production produces small amounts of potash that are marketable, but the brines are not adequate grade to sustain potash production alone. Potassium-40 concentrations obtained from regional geophysics do not show potassium anomalies indicative of a near-surface potash. The mineral potential classification for potash in the playas within the Study Area is M/B, outside of playas the mineral potential classification for potash is L/D (Figure 4.20).

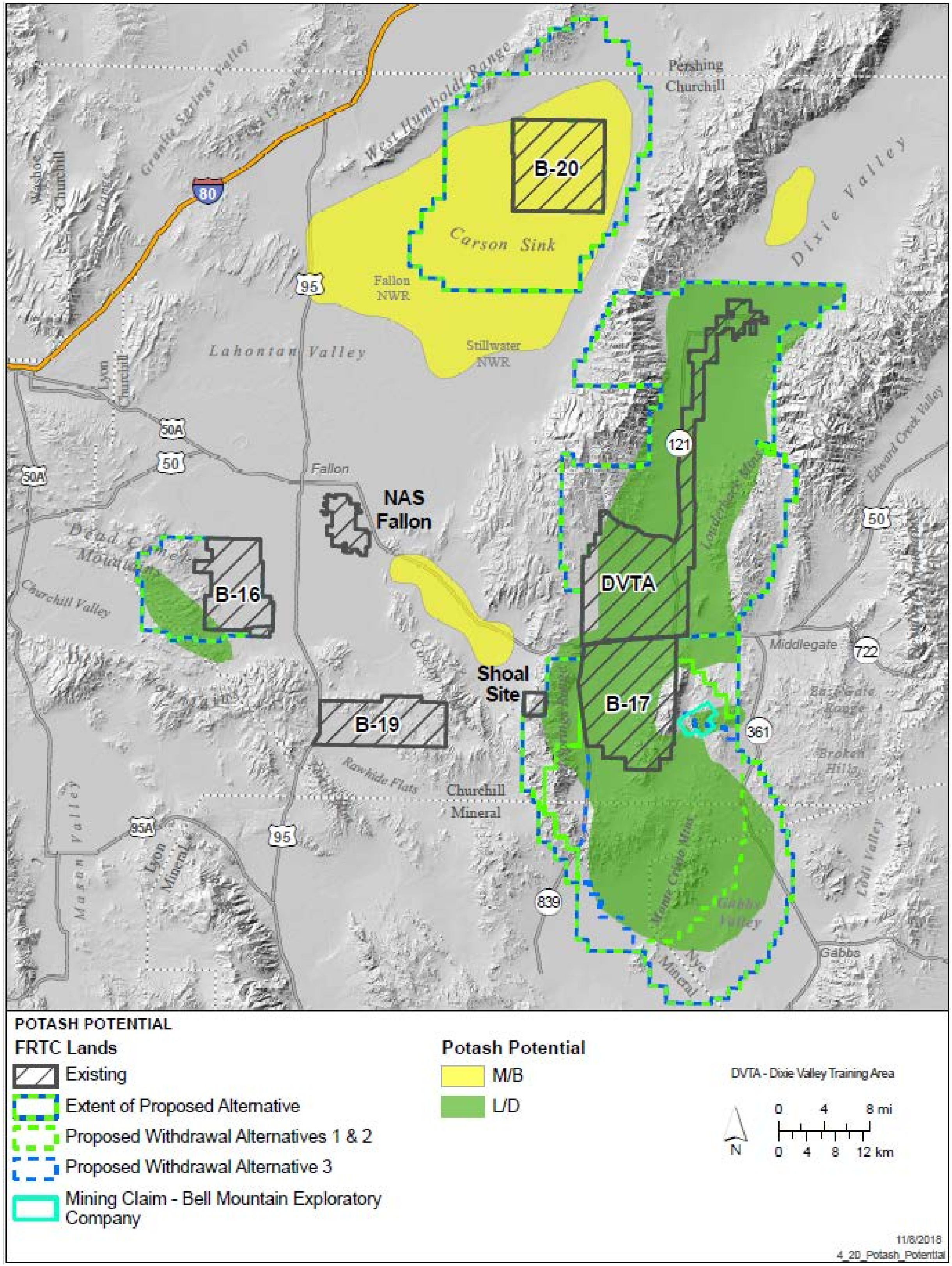


Figure 4.20: Potash Potential

4.2.8 Sodium Minerals

NBMG (2016) indicates the Huck Salt mine is Nevada's only commercial producer of Salt. Salt is mined from the Fourmile Flat playa located south of U.S. Route 50 approximately four miles west of existing and proposed DVTA withdrawal areas and approximately four miles northeast of the existing B-19 withdrawal area in Salt Wells Basin. Huck Salt mines evaporite deposits from the dry lake bed surface for commercial purposes. Eightmile Flats is a playa also located in the Salt Wells Basin west of the Sand Springs Range. Salt was previously mined from the large playa known as Carson Sink. Existing and proposed B- 20 withdrawal areas are located in the Carson Sink basin. Although there is potential for mining of salt from playas within and adjacent to the Study Area, there is no current production of salt. Currently, there does not appear to be an economic basis for development of additional sodium resources within the Study Area. The mineral potential classification for sodium minerals in the playas within the Study Area is M/D, outside of the playas the mineral potential classification is L/D (Figure 4.21).

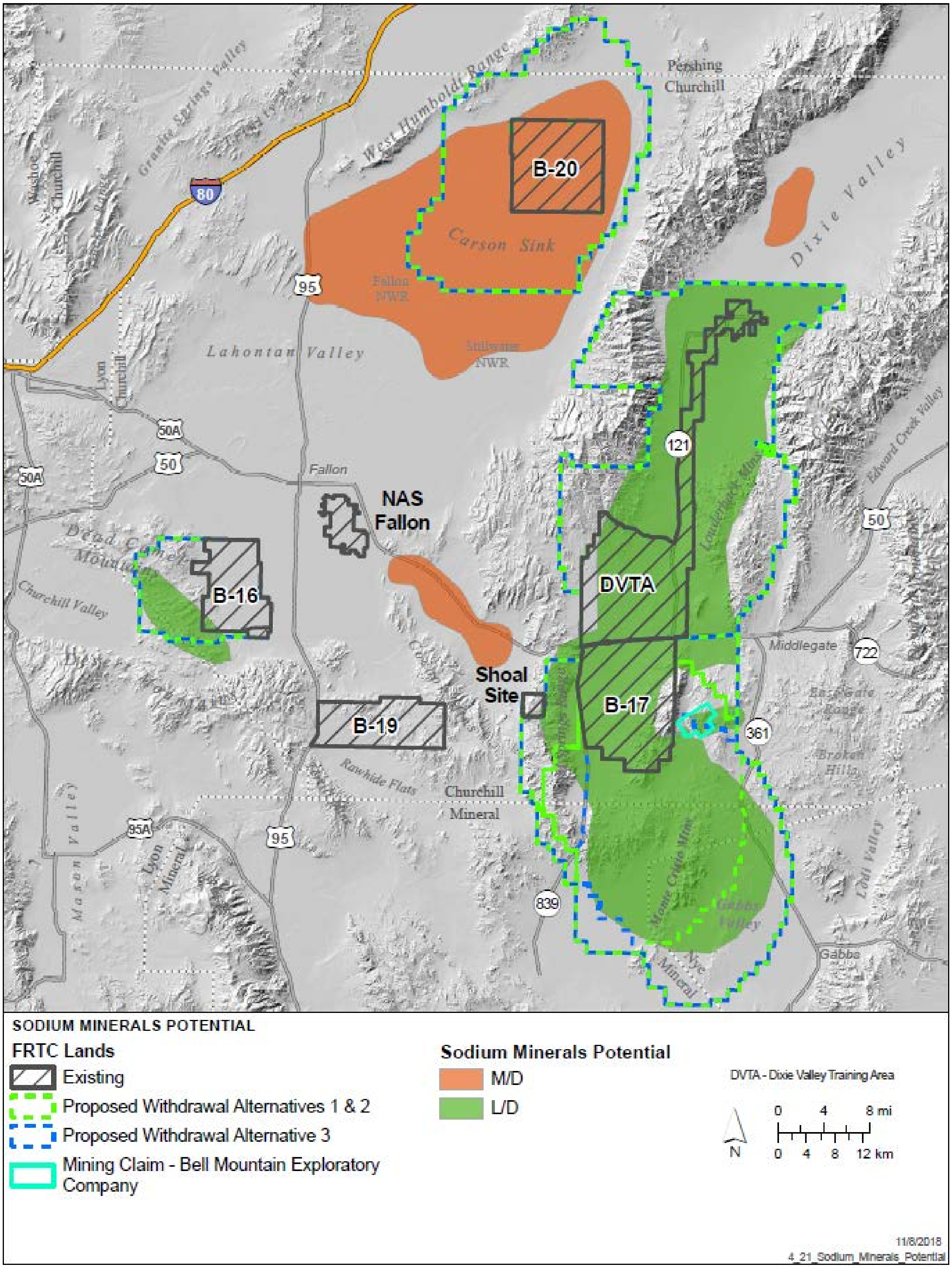


Figure 4.21: Sodium Minerals Potential

4.3 Salable Minerals

The following sections present mineral potential classifications for salable minerals. Table 4.5 presents a summary of the mineral potential classification for leasable minerals in each withdrawal area.

4.3.1 Aggregate, Sand & Gravel

The supply of aggregate, sand, and gravel within the Study Area exceeds foreseeable demand. These materials typically are comprised of unconsolidated alluvial material present on alluvial fans at the margin of mountain ranges and in most basin and valley drainages within the Study Area. Demand for these materials is based on infrastructure construction. As such, the largest production facilities tend to be centered near urban areas as bulk transportation over great distances can be expensive.

Aggregate, sand, and gravel operations within the Study Area are typically small scale and provide low quality material for local industrial and transportation projects. These types of material primarily are used for aggregate base and not as a source for high-quality concrete or asphalt aggregate. Given the relatively rural nature of the Study Area, high-quality aggregate derived from bed rock sources would be prohibitive to use as a source to satisfy urban demand based on associated transportation and handling costs. The mineral potential classification rating for aggregate, sand, and gravel in the quaternary alluvial valleys of the Study Area is H/D.

4.3.2 Clay Minerals

The past-producing Some Tuesday clay (kaolinite) mine is located in the Dead Camel Mountains within the proposed B-16 withdrawal area. There are no other present and/or former clay mining operations within the Study Area boundaries.

Geologically favorable conditions exist within the Study Area for production of clay; however, demand for clay can be highly specialized and transportation of clay from relatively isolated areas is susceptible to similar constraints as those discussed for aggregates. Thus far there has been limited interest in developing clay resources within the Study Area. The mineral potential classification for clay deposits in the Study Area is M/D.

4.3.3 Pumice & Cinder

Pumice is used in abrasives, lightweight cement aggregate, and concrete building blocks and is currently not produced in Nevada (USGS, 2018), although there are several occurrences and former mines outside the Study Area. Papke and Castor (2003) indicate there are no current, or historical, pumice, pumicite, or cinder, operations within or adjacent to Study Area boundaries. The mineral potential classification for pumice, pumicite, and cinder is L/C.

Table 4.5: Summary of Salable Resources

Withdrawal Area	Location	Mineral Resource	Resource Potential	Certainty Level	Comments
B-16	---	Aggregate, Sand & Gravel	High	D	Geologically favorable conditions
	---	Clay	Moderate	D	Defined by historic production
	---	Pumice & Cinder	Low	C	Defined by Papke and Castor, 2003
	---	Building, Ornamental, & Specialty Stone	Low	B	Geologically favorable conditions (bedrock only)
	---	Petrified Wood	Low	C	Geologically favorable conditions
B-17	---	Aggregate, Sand & Gravel	High	D	Geologically favorable conditions
	---	Clay	Moderate	D	Geologically favorable conditions
	---	Pumice & Cinder	Low	C	Defined by Papke and Castor, 2003
	---	Building, Ornamental, & Specialty Stone	High	B	Defined by historic production
	Slate Mountain	Petrified Wood	Moderate	C	Defined by Mustoe, 2015
B-20	---	Aggregate, Sand & Gravel	High	D	Geologically favorable conditions
	---	Clay	Moderate	D	Geologically favorable conditions
	---	Pumice & Cinder	Low	C	Defined by Papke and Castor, 2003
	---	Building, Ornamental, & Specialty Stone	Low	B	Geologically favorable conditions (bedrock only)
	---	Petrified Wood	Low	C	Geologically favorable conditions
DVTA	---	Aggregate, Sand & Gravel	High	D	Geologically favorable conditions
	---	Clay	Moderate	D	Geologically favorable conditions
	---	Pumice & Cinder	Low	C	Defined by Papke and Castor, 2003
	---	Building, Ornamental, & Specialty Stone	Low	B	Geologically favorable conditions (bedrock only)
	---	Petrified Wood	Low	C	Geologically favorable conditions

4.3.4 Building, Ornamental, and Specialty Stone

Building stone consists of dimension stone that can be cut and finished in specific shapes for use in building construction, and well as decorative rock that can be used in landscaping, wall facing, and floor tiles. Requirements for building stone include durable materials with aesthetically desirable colors and textures, and low fracture density and/or favorable fracture orientation.

Assessment findings indicate dimension/building/ornamental stone and/or landscape rock is not produced within or adjacent to Study Area boundaries. Favorable lithologies exist within the Study Area; however, due to the area’s recent history of hydrothermal alteration the suitability of materials may vary locally. Development of the potential is constrained as discussed for other saleable goods such as aggregates and clay. The mineral potential classification for building, ornamental, and specialty stone is H/B for the Gabbs Valley area (BLM, 2013) and L/B within the rest of the bedrock ranges of the Study Area.

4.3.5 Petrified Wood

Petrified wood occurs southeast of Slate Mountain between Fairview Range, the Sinkavata Hills and Bell Flat and in the Gabbs Valley area (Mustoe, 2015). This area is located within the proposed B-17 withdrawal area. Although there likely are other occurrences of petrified wood throughout the Study Area, none are considered significant. Geologically favorable conditions exist within portions of the Study Area for limited commercial development; however, it is likely larger more dependable deposits exist closer to urbanized areas. Thus far, there has been no commercial interest in development of petrified wood sources within the Study Area. The mineral potential classification petrified wood is M/C for the Slate Mountain area in B-17 and L/C elsewhere in the Study Area.

4.4 Strategic and Critical Minerals

On May 18, 2018, under Executive Order 13817, the Department of the Interior published a list of 35 mineral commodities considered critical to the economic and national security of the United States (Federal Register 83 FR 23295).

Under the Executive Order, these commodities qualify as “critical minerals,” because each has been identified as a non-fuel mineral, or mineral material, that is essential to the economic and national security of the United States. By definition these minerals are essential in the manufacturing of critical products, the absence of which would have significant consequences for the economy, or national security. These minerals have supply chains, which are vulnerable to disruption.

The 35 Critical Minerals are presented, along with commentary on their mineral potential within the proposed Withdrawal Areas, in Table 4.6.

Table 4.6: Critical Minerals

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Aluminum (bauxite)	L/B	Primary ore of aluminum, commonly found in lateritic bauxite deposits, used in almost all sectors of the economy.	Used in almost all sectors of the economy.	There are no observations of laterite deposits within the area of interest and other potential sources for Aluminum as secondary or by-products appear to be negligible.	USGS MCS 2017; USGS Minerals Yearbook (2018)
Antimony	H/D & M/B	Occurs in carbonate replacement deposits, skarns, epithermal and porphyry deposits, often as secondary or gangue minerals.	Used in batteries and flame retardants.	Historic records indicate some secondary Antimony production in the Poinsettia and Wild Horse districts. Antimony present in many deposits in the area but often treated as a deleterious mineral and are removed and disposed of during the recovery of precious minerals.	USGS Fact Sheet 2015–3021
Arsenic	M/B	Commonly found in minor concentrations and recovered as by-product in processing of copper, gold and lead ores or by direct processing of arsenopyrite and other arsenic-bearing minerals.	Used in lumber preservatives, pesticides, and semi-conductors.	Arsenic is present in many deposits in the area but often treated as a deleterious mineral and are removed and disposed of during the recovery of precious minerals.	USGS MCS 2018; USGS Minerals Yearbook (2016)

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Barite (Ba)	H/D & M/B (see Section 4.1.2.1)	Commonly found in bedded-sedimentary, bedded-volcanic, vein, and replacement deposits.	Used in cement and petroleum industries.	Barite has been historically produced from two mines in the Eagleville District; not actively being explored for in the Study Area.	USGS MCS 2018; USGS Professional Paper 1802-D
Beryllium	M/B	Occurs in uncommon geological settings and specific deposit types such as intrusion of fluorine and beryllium rich magmas into carbonate rocks as well as in Beryl-bearing pegmatites.	Used as an alloying agent in aerospace and defense industries.	Beryllium present in many deposits in the area but often treated as a deleterious mineral and are removed and disposed of during the recovery of precious minerals.	USGS Fact Sheet 2012–3056
Bismuth	L/B	Commonly found in minor concentrations and recovered as by-product in processing of lead and tungsten ores.	Used in medical and atomic research.	No indications of bismuth occurring in the Study Area; however, there are a number of zinc and Tungsten occurrences where Bismuth may be present.	USGS MCS 2018; USGS Minerals Yearbook (2015)
Cesium	ND	Occurs in uncommon geological settings and specific deposit types such as in pollucite-bearing pegmatites and recovered as by-product in nuclear fission.	Used in research and development.	No indications of cesium occurring in the Study Area.	USGS MCS 2018

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Chromium	L/B	Occurs in uncommon geological settings and specific deposit types such as chromite-bearing stratiform and podiform ultramafic intrusive deposits.	Used primarily in stainless steel and other alloys.	There are no observations of these special geological settings or deposits occurring within the Study Area.	USGS Fact Sheet 2010–3089
Cobalt	M/B & M/C	Commonly found in minor concentrations and recovered as by-product in processing of copper and nickel ore from sediment hosted stratiform copper deposits, magmatic nickel sulphide deposits and nickel laterite deposits.	Used in rechargeable batteries and superalloys.	There are no observations of these special geological settings or deposits occurring within the Study Area; however, there are several occurrences of anomalous cobalt values from the NURE and PLUTO data sets located along the northern margin of the B-20 expansion areas as well as within the DVTA and B-17 expansion areas (Figure 2.15). These anomalies are likely representative of secondary cobalt associated with base metal deposits. The mineral potential is M/C where anomalies are present.	USGS Fact Sheet 2011–3081

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Fluorspar	H/D & M/B (see Section 4.1.2.3)	Commonly found in carbonate replacement deposits and in minor concentrations and recovered as by-product in processing of limestone and uranium ores.	Used in the manufacture of aluminum, gasoline and uranium fuel.	Fluorspar historically mined in the IXL Canyon, the Mountain Wells and Broken Hills districts.	USGS MCS 2018; USGS Minerals Yearbook (2015)
Gallium	L/B	Commonly found in minor concentrations and recovered as by-product in processing of aluminum from bauxite deposits as well as from processing zinc ores.	Used for integrated circuits and optical devices like LEDs.	No indications of Gallium occurring in the Study Area; however, there is known zinc mineralization in the Study Area that may have potential associated Gallium mineralization.	USGS Fact Sheet 2013–3006
Germanium	L/B	Commonly found in minor concentrations and recovered as by-product in processing of zinc and other ores.	Used for fiber optics and night vision applications.	No indications of Germanium occurring in the Study Area; however, there is known zinc mineralization in the Study Area that may have potential associated Germanium mineralization.	USGS Fact Sheet 2015-3011
Graphite C (t)	ND	Commonly found as veins and or layers in metamorphosed marble, schist and gneiss.	Used for lubricants, batteries and fuel cells.	No indications of Graphite occurring in the Study Area.	USGS MCS 2018; USGS Minerals Yearbook (2014)

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Hafnium	L/A	Occurs in association with Zirconium in uncommon geological settings and specific rock types such as heavy mineral sands deposits.	Used for nuclear control rods, alloys and high-temperature ceramics.	No indications of Hafnium occurring in the Study Area and no known mineral sands deposits in the Study Area.	USGS MCS 2018; USGS Minerals Yearbook (2015)
Helium	L/B	Commonly extracted as a by-product during natural gas processing.	Used for MRIs, lifting agent and research.	There are isolated natural gas seeps in the Study Area that may have the potential to include Helium.	USGS MCS 2018; USGS Minerals Yearbook (2015)
Indium	L/B	Commonly found in minor concentrations and recovered as by-product in processing of zinc and other ores.	Mostly used in LCD screens.	No indications of Indium in the Study Area; however, there are occurrences of Zinc that may have associated Indium.	USGS Fact Sheet 2015-3012
Lithium	M/C & M/B (see Section 4.1.2.5)	Occur in uncommon geological settings and specific deposit types such as closed-basin brines, pegmatites and related granites, lithium-enriched clays, oilfield brines, geothermal brines, and lithium-enriched zeolite deposits.	Used primarily for batteries.	There are known isolated occurrences of lithium enrichment associated with playas in the Study Area; however, there have been no significant lithium resources identified to date in the Study Area.	USGS Fact Sheet 2014–3035

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Magnesium	M/B	Commonly found in magnesium-bearing brines and also recovered as a by-product in processing of other ores.	Used in furnace linings for manufacturing steel and ceramics.	No indications of Magnesium in the Study Area; however, there is the potential for Magnesium-enriched brines associate with the playas and geothermal activity in the Study Area.	USGS MCS 2018; USGS Minerals Yearbook (2015)
Manganese	M/B	Commonly found in manganese oxide deposits, primarily as pyrolusite (Manganese dioxide); also common as gangue associated with gold mineralization.	Used in steelmaking.	Manganese-oxides are known to occur in the study area; however, they are in the form of oxide staining gauge mineralization in association with gold mineralization are not considered to be present in economic concentrations.	USGS Fact Sheet 2014–3087
Niobium	ND	Occurs in association with Tantalum in uncommon geological settings and specific rock types such as silica-deficient alkaline igneous rocks, granite-syenite and carbonatite complexes.	Used mostly in steel alloys.	No indications of Niobium occurring in the Study Area.	USGS Fact Sheet 2014–3054

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Platinum Group Elements (PGE)	ND	Occur in uncommon geological settings and specific deposit types such as magmatic Ni-Cu-PGE deposits, or placer deposits formed by the erosion of PGE bearing magmatic deposits.	Used for catalytic agents.	No indications of PGE mineralization occurring in the Study Area.	USGS Fact Sheet 2014–3064
Potash (K)	M/B & L/D (see Section 4.2.7)	Primary ore of potassium commonly found in evaporite and brine deposits.	Primarily used as a fertilizer.	There are no known deposits of potash or known potash-enriched brines in the Study Area; however, the potential exists for both near surface and deeper brine hosted Potash mineralization, especially in the playas.	USGS MCS 2017; USGS Minerals Yearbook (2018)
Rare Earth Element (REE) Group	ND	Occur in uncommon geological settings and specific rock types such as carbonatites, silica-deficient alkaline igneous rocks and specialized clays.	Primarily used in batteries and electronics.	No indications of REE mineralization occurring in the Study Area.	USGS Fact Sheet 2014–3078
Rhenium	L/B	Commonly found in minor concentrations and recovered as by-product in processing of copper, molybdenum ores from porphyry deposits.	Used for lead-free gasoline and superalloys.	No indications of Rhenium in the Study Area; however, there are occurrences of Copper and Molybdenum mineralization in the Study Area that may have associated Rhenium.	USGS Fact Sheet 2014–3101

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Rubidium	L/B	Commonly found in minor concentrations and recovered as by-product in processing cesium, lithium and strontium ores from evaporate and brine deposits.	Used for research and development in electronics.	No indications of Rubidium in the Study Area; however, there are occurrences of Lithium mineralization in the Study Area that may have associated Rubidium.	USGS MCS 2018
Scandium	ND	Commonly found in minor concentrations and recovered as by-product in processing uranium ore and nickel and aluminum ores from bauxite deposits.	Used for alloys and fuel cells.	No indications of Scandium in the Study Area.	USGS MCS 2018
Strontium	ND	Occur in uncommon geological settings and specific deposit types such as celestite-bearing clays and sedimentary deposits.	Used for pyrotechnics and ceramic magnets.	No indications of Strontium in the Study Area.	USGS MCS 2018; USGS Minerals Yearbook (2015)
Tantalum	ND	Occurs in association with Niobium in uncommon geological settings and specific rock types such as silica-deficient alkaline igneous rocks, granite-syenite and carbonatite complexes.	Used in electronic components.	No indications of Tantalum in the Study Area.	USGS Fact Sheet 2014–3054

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Tellurium	L/B	Commonly found in minor concentrations and recovered as by-product in processing of copper and gold ore from porphyry deposits and from volcanogenic massive sulfide (VMS) deposits.	Used in steelmaking and solar cells.	No indications of Tellurium in the Study Area; however, there are occurrences of Gold mineralization in the Study Area that may have associated Tellurium.	USGS Fact Sheet 2014–3077
Tin	L/B	Occur in uncommon geological settings and specific deposit types such as cassiterite-bearing pegmatites and granitic intrusions and placer deposits formed by the erosion of cassiterite-bearing felsic intrusive rocks.	Used as protective coatings and alloys for steel.	There are known isolated occurrences of Tin in the Study Area; however, there have been no significant Tin resources identified to date in the Study Area.	USGS MCS 2018; USGS Minerals Yearbook (2015); USGS MRDS
Titanium	ND	Occur in uncommon geological settings and specific deposit types such as heavy mineral sands deposits and ilmenite-bearing mafic intrusion-related deposits.	Overwhelmingly used as a white pigment or metal alloys.	There are known isolated occurrences of Titanium in the Study Area; however, there have been no significant Titanium resources identified to date in the Study Area.	USGS Fact Sheet 2013–3059; USGS MRDS
Tungsten	H/D & M/B	Occurs, often in association with molybdenum, tin and other metals, in uncommon geological settings and specific deposit types such as pegmatites and hydrothermal deposits.	Primarily used to make wear-resistant metals.	Tungsten mineralization occurs in the Study Area in association with skarn and porphyry base and precious minerals deposits.	USGS MCS 2018; USGS Minerals Yearbook (2015)

Critical Mineral	Potential & Certainty Assessment	Geological Description/Comments	Use	Potential & Certainty Comments	Mineral & Geological Descriptions Source
Uranium	L/B	Occur in uncommon geological settings and specific deposit types associated with weathering and transport or fluid transport and deposition associated with uranium-rich source rocks.	Primarily used for nuclear fuel.	There are known isolated occurrences of Uranium in the Study Area (Chalk Mountain); however, there have been no significant Uranium resources identified to date in the Study Area.	Corn and others, 2008; USGS MRDS
Vanadium	ND	Commonly recovered by secondary processing of by-products from magnetite- and titanium-bearing ores.	Primarily used for titanium alloys.	There are known isolated occurrences of Vanadium in the Study Area; however, there have been no significant Vanadium resources identified to date in the Study Area.	USGS MCS 2018; USGS Minerals Yearbook (2015); USGS MRDS
Zirconium	L/A	Occurs in association with Hafnium in uncommon geological settings and specific rock types such as heavy mineral sands deposits.	Used in the high-temperature ceramics industries.	No indications of Zirconium in the Study Area and no known mineral sands deposits identified to date in the Study Area.	USGS MCS 2018; USGS Minerals Yearbook (2015)

4.5 Implications of Alternatives on Potential Resource Access

The EIS alternatives affect the geographic extent and management of mineral resources in the proposed land withdrawals. The following summarizes the major effects of the alternatives on the access to potential resources.

Proposed alternatives 1 and 2 have the same geographic extent. The difference is that under proposed Alternative 2 the DVTA is open to the development of geothermal and salable minerals on the westside of Nevada state route 121/Dixie Valley Road, and a small part of the southern portion of the proposed B-16 withdrawal (approximately 300 ac) would be left open for public access. The geothermal potential for the area opened to geothermal development in Alternative 2 is an H/D (Figure 4.16).

Proposed alternative 3 significantly changes the geographic extent of the proposed DVTA and B-17 withdrawal areas. Land south of US 50 is not withdrawn for the DVTA, and the existing Bell Mountain Claims in the B-17 expansion area will be recognized. Land management of mineral resources in the proposed DVTA withdrawal will be same as Alternative 2. Besides providing access to the Bell Mountain gold claims, the geographic extent of proposed Alternative 3 does not include much of the land classified as high potential gold districts. Districts fully or partially removed from the proposed land withdrawal with gold potentials in Alternative 3 include; most of Sand Springs (H/D), Leonard (H/C), and Gold Basin (H/C) Districts, and portions of the Rawhide (H/D), Bell Mountain (H/D) and Fairview (H/D) Districts (Figure 4.3). In addition, two mining districts with high tungsten potential [e.g., Sand Springs (H/D) and Leonard (H/D)] are open for development under proposed Alternative 3 (Figure 4.9).

5.0 REASONABLY FORESEEABLE DEVELOMENT SCENARIO

This section of the report reviews scenarios for the reasonably foreseeable development of locatable, leasable and saleable minerals in the proposed withdrawal area. Each scenario for reasonably foreseeable development presents a high-level review of the steps required to develop and produce commercial products profitably.

5.1 Locatable Minerals

The technical review conducted in prior sections of the report has identified the following potential locatable mineral commodities in the Study Area:

- Gold
- Silver
- Copper
- Lead
- Zinc
- Tungsten
- Molybdenum
- Lithium
- Fluorspar
- Barite
- Diatomite
- Clay
- Gypsum
- Silica

Typically, the development of a mine goes through five stages, with each stage using progressively more sophisticated (and more expensive) techniques over a successively smaller area to identify, develop, and produce an economic mineral deposit. The full sequence of developing a mineral project involves reconnaissance, prospecting, exploration, economic evaluation, and development.

Reconnaissance: Reconnaissance is the first stage in exploring for a mineral deposit. This involves an initial literature search for the area of interest using available references, such as publications, reports, maps, and aerial photographs. Because the Study Area is large, varying from hundreds to thousands of square miles, this stage normally involves large-scale mapping, regional geochemical and/or geophysical studies, and remote sensing with aerial or satellite imagery. These studies are generally undertaken with minimal surface disturbance, which usually consists of stream sediment, soil, or rock sampling. Minor off-highway vehicle use may be required.

Prospecting: If reconnaissance identifies anomalous geochemical or geophysical readings, rare or unusual geological features, evidence of mineralization, or a historical reference to mineral occurrence, a prospecting area of interest is identified. This area can range from a single square mile to an entire mountain range of several hundred square miles.

Activity to locate a mineral prospect includes more detailed mapping, sampling, and geochemical and geophysical study programs. This is the time when property acquisition efforts usually begin, and most mining claims are located to secure ground while trying to make a mineral discovery. Surface-disturbing activities associated with prospecting include more intense soil and rock chip sampling, using mostly hand tools; frequent off-highway vehicle use; and placement and maintenance of mining claim monuments. This activity is usually considered casual use and does not require BLM notification or approval.

Exploration: Upon location of a sufficiently anomalous mineral occurrence or favorable occurrence indicator, a mineral prospect is established and subjected to more intense evaluation through exploration techniques. Activities during exploration include those used during prospecting, but at a more intense level and in a small area. In addition, road construction, trenching, and drilling may take place. In the later stages of exploration, an exploratory adit or shaft may be driven. If the prospect already has underground workings, these may be sampled, drilled, or extended. Exploration activities typically use mechanized earth-moving equipment, drill rigs, etc., and may involve the use of explosives.

Typical exploration projects could include in-stream dredging with portable suction dredges; exploratory drilling, which could include construction of new roads; use of explosives to sample rock outcroppings; and excavation of test pits. If the exploration project disturbs 5 ac or less, it is conducted under a notice which requires the operator to notify the BLM at least 15 days prior to beginning the activity. If a project disturbs more than 5 ac, it is conducted under a plan of operations and requires NEPA compliance prior to approval.

Economic evaluation: If an exploration project discovers a potentially economic deposit, activity would intensify to obtain detailed knowledge of the deposit (such as ore grade and deposit size), possible mining methods, and mineral processing requirements. This would involve applying all the previously used exploration tools in a more intense effort. Once enough information is obtained, a feasibility study (FS) would be conducted to decide whether to proceed with mine development and what mining and ore processing methods would be used. Economic evaluations typically take multiple years, and in many cases the first evaluation conducted is a preliminary economic assessment (PEA) followed by a pre-feasibility study (PFS) leading up to a full FS when an economic decision can be made to proceed with a mining project.

Mine development: Once the decision to develop a property has been made, the mine permitting process begins. Upon approval, work begins on development of the mine infrastructure. This includes constructing the mill, offices, and laboratory; driving development workings if the property is to be an underground mine, or pre-stripping if it is to be an open-pit mine; building access or haul roads; and placing utility services. Evaluations of ore reserves may be refined at this time.

Once the necessary facilities are in place, production begins. Satellite exploration efforts may be conducted simultaneously to expand the mine’s reserve base and extend the project life. The property is reclaimed concurrently with the mining operation or upon its completion. Often uneconomic resources remain unmined and the property dormant until changes in commodity prices, regulatory requirements or production technology makes these resources economically feasible to mine.

Activities on these lands typically include mining, ore processing, tailings disposal, waste rock placement, solution processing, metal refining, and placement of support facilities, such as maintenance shops, laboratories, and offices. Such activities require the use of heavy earth-moving equipment and explosives for mining and materials handling, exploration equipment for refining the ore reserve base, hazardous or dangerous reagents for processing requirements, and other equipment for general construction.

The size of mines varies greatly, and not all mines require all of the previously mentioned facilities and equipment. The amount of land involved can range from only a few ac to several hundred ac. Most exploration projects disturb 5 ac, or less, which would require a Notice of Intent. Projects disturbing more than 5 ac require an approved plan of operations pursuant to 43 CFR 3809.1-4.

Mine development and permitting is a multiple-year process. Although actual mine site construction can normally be completed in 2 to 3 years for most surface mining locations, the permitting process can typically take 5 to 10 years. From Golder's understanding of the current permitting process in Nevada, the average time to permit a new mine is 7 years. Further, investments in power lines, securing water sources, and building roads or rail for transportation will typically require an investment larger than the mine and milling facilities.

5.1.1 Locatable- Reasonably Foreseeable Development Scenarios

The following presents the reasonably foreseeable development scenarios for locatable resources.

5.1.1.1 Metals/Gold

Exploration: Based on historical mineral exploration activity, and particularly with known occurrences in the planning area of epithermal type gold deposits, exploration for gold is expected to take place during the life of this plan.

Depending on the market for gold, multiple exploration projects for epithermal gold deposits are expected within the area over the next 20 years. A typical epithermal gold exploration project involves six drill holes and approximately 0.5 mile of new road 12 feet wide (total disturbed width of 20 feet) for each drill hole, resulting in 7 ac of disturbance/project.

Economic evaluation/mine development: Exploration activity will likely result in the discovery of 1 open-pit deposit, employing between 100 to 300 people. During construction the number of employees on site typically will be 2 to 3 times larger than the long-term staff for mine and milling operations. The potential deposit will likely be in or adjacent to areas of known potential for gold/silver. Of critical importance to the economic viability of a new deposit is the long-term commodity prices used for the metals which will be produced from the discovery in the economic and financial modeling.

A typical Nevada open-pit metal mine is expected to contain between 5 to 90 million tons of ore, with a probable size of 15 million tons, averaging 0.06 troy ounces of gold per ton. Based on typical operations detailed exploration and feasibility studies would involve the construction of about 30 miles of road 12 feet wide (total disturbed width of 20 feet with ditches, cuts, and fills), and 300 drill sites, for a total disturbance of 75 ac. Development of the deposit will typically involve creation of an open pit, approximately 2,100 feet in diameter and 800 feet deep; a mill complex; a cyanide heap leach pad; a tailings disposal facility; a waste disposal facility; approximately 5 miles of internal graveled haul road 90 feet wide with a total disturbance of 100 feet; and 15 miles of all-weather access road 20 feet wide (total disturbed width of 36 feet). Surface disturbance will commonly cover approximately 85 ac for the pit, 40 ac for the mill complex, 65 ac for the heap leach pad, 140 ac for the tailings disposal facilities, 260 ac for the waste disposal facilities, 60 ac for internal haul roads, and 65 ac for access roads. Total surface disturbance caused by this project will be on the order 715 ac. It would not be uncommon for a project of this type to take at least ten years or more to develop.

5.1.1.2 Industrial Minerals

Exploration: Based on historic mineral exploration activity, and known occurrences in the planning area, a moderate amount of exploration for industrial minerals—mainly lithium—is expected during the life of this plan. Depending on market conditions, several projects are expected for industrial minerals. Exploration for these commodities consists of core or auger drill holes or trenching and road construction. An average project would involve up to 10 core or auger holes; 5 trenches 20–25 feet wide, 60–125 feet long, and 15–25 feet deep; and 1,000 feet of road 12 feet wide (total disturbed width of 20 feet), for a disturbance of 0.8 to 1 acre/project.

Economic evaluation/mine development: Exploration activity is not expected to result in the discovery of an economically mineable deposit. In spite of the low probability of discovery the following scenario is appropriate based on mine models developed by the U.S. Bureau of Mines. The industrial mineral deposit is expected to contain between 50,000 and 120,000 tons of ore, most probably about 85,000 tons, with an assumed moisture content of 25 percent. Development of the deposit will involve an open pit approximately 1,000 feet long by 130 feet wide by 30 feet deep, with an industrial mineral bed 20 feet thick; a mill complex, assumed to be on public land 15 miles off-site and adjacent to a paved road; a stockpile near the pit; 100 feet of haul road 20 feet wide (total disturbed width of 36 feet); and 10 miles of access road 20 feet wide (total disturbed width of 36 feet). Typically, surface disturbance resulting from this mine will typically be on the order of 3 ac for the pit, 1 acre for the stockpile, 0.1 acre for the haul road, 44 ac for the access road, and 5 ac for the mill.

5.2 Leasable Minerals

The technical review in prior sections of the report has identified the following potential leasable minerals in the Study Area:

- Geothermal
- Salt
- Potash

Further, the analysis indicates an extremely low probability of oil & gas, or coal development in this geographic area.

Development of salt, potash, and sulfur resources would be similar to the impact of an industrial mineral operation as outlined in the Industrial Minerals Section of 5.1.3. Salt is primarily used for deicing of roads and as a chemical agent in the production of chlorine and caustic soda. Potash is almost exclusively used as the source of chemical potassium for fertilizer and other agricultural products. Over 90% of sulfur is used to produce sulfuric acid which is used in many chemical and manufacturing processes.

The balance of this section will focus on geothermal development.

Leasing land for geothermal development does not affect the environment, but lease issuance confers the future right to develop geothermal resources, subject to applicable regulations and lease stipulations. An RFD discloses future potential direct and indirect impacts that occur once the lands are leased. This evaluation does not replace the requirement that BLM conduct a site-specific environmental assessment (EA) at the exploration, development, and production stages, in order to comply with NEPA requirements. Geothermal development can be broken down into five generally sequential phases: exploration, development and production followed by reclamation and abandonment.

During exploration, all activities necessary to explore for geothermal resources are conducted including: geologic, geochemical, and geophysical surveys, drilling temperature gradient wells plus drilling exploration wells. Most activities at this stage are proposed to the BLM via a Notice of Intent to Conduct Geothermal Resource Exploration Operations. Geological, geochemical, and geophysical surveys typically involve analyzing the surface geology, collecting water data and samples from hot springs, and the collection of geophysical data by various methods. Cross-country travel could occur in order to complete the surveys and this work typically covers a broad surface area. These surveys typically cause minimal surface disturbance and are often considered casual use. If the proposed activities exceed the casual use threshold, additional analysis may be required under NEPA.

Based on the analysis of the data gathered from the geologic, geochemical, and geophysical surveys, inference can be made as to where higher temperature gradients could occur. The higher temperature gradients are then confirmed by drilling temperature gradient (TG) wells (typical programs at this stage are on the order of 6 drill holes). These wells are usually less than seven (7) inches in diameter and are drilled to depths of several hundred to several thousand feet. Well drilling occurs in association with road and well pad construction. Well pads are typically 0.1 ac (55 feet by 80 feet) in size and may be established without removing existing vegetation. Wells are typically drilled next to existing roads, but new road may need to be built in order to get an accurate extent of the temperature anomaly. Temperature gradient studies may be categorically excluded from NEPA. When greater levels of disturbance are necessary (for example, road building), preparation of an EA may be appropriate.

Upon completion of exploration activities focused on temperature gradient wells, and the confirmation of a sufficient temperature anomaly, one or more exploration wells could be drilled in order to test the prospect. These wells may be several hundred to several thousand feet deep and are typically 2,000 to 4,000 feet deep. A Geothermal Drilling Permit (GDP) must be approved for each well drilled. Each well pad with associated facilities typically disturbs an area of about 350 feet by 350 feet, or approximately 3 ac. In many cases a new road may need to be constructed into the site, creating additional disturbance. One, or more, GDPs will typically be analyzed in an EA.

If the exploration activities have produced results that strongly indicate the presence of a heat reservoir capable of commercial production, then developments of the field will ensue. This is the stage where most of the ground disturbing activities will occur. Development and utilization proposals require NEPA analysis, often at the EA level. In certain circumstances, an EIS might be required. The production limits of a field are determined by drilling of production and injection wells, which often results in more surface disturbance to construct additional roads and well pads. In the early development stages, the status of any given well may be uncertain due to limited knowledge of the details of the reservoir. Once there is confidence about the setting and geometry of the reservoir, development of production facilities can begin.

Development of production capabilities could include the construction of a geothermal electric generating plant, direct use facilities (such as green houses or dehydration plants), or a combination of the two. Other facilities that would be constructed include pipelines, at least one electric transmission line, and administrative facilities such as offices, a warehouse, and maintenance facilities. If the development is for direct use, the generating facilities would be replaced by greenhouses, dehydration plants, and possibly cooling ponds.

The reclamation and abandonment, or close-out, stage involves abandonment when exploration is unsuccessful or after production ceases. This stage includes the following discrete operations: surface equipment removal, cementing and capping drill holes and wells, and surface rehabilitation. All surface disturbances must be reclaimed to BLM standards. Reclamation includes removing all facilities, re-grading and re-contouring all surface disturbances to blend with the surrounding topography, and re-establishment of a desirable variety of vegetation.

5.2.1 Geothermal Reasonable Foreseeable Development

Until actual geothermal exploration and development begins, it is difficult to quantify the resource potential and possible future intensified production measures necessary to develop the resources. In order to assess environmental impacts resulting from an action as general as geothermal exploration, development, and production, it is necessary to assume levels of intensities of such development.

Several models were assumed which describe the major processes and actions involved in the various stages of lease implementation. These models serve as the baseline against which to analyze impacts on the existing environment.

The reasonable foreseeable development here envisions that over the next 20 years, exploration drilling occurs on all geothermal leases, some of which lead to more detailed exploration drilling, and a few of which lead to the discovery of geothermal resources capable of developing one 20 to 30-megawatt (MW) geothermal power plant. The 20-MW power plant is used as a typical size to estimate the amount of disturbance that could be involved for the RFD. These calculations are meant to be used as an indicator of the impacts involved, not as a cap or bound on the size of any geothermal power plant development. The discussion below looks at the potential surface disturbances from this scenario, and then the other potential environmental impacts from development of the geothermal resources.

Exploration: During the exploration stage, surface disturbance is minimal with few adverse impacts until the decision is made to drill one or more exploration wells. If we assume that as many as three temperature gradient or exploration flow test wells will be drilled on each lease. This would disturb as much as three ac (one acre per drill site). Three new access roads, each typically 0.5 mile in length, would disturb an additional 1.5 ac. Therefore, the total disturbance per lease is commonly approximately 4.5 ac. Exploration drilling surface impacts are transitory in that unsuccessful exploration programs are abandoned, and the surface impacts are reclaimed usually within a two year period. Components from successful exploration programs can be used through the development process, frequently using the existing surface disturbances for some of the development activities.

Economic Evaluation and Development: The following describes the construction activities required to develop a 20 MW electrical power generating plant, associated wells, pipelines, roads, and electrical transmission lines. The number of wells includes those used for production, standby, and reinjection. The timeframe for development of a geothermal plant once the field has been identified can be as short as 2 to 3 years.

Up to 6 production or injection wells could be drilled on each lease. Each well pad would disturb approximately 5 ac, and a mainline road would disturb approximately 10 ac. Each pipeline will disturb approximately 5 ac and each of 5 access roads will disturb approximately 7 ac. A power plant will occupy approximately 30 ac, a disposal pond disturbs approximately 5 ac, and a 25-mile transmission line would disturb approximately 10 ac. Total surface disturbance for each plant for this phase of operation will total approximately 125 ac.

5.3 Saleable Minerals

The most likely development of saleable minerals in the Study Area is sand/gravel and rock aggregates. The major use of saleable minerals (primarily sand and gravel and crushed/broken rock) will continue to be for road construction and maintenance. Much of this activity will be routine seasonal maintenance on county roads, which will result in a moderate increase in demand for these materials. Because the population of the area is expected to increase over the life of this plan, it is likely that public demand for saleable minerals will increase slightly over current levels. In addition to sand and gravel, and rock aggregate, a small amount of demand for decorative stone may also develop.

Development of a saleable mineral deposit goes through a sequence similar to that for locatable minerals and includes reconnaissance, prospecting, exploration (sampling and testing), and development. Unlike the process for locatable minerals, however, written approval (such as a permit) must be obtained from the BLM and the material must be purchased by the operator (in the case of a private citizen or commercial operator) before the deposit can be developed, as required by the 1947 “Materials Act,” as amended (30 U.S.C. 601 et seq.). The act also grants the Federal government discretionary authority to deny permission to develop a deposit if the damage to public land, or resources, would outweigh the economic benefits of development.

Reconnaissance and prospecting for saleable minerals involves a literature search, field examination, geologic mapping (if necessary), and surface sampling. Surface disturbance is usually negligible. Exploration is usually confined to a small area and generally involves drilling or core drilling to determine whether the material meets construction standards. Because exploration is normally limited to areas with good access to major roads, little or no road construction is involved. A typical operation usually involves several small trenches or core and/or auger holes and typically disturbs less than 0.01 acre per site. Mine development normally involves a pit or quarry, space for processing (crusher, stockpile, and occasionally an asphalt plant), and a staging area for trucks (loading and a turnaround area). Disturbance normally covers about 2 to 3 ac per project.

5.3.1 Saleable Minerals Reasonable Foreseeable Development

For this analysis it is assumed there are a limited number of rock aggregate or sand and gravel operations developed in the study given the current lack of operations.

Exploration: A typical sand and gravel operation would involve up to five trenches, perhaps 8 by 10 feet and up to 20 feet deep, disturbing about 100 square feet per trench, or about 0.01acre/project; total disturbance would be approximately 0.15 acre. A typical rock aggregate exploration project will involve up to eight core holes, disturbing about 0.01 acre/hole, or 0.1 acre/project; total disturbance would be about 1 acre. A typical decorative rock exploration project will use no mechanized equipment and will be limited to surface sampling, essentially identical to a prospecting project; surface disturbance will be negligible.

Economic Evaluation and Development: For sand and gravel, rock aggregate and decorative stone are outlined below.

Sand and gravel: During the life of the plan, it is expected that 1 new sand and gravel deposit with good quality material will be developed in easily accessible areas (such as within a few miles of major roads). Site-specific assessments required by NEPA, and inventories of cultural resources and threatened and endangered species, will be conducted prior to development. A typical development of a sand and gravel deposit will contain a pit, stockpile area, processing area (crusher, washer, screener, conveyor, and perhaps asphalt plant), truck loading and turnaround area, and about 0.5 mile of new road 20 feet wide (36 feet total disturbed width). Disturbance for each project will typically be 2 ac for the pit, processing, and gravel and waste stockpile and 2 ac for the access road, or approximately 4 ac/project.

Rock aggregate: During the life of this plan, it is expected that 1 new deposit of good quality material will be developed in easily accessible areas (such as within a few miles of major roads). When the County Highway Departments need additional sources of material for major projects, highway material rights-of-way will be granted under title 23 of the “Federal Highway Act” for needed deposits adjacent to highways.

Like sand and gravel, rock aggregate deposits will require site-specific NEPA assessments and inventories of cultural resources and threatened and endangered species prior to development.

A typical rock aggregate quarry will be essentially the same as a sand and gravel operation and contain a pit, stockpile area, truck turnaround and loading area, processing area (crusher, screener, washer, conveyor, asphalt plant, etc.), and about 2,500 feet of new access road 20 feet wide (36 feet total disturbed width). Disturbance will typically cover 2 ac for the quarry operations and 2 ac for the access road, or 4 ac per project.

Decorative stone: As population increases over the next 15 to 20 years this may result in a moderate increase in demand for decorative material. It is expected that 1 new collecting site will be designated to meet the increase in demand. This site could be located throughout the planning area and will generally be reached by existing roads. Site-specific NEPA assessments and inventories for cultural resources and threatened and endangered species will be required prior to designation.

Extraction of the material will be by surface methods only, such as loading onto pickup or flatbed trucks or pallets, by hand or by rubber-tired front-end loaders. Surface disturbance resulting from this operation will be negligible.

6.0 CONCLUSIONS

This MPR has been prepared in support of an EIS for the land withdrawal extension and expansion at the NAS - FRTC, in Churchill, Lyon, Mineral, Nye, and Pershing Counties, Nevada. The FRTC is part of the DON. This MPR has been prepared in accordance with Bureau of Land Management guidelines for mineral resource assessments.

6.1 Metallic Locatable

Metallic locatable mineral resources were historically produced in 11 of the 21 mining districts in the Study Area. The precious metals, silver and gold, were the most common metals produced. Silver production occurred at eight mining districts and gold production occurred at seven of the mining districts. All the precious metal occurrences are associated with vein-hosted epithermal mineralization, base metal occurrences are generally pluton-related.

Other metals historically produced include tungsten at three mining districts, lead at two mining districts, and antimony at one of the districts. With exception of the proposed B-16 area, all the proposed withdrawal areas have a history of metallic mineral resource production. Mineral districts with known mineral production are assigned a resource potential classification of H/D for the commodity produced. Either copper, molybdenum or zinc minerals were identified, but not produced, at nine of the mining districts. Mineral districts with metals which were identified, but do not have records of production were assigned a resource potential classification of H/C. See Figure 4.3 through Figure 4.9 for the geographic distributions of mineral resource potential classifications for metallic locatables.

6.2 Industrial Locatable

Lithium is an industrial locatable mineral of special interest due to the development and use of lithium-ion batteries; at present Nevada is host to the only active lithium producer in the US. Anomalous concentrations of lithium have been detected in playa sediments adjacent to the proposed withdrawal areas. The resource potential classification for lithium-bearing clay is M/B in playas where surface sediment samples have recorded between 100 and 300 ppm lithium, and M/A in all other playas. The resource potential classification for lithium-enriched brines is based on the lithium content and Li:Cl ratio of groundwater in playas. Playas are classified as M/C, or M/B, depending on groundwater geochemistry. Playas without well data are assigned a mineral potential of M/A.

A comparison of playas in the Study Area to playas in Clayton Valley, located in central Nevada and well outside of the Study Area, where lithium is being recovered from brine, suggests that the conditions responsible for economic lithium concentrations at Clayton Valley do not exist in the Study Area. Further surface and subsurface exploration including the completion of wells and groundwater sampling will be required to further define the potential for lithium mineralization in the Study Area. See Figures 4.13 and 4.14 for the geographic distribution of mineral potential designations for lithium.

6.3 Leasable

The leasable commodity with the highest potential in the Study Area is geothermal. The Study Area is in an area of the Great Basin province with a high concentration of producing geothermal power plants, geothermal occurrences (e.g., hot springs, hot wells, hot gradient holes), and active geothermal exploration activity. The region is characterized by high geothermal gradients resulting from crustal and lithospheric thinning caused by the tectonic extension of the Great Basin. The geothermal gradient in the Study Area is high relative to most other areas of the Great Basin. The Late Quaternary seismicity and high crustal strain rate which characterize the Study Area are factors associated with high geothermal potential. Range-front faults along the margins of the mountain ranges are favorable structural settings as these structures provide highly permeable conduits for deep circulating groundwater.

Areas with known hot springs, high temperature-gradient occurrences, or areas that are near existing geothermal power plants are assigned a geothermal resource potential of H/D. Areas which possess analogous structural settings to known productive systems, but lack sufficient well data are assigned H/C, or H/B. Areas where existing well data suggest lower thermal gradients, but which are still located in favorable structural settings are assigned a potential of M/C or M/B depending on quantity of available information. See Figure 4.16 for the geographic distribution of geothermal resource potential designations.

The potential for oil and gas, oil shale, native asphalt and coal resources in the Study Area is low (L/D and L/C). While there are historical wells with oil and gas shows in the Study Area, there are no currently producing wells. This is likely because the geologic units which are the source-rocks of petroleum elsewhere in the Great Basin do not occur in the Study Area. There is one oil and gas lease located within the Study Area, in the Gabbs Valley area, but this lease is not producing. There are no recorded coal occurrences within the Study Area, and the geological environment is not suitable for such deposits. See Figure 4.18 and Figure 4.19 for the geographic distributions of mineral potential designations for oil and gas, and oil shale.

There is moderate potential (M/B) for potash and sodium minerals within the B-20 Carson Sink area; however, there is no active production within the playas. See Figure 4.20 and Figure 4.21 for the geographic distributions of mineral potential designations for potash and sodium, respectively.

6.4 Salable

The highest potential for salable resources in the Study Area is associated with industrial and construction materials such as aggregate, sand and gravel derived from alluvial sources, and to a lesser extent, clay minerals. The value of these resources is limited by lack of access and distance to markets. In addition, there appear to be adequate off-site resources to support industrial mineral and construction material demand in the vicinity of the Study Area. At present and for the foreseeable future, limited demand for on-site resources is anticipated. There is some low potential for building and ornamental stone, as there are records of historic production in the Gabbs Valley area, however, like aggregate, market access and distance has kept demand low.

6.5 Critical Minerals

Several of the minerals which are included under Executive Order 13817 on the list of 35 mineral commodities considered critical to the economic and national security of the United States (Federal Register 83 FR 23295) have a low to moderate potential for occurrence in the Study Area. Refer to Table 4.6 for the list of 35 critical minerals and potential classification. Barite, Fluorspar, and Tungsten are the only minerals on the list of 35 with high potential (both classified as H/D) within the Study Area; they were historically produced from mines in the

Study Area, but there is no current production or exploration activity for these minerals in the proposed withdrawal areas. While there is low to moderate potential within the Study Area for several of the 35 critical minerals, all would require a significant increase in exploration activity to identify a potential economically recoverable resource for future development.

6.6 Effects of Alternatives

The proposed alternatives affect the geographic extent and management of mineral resources in the proposed land withdrawals. Alternative 1 is the most restrictive to access of mineral resources and Alternative 3 is the least restrictive. Alternative 2, has nearly the same geographic extent as Alternative 1, but allows for the development of geothermal and salable commodities in the proposed DVTA withdrawal area on the westside of Nevada State Route 121/Dixie Valley Road. The geothermal potential is an H/D in the area opened for geothermal development in Alternative 2. Alternative 3 significantly changes the geographic extent of the proposed DVTA and B-17 areas, provides access to the Bell Mountain gold claims, and allows for geothermal and salable development in the proposed DVTA withdrawal area. Alternative 3 provides access to the high potential geothermal resources west of State Route 121/Dixie Road, and opens up several mining districts with a high potential for precious and base metal development.

6.7 Reasonable and Foreseeable Development

Golder's evaluation of scenarios for the reasonably foreseeable development of locatable, leasable, and saleable minerals in the proposed withdrawal area suggests the following may occur:

- Locatable Minerals:
  - One open-pit metal operation impacting 700 plus ac
  - One open-pit industrial mineral operation impacting 55 ac
- Leasable Minerals:
  - One geothermal operation impacting 125 ac
- Saleable Minerals:
  - One sand and gravel or rock aggregate operation impacting 4 ac

6.8 Recommendations

Golder recommends collecting field data to verify the MPR findings where possible. Field verification activities which could increase the potential or certainty classifications would include: confirmation of the geochemical anomalies outside of known mining districts, identification of hot springs deposits (sinter) and structures for geothermal targets, and possible playa sampling (groundwater, surface water, and solid samples) to better understand lithium potential.

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APPENDIX A

Single Element Anomaly Geochemical Data

Appendix A: Single Element Anomaly Geochemical Data

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	0	11	0	362.4	-500	-30	0	0
NURE	0	9.792	0	-200	-500	-30	0	0
NURE	0	3.196	0	164.7	-500	-30	0	0
NURE	0	3.438	0	170.6	-500	-30	0	0
NURE	0	3.181	0	430.6	-500	-30	0	0
NURE	0	17.84	0	-200	-500	-30	0	0
NURE	0	5.571	0	-200	-500	-30	0	0
NURE	0	6.959	0	-200	-500	-30	0	0
NURE	0	15.76	0	-200	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	0	0	0	0	0	0	0	0
NURE	0	5.028	0	168	-500	-30	0	0
NURE	0	8.577	0	356.3	-500	-30	0	0
NURE	0	29.08	0	-200	-500	-30	0	0
NURE	0	9.841	0	372.2	-500	-30	0	0
NURE	16	5	6	40	2.2	3	-0.01	35
NURE	0	0	0	0	0	0	0	0
NURE	20	5	8	37	0.1	-2	-0.01	-10
NURE	14	-5	6	40	0.3	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	14	-5	8	40	0.4	-2	-0.01	-10
NURE	13	5	20	202	0.1	3	-0.01	30
NURE	0	0	0	0	0	0	0	0
NURE	17	-5	21	172	0.6	-2	-0.01	10
NURE	25	0	0	0	0	-2	-0.01	66
NURE	16	-5	15	50	0.7	-2	-0.01	10
NURE	15	-5	6	20	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	28	-5	13	35	0.2	-2	-0.01	10
NURE	18	7	12	32	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	7	-5	12	15	0.1	-2	-0.01	-10
NURE	20	7	11	70	0.2	3	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	19	-5	13	82	0.5	-2	-0.01	-10
NURE	19	7	9	32	0.4	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	19	5	12	93	0.4	2	-0.01	-10
NURE	17	5	12	67	0.8	-2	12.653	20
NURE	0	0	0	0	0	0	0	0
NURE	15	7	9	47	1	-2	-0.01	-10
NURE	17	-5	7	35	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	17	5	10	65	0.4	-2	-0.01	10
NURE	18	-5	4	30	0.2	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	16	-5	6	27	0.4	-2	-0.01	10
NURE	23	-5	5	17	0.1	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	17	5	7	25	0.1	-2	-0.01	-10
NURE	21	10	17	30	0.5	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	17	10	26	37	0.2	-2	-0.01	10
NURE	23	7	7	17	0.3	2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	33	10	14	40	0.1	-2	-0.01	15
NURE	18	5	33	65	0.1	3	-0.01	30
NURE	0	0	0	0	0	0	0	0
NURE	26	7	86	108	0.1	-2	-0.01	-10
NURE	23	7	11	52	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	9	5	15	45	0.4	-2	-0.01	10
NURE	21	10	18	55	0.2	-2	-0.01	35
NURE	0	0	0	0	0	0	0	0
NURE	24	7	25	67	0.1	-2	-0.01	-10
NURE	18	10	11	32	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	27	5	18	55	0.1	-2	-0.01	-10
NURE	0	4.83	0	73.95	-500	-30	0	0
NURE	0	4.92	0	-200	-500	-30	0	0
NURE	23	-5	7	45	3.3	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	32	10	25	62	0.2	2	-0.01	10
NURE	23	-5	4	52	0.2	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	18	-5	3	27	0.2	-2	-0.01	10
NURE	5	10	12	35	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	35	10	25	70	0.1	-2	-0.01	20
NURE	5	10	13	40	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	25	10	23	73	0.3	-2	-0.01	-10
NURE	50	7	9	50	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	33	-5	4	20	0.3	-2	-0.01	15
NURE	5	10	12	82	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	26	-5	5	42	0.3	-2	-0.01	15
NURE	0	2.433	0	78.8	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	5	7	8	42	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	22	7	6	52	0.1	-2	-0.01	10
NURE	5	7	10	42	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	22	5	15	50	0.1	-2	-0.01	10
NURE	5	15	20	67	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	29	7	35	65	0.3	-2	-0.01	15
NURE	5	10	16	47	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	21	7	21	67	0.2	-2	-0.01	15
NURE	10	12	27	67	0.2	10	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	22	10	63	72	0.2	4	-0.01	20
NURE	15	17	27	82	0.5	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	35	10	49	150	0.2	-2	-0.01	15
NURE	10	10	17	55	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	31	12	35	85	0.4	-2	-0.01	15
NURE	15	12	26	80	0.7	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	25	15	36	133	0.7	75	-0.01	15
NURE	35	12	37	1000	2.3	5	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	10	5	27	635	1	-2	-0.01	25
NURE	30	7	13	65	0.4	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	6	10	8	45	0.2	-2	-0.01	15
NURE	5	10	13	47	0.3	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	24	-5	15	52	0.2	2	-0.01	-10
NURE	40	7	12	35	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	49	5	13	37	0.6	10	-0.01	-10
NURE	15	5	9	30	0.5	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	28	5	8	22	0.3	2	-0.01	10
NURE	15	10	19	60	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	20	7	22	60	0.4	3	-0.01	-10
NURE	10	7	17	50	0.5	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	14	7	20	52	0.2	-2	0.164	-10
NURE	0	-3	0	-200	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	10	12	11	52	0.6	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	12	5	9	68	0.3	-2	-0.01	10
NURE	15	12	11	42	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	21	-5	4	35	0.1	-2	-0.01	10
NURE	20	12	14	42	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	23	12	18	65	0.2	-2	-0.01	35
NURE	5	7	9	32	0.4	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	21	5	6	37	0.3	-2	-0.01	15
NURE	15	7	8	32	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	27	-5	4	32	0.1	-2	-0.01	15
NURE	25	12	12	77	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	16	7	8	47	0.2	-2	-0.01	-10
NURE	10	15	12	57	0.4	-2	-0.01	10

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	0	0	0	0	0	0	0	0
NURE	12	-5	6	35	0.1	-2	-0.01	15
NURE	65	10	14	57	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	10	7	8	50	0.2	-2	-0.01	10
NURE	25	10	11	55	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	6	-5	5	22	0.3	-2	-0.01	10
NURE	10	10	13	55	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	12	7	10	52	0.1	-2	-0.01	15
NURE	10	10	9	32	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	15	5	11	42	0.1	-2	-0.01	-10
NURE	5	7	10	40	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	29	-5	5	42	0.2	-2	-0.01	-10
NURE	5	7	8	35	0.5	3	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	18	-5	6	32	0.1	-2	-0.01	10
NURE	10	55	9	32	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	29	-5	6	42	0.6	-2	-0.01	10
NURE	10	7	12	37	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	23	-5	6	37	0.7	-2	-0.01	-10
NURE	5	10	7	35	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	18	-5	4	18	0.3	-2	-0.01	15
NURE	35	12	13	75	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	20	-5	6	42	0.1	-2	-0.01	20
NURE	10	10	15	70	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	17	5	10	37	0.2	-2	-0.01	20
NURE	35	15	8	67	0.4	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	20	12	20	75	0.4	-2	0.129	-10
NURE	5	5	8	50	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	27	-5	6	40	0.3	-2	-0.01	-10
NURE	10	12	11	55	0.5	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	24	-5	4	40	0.2	-2	-0.01	-10
NURE	10	7	10	35	0.5	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	17	7	10	40	0.2	-2	-0.01	-10
NURE	20	12	11	40	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	23	10	5	32	0.3	-2	-0.01	-10
NURE	10	7	15	40	0.5	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	20	-5	8	35	0.3	-2	-0.01	10
NURE	10	10	10	32	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	17	-5	5	35	0.2	-2	-0.01	15
NURE	10	10	13	45	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	31	-5	4	35	0.1	-2	-0.01	15
NURE	15	7	10	45	0.7	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	36	-5	5	27	0.2	-2	-0.01	10
NURE	10	10	12	45	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	31	-5	3	35	0.3	-2	-0.01	15
NURE	0	5.571	0	163.1	-500	-30	0	0
NURE	5	7	8	37	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	21	-5	7	40	0.2	-2	-0.01	20
NURE	15	10	11	57	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	20	-5	8	45	0.1	-2	-0.01	10
NURE	20	10	10	37	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	21	-5	5	37	0.2	-2	-0.01	10
NURE	15	7	12	42	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	24	7	6	42	0.3	-2	-0.01	-10
NURE	15	7	12	42	0.4	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	20	-5	4	40	0.2	-2	-0.01	-10
NURE	5	7	11	37	0.6	-2	18.027	10
NURE	0	0	0	0	0	0	0	0
NURE	13	-5	5	37	0.3	-2	-0.01	-10
NURE	10	5	10	32	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	18	7	6	42	0.2	-2	-0.01	40
NURE	10	7	10	52	0.5	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	18	-5	5	52	0.2	-2	-0.01	-10
NURE	5	5	9	40	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	19	-5	6	40	0.1	-2	-0.01	10
NURE	10	-5	9	42	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	17	-5	3	37	0.2	-2	-0.01	20
NURE	0	2.589	0	-200	-500	-30	0	0
NURE	0	4.64	0	-200	-500	-30	0	0
NURE	0	5.049	0	-200	-500	-30	0	0
NURE	5	5	10	25	0.6	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	7	8	0.2	-2	-0.01	20
NURE	5	5	10	25	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	13	5	7	10	0.1	-2	-0.01	20
NURE	5	-5	10	22	0.6	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	14	-5	8	8	0.2	-2	-0.01	30
NURE	10	5	12	40	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	17	15	17	57	0.2	-2	-0.01	10
NURE	15	12	15	50	0.5	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	24	20	21	72	0.3	-2	-0.01	10
NURE	10	5	10	32	0.4	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	13	15	13	47	0.3	-2	0.145	15
NURE	10	12	11	37	0.3	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	7	-5	15	47	0.3	-2	-0.01	-10
NURE	10	7	13	42	0.1	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	12	10	13	50	0.2	-2	-0.01	15
NURE	10	10	19	70	0.9	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	18	10	28	108	0.1	-2	-0.01	15
NURE	15	5	28	85	0.9	10	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	13	22	44	167	0.3	15	-0.01	15
NURE	10	7	28	62	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	23	5	15	60	0.2	-2	-0.01	10
NURE	5	5	8	30	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	5	32	0.2	-2	-0.01	25
NURE	10	-5	10	47	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	21	-5	6	42	0.2	-2	-0.01	10
NURE	10	-5	10	35	0.6	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	29	-5	5	37	0.1	-2	-0.01	15
NURE	10	-5	10	37	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	32	7	11	47	0.1	-2	-0.01	20
NURE	15	-5	9	40	1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	27	5	7	55	0.2	-2	-0.01	15
NURE	10	5	11	50	0.8	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	22	-5	5	37	0.2	-2	-0.01	20
NURE	0	2.764	0	-200	-500	-30	0	0
NURE	0	3.027	0	-200	-500	-30	0	0
NURE	5	7	13	30	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	13	5	7	15	0.1	-2	-0.01	15
NURE	5	10	11	32	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	13	-5	5	10	0.2	-2	-0.01	15
NURE	10	-5	10	30	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	10	7	14	45	0.2	-2	-0.01	10
NURE	5	-5	12	35	0.3	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	5	15	8	25	0.8	-2	-0.01	10
NURE	5	7	11	35	0.2	2	-0.01	35
NURE	0	0	0	0	0	0	0	0
NURE	8	-5	14	47	0.1	-2	-0.01	-10
NURE	10	5	10	37	0.6	3	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	11	7	14	47	0.2	-2	-0.01	-10
NURE	5	5	13	40	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	5	10	14	42	0.2	-2	-0.01	-10
NURE	5	7	11	37	0.2	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	8	7	12	55	0.2	-2	-0.01	10
NURE	10	7	13	37	0.2	2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	13	-5	10	35	0.2	-2	-0.01	-10
NURE	5	7	10	32	0.6	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	19	-5	8	37	0.1	-2	-0.01	15
NURE	5	10	12	40	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	20	-5	10	52	0.1	-2	-0.01	10
NURE	10	7	12	45	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	23	-5	6	45	0.2	-2	-0.01	15
NURE	10	5	9	37	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	23	-5	3	45	0.1	-2	-0.01	15
NURE	10	-5	10	40	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	25	5	10	52	0.1	-2	-0.01	20
NURE	0	3.595	0	-200	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	5	-5	9	30	0.6	-2	0.048	20
NURE	0	0	0	0	0	0	0	0
NURE	12	5	9	35	0.2	-2	-0.01	10
NURE	5	7	8	30	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	6	-5	6	17	0.2	-2	-0.01	-10
NURE	5	7	7	25	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	5	4	17	0.1	-2	-0.01	-10
NURE	10	-5	8	35	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	12	5	11	42	0.1	-2	-0.01	-10
NURE	10	5	11	30	0.4	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	15	5	13	45	0.1	-2	-0.01	10
NURE	10	-5	9	37	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	12	5	7	37	0.1	-2	-0.01	15
NURE	5	5	8	25	0.3	2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	14	77	6	27	0.1	-2	-0.01	10
NURE	5	7	11	37	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	8	30	0.1	-2	-0.01	20
NURE	10	-5	8	30	0.6	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	18	-5	6	22	0.1	-2	-0.01	10
NURE	10	5	14	70	0.4	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	10	5	42	190	0.1	-2	-0.01	45
NURE	5	-5	7	30	0.5	-2	0.013	10
NURE	0	0	0	0	0	0	0	0
NURE	21	-5	6	40	0.2	-2	-0.01	20
NURE	5	7	11	52	0.5	-2	-0.01	40
NURE	0	0	0	0	0	0	0	0
NURE	21	5	12	60	0.2	-2	-0.01	30
NURE	10	-5	11	47	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	25	-5	11	57	0.3	-2	-0.01	20
NURE	10	7	8	40	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	21	-5	7	45	0.3	-2	-0.01	20
NURE	5	12	12	22	0.5	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	7	-5	6	10	0.3	-2	-0.01	-10
NURE	5	17	28	55	0.5	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	19	8	27	63	0.2	-2	-0.01	15
NURE	5	10	13	27	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	9	8	9	18	0.1	-2	-0.01	15
NURE	5	7	13	27	0.8	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	9	8	11	23	0.3	-2	-0.01	20
NURE	5	15	9	20	0.8	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	11	5	6	10	0.1	-2	-0.01	25
NURE	10	12	28	55	0.8	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	31	12	30	63	0.1	-2	-0.01	15
NURE	5	7	15	42	0.9	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	18	10	22	50	0.4	-2	-0.01	15
NURE	15	10	19	55	0.6	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	27	22	23	70	0.7	-2	-0.01	10
NURE	10	7	21	45	0.2	-2	0.037	10
NURE	0	0	0	0	0	0	0	0
NURE	13	15	28	57	0.2	-2	-0.01	-10
NURE	10	5	14	67	0.4	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	6	7	14	60	0.3	-2	-0.01	15
NURE	5	5	14	37	0.5	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	6	7	10	32	0.3	-2	-0.01	-10
NURE	10	7	18	50	0.4	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	10	10	20	55	0.2	-2	-0.01	-10
NURE	10	7	8	27	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	15	10	11	47	0.2	-2	-0.01	10
NURE	5	-5	8	25	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	17	5	10	42	0.2	-2	-0.01	10
NURE	10	5	9	27	0.3	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	17	5	11	40	0.2	-2	-0.01	15
NURE	10	-5	10	32	0.4	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	16	7	12	45	0.1	-2	-0.01	15
NURE	10	-5	12	42	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	23	-5	9	37	0.2	-2	-0.01	15
NURE	10	5	10	35	0.6	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	26	-5	5	25	0.2	-2	-0.01	15
NURE	10	-5	10	32	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	17	7	6	32	0.2	-2	-0.01	15
NURE	10	-5	7	35	0.7	-2	0.014	30
NURE	0	0	0	0	0	0	0	0
NURE	20	-5	6	35	0.2	-2	-0.01	55
NURE	15	-5	99	40	0.6	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	26	5	9	32	0.1	-2	-0.01	15
NURE	10	7	9	32	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	20	7	7	30	0.1	-2	-0.01	10
NURE	9	5	10	35	0.1	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	15	-5	17	77	0.3	-2	-0.01	30
NURE	0	0	0	0	0	0	0	0
NURE	15	5	7	62	0.2	-2	-0.01	30
NURE	13	-5	11	50	0.4	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	10	-5	10	25	0.1	-2	-0.01	30
NURE	13	-5	13	90	0.2	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	10	7	5	65	0.2	-2	-0.01	25
NURE	15	-5	10	55	0.2	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	20	10	10	52	0.2	-2	-0.01	15
NURE	13	-5	13	47	0.2	-2	-0.01	15

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	5	20	0.3	-2	-0.01	10
NURE	11	-5	7	40	0.3	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	20	12	6	35	0.3	-2	-0.01	20
NURE	11	5	11	47	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	7	50	4.4	-2	-0.01	-10
NURE	10	7	14	45	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	5	5	9	17	0.5	-2	-0.01	10
NURE	10	10	15	52	0.1	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	8	42	0.6	-2	-0.01	40
NURE	10	5	12	37	0.4	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	20	15	10	30	0.4	-2	-0.01	-10
NURE	11	7	15	42	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	15	10	13	42	0.4	-2	-0.01	75
NURE	10	-5	12	37	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	25	5	14	45	0.3	-2	-0.01	-10
NURE	9	12	15	40	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	15	12	17	47	0.2	-2	-0.01	-10
NURE	11	5	11	32	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	20	10	10	37	0.3	-2	-0.01	-10
NURE	8	7	11	37	0.1	2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	8	5	12	35	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	11	-5	12	40	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	10	5	10	35	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	11	-5	14	37	0.1	2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	15	10	6	20	0.5	15	-0.01	10
NURE	11	-5	14	37	0.1	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	10	7	8	25	0.3	-2	-0.01	30
NURE	14	-5	12	47	0.3	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	20	5	6	22	0.1	-2	-0.01	20
NURE	13	-5	13	42	0.6	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	10	7	10	15	0.4	-2	-0.01	20
NURE	12	-5	12	42	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	10	12	10	35	0.1	-2	-0.01	15
NURE	20	7	13	47	0.1	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	7	25	0.1	-2	-0.01	15
NURE	19	-5	14	45	0.3	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	15	5	10	25	0.3	-2	-0.01	-10
NURE	8	7	19	47	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	7	18	27	0.2	-2	-0.01	-10
NURE	6	5	13	40	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	5	15	11	37	0.4	-2	-0.01	15
NURE	8	7	11	32	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	-5	7	22	0.6	-2	-0.01	-10
NURE	9	5	15	37	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	10	12	14	42	4.4	-2	-0.01	-10
NURE	7	5	17	37	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	10	10	11	30	0.1	-2	-0.01	-10
NURE	10	5	15	45	0.4	-2	-0.01	10

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	12	7	11	40	0.1	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	111	-5	10	27	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	12	-5	9	30	0.1	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	8	10	11	32	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	0	5.448	0	-200	-500	-30	0	0
NURE	0	8.797	0	-200	-500	-30	0	0
NURE	16	5	12	37	2.2	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	10	12	7	40	0.2	-2	-0.01	10
NURE	11	5	13	42	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	5	12	15	45	0.1	-2	-0.01	-10
NURE	13	-5	16	40	0.1	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	10	10	10	25	0.2	-2	-0.01	25
NURE	10	-5	25	42	0.1	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	5	12	43	52	0.1	-2	26.207	20
NURE	13	7	17	37	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	15	-5	17	35	0.5	-2	-0.01	-10
NURE	10	12	14	27	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	10	7	21	37	0.4	-2	-0.01	-10
NURE	8	5	19	32	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	10	7	18	27	0.5	-2	17.74	-10
NURE	7	-5	11	27	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	-5	16	27	0.4	-2	-0.01	-10
NURE	10	7	15	32	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	7	18	30	0.6	-2	-0.01	-10
NURE	6	12	18	52	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	5	17	19	62	0.2	-2	-0.01	-10
NURE	-5	15	18	40	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	5	-5	16	40	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	5	7	10	30	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	8	5	16	42	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	9	5	13	37	0.4	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	7	10	14	42	0.3	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	14	7	10	40	0.1	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	0	0
NURE	6	5	10	35	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	7	-5	10	32	0.1	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	6	-5	18	45	0.2	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	0	2.949	0	-200	-500	-30	0	0
NURE	0	-3	0	-200	-500	-30	0	0
NURE	0	-3	0	67.55	-500	-30	0	0
NURE	0	3.507	0	-200	-500	-30	0	0

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	0	22.58	0	-200	-500	-30	0	0
NURE	0	4.96	0	-200	-500	-30	0	0
NURE	0	5.949	0	123.7	-500	-30	0	0
NURE	17	10	9	45	0.1	-2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	35	7	6	30	0.1	-2	-0.01	25
NURE	14	-5	20	52	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	5	20	37	52	0.6	-2	-0.01	10
NURE	11	10	18	45	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	20	32	65	0.4	-2	-0.01	-10
NURE	11	7	173	57	0.3	10	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	7	44	45	0.4	-2	-0.01	20
NURE	8	7	13	32	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	15	10	14	25	0.2	-2	-0.01	-10
NURE	11	5	12	32	0.1	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	25	10	7	32	0.1	-2	-0.01	10
NURE	9	10	12	30	0.3	-2	7.553	-10
NURE	0	0	0	0	0	0	0	0
NURE	20	7	15	35	0.4	-2	-0.01	15
NURE	12	7	12	40	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	20	-5	13	50	0.5	-2	-0.01	20
NURE	66	7	12	42	0.3	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	9	7	10	45	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	9	5	9	35	0.1	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	10	7	10	35	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	11	5	10	37	0.1	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	9	7	9	30	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	9	-5	11	37	0.2	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	0	0	0	0	0	0	-0.01	0
NURE	10	5	27	22	0.6	-2	-0.01	-10
NURE	6	10	114	30	0.4	50	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	18	5	15	22	0.1	-2	-0.01	15
NURE	10	-5	12	30	0.2	4	-0.01	35
NURE	0	0	0	0	0	0	0	0
NURE	0	3.521	0	-200	-500	-30	0	0
NURE	10	-5	9	22	0.2	-2	-0.01	-10
NURE	6	5	10	27	0.2	15	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	23	5	16	27	0.2	-2	-0.01	-10
NURE	9	5	15	47	0.1	15	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	14	7	110	25	0.5	50	-0.01	-10
NURE	10	5	77	27	0.5	0	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	18	5	13	22	0.2	-2	-0.01	-10
NURE	7	-5	25	42	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	9	5	12	27	0.1	-2	-0.01	-10
NURE	20	5	16	32	0.3	4	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	11	10	11	30	0.1	-2	-0.01	10
NURE	17	-5	14	30	0.2	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	5	10	31	25	0.2	-2	-0.01	15
NURE	14	5	20	27	0.3	4	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	5	7	6	15	0.1	-2	-0.01	10
NURE	15	7	13	32	0.4	-2	-0.01	-10
NURE	0	0	0	0	0	0	0	0
NURE	0	3.36	0	86.18	-500	-30	0	0

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NURE	15	5	4	22	0.1	0	-0.01	-10
NURE	11	5	16	40	0.1	-2	-0.01	10
NURE	0	0	0	0	0	0	0	0
NURE	25	5	5	17	0.1	-2	-0.01	10
NURE	22	-5	12	35	0.1	-2	-0.01	20
NURE	0	0	0	0	0	0	0	0
NURE	6	7	16	22	0.4	-2	-0.01	-10
NURE	10	5	15	42	0.1	2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	10	7	8	20	0.1	-2	-0.01	-10
NURE	9	-5	12	35	0.1	2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	8	5	10	22	0.2	-2	-0.01	-10
NURE	22	7	16	45	0.3	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
NURE	12	5	9	20	0.2	-2	-0.01	10
NURE	23	-5	12	27	0.2	2	-0.01	25
NURE	0	0	0	0	0	0	0	0
NURE	14	5	11	25	0.2	-2	-0.01	-10
NURE	19	7	12	32	0.2	-2	0.018	25
NURE	0	0	0	0	0	0	0	0
NURE	5	7	8	25	0.3	-2	-0.01	10
NURE	18	-5	10	30	0.4	-2	-0.01	15
NURE	0	0	0	0	0	0	0	0
PLUTO	66	22	54	380	2	0	8	17
PLUTO	0	0	0	0	0	0	0.022	0
PLUTO	45	20	67	440	2	0	8	24
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	39	20	53	220	2	0	8	9
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	89	14	19	150	2	0	8	11
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	52	12	31	230	2	0	8	12
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	74	11	29	280	2	0	8	15
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	22	51	78	38	2	0	8	7
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	42	7	16	64	2	0	8	16
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	42	13	27	84	2	0	8	18
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	33	11	18	87	2	0	8	13
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	33	29	21	29	2	0	8	21
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	38	27	30	43	2	0	8	26
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	23	49	18	43	2	0	8	8
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	61	25	67	560	2	0	8	26
PLUTO	0	0	0	0	0	0	0.004	0
PLUTO	43	10	17	73	2	0	8	9
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	42	24	26	47	2	0	8	19
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	0	30	30	200	0.5	20	10	50
PLUTO	0	0	0	0	0	0	0.05	0
PLUTO	0	0	0	0	0	0	0	0
PLUTO	0	0	0	0	0	0	0	0
PLUTO	39	14	35	70	2	0	8	12
PLUTO	0	0	0	0	0	0	0	0
PLUTO	0	0	0	0	0	0	0	0
PLUTO	0	0	0	0	0	0	0	0
PLUTO	27	16	33	77	2	0	8	17
PLUTO	0	0	0	0	0	0	0	0
PLUTO	55	9	16	130	2	0	8	6
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	56	11	15	69	2	0	8	12
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	39	10	22	150	2	0	8	14
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	54	7	14	140	2	0	8	8
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	28	8	10	110	2	0	8	16
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	37	5	8	66	2	0	8	11
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	28	5	10	69	2	0	8	14
PLUTO	0	0	0	0	0	0	0.002	0

DataBase	Lithium	Cobalt	Copper	Zinc	Silver	Tungsten	Gold	Lead
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
PLUTO	48	14	34	250	2	0	8	12
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	42	9	16	77	2	0	8	11
PLUTO	31	10	9	83	2	0	8	31
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	32	5	6	60	2	0	8	29
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	38	8	11	84	2	0	8	31
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	55	10	19	73	2	0	8	27
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	55	13	34	100	2	0	8	25
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	41	8	23	80	2	0	8	21
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	66	15	29	77	2	0	8	23
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	55	12	24	79	2	0	8	20
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	33	8	8	92	2	0	8	30
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	33	9	8	49	2	0	8	26
PLUTO	0	0	0	0	0	0	0.002	0
PLUTO	32	9	10	65	2	0	8	28
PLUTO	0	0	0	0	0	0	0.002	0

Note: negative sign (-) indicates value is below detection limit

APPENDIX B

Lithium Content of Great Basin Playa Sediments

Appendix B: Lithium Content of Great Basin Playa Sediments

Playa	Mean Li (ppm)	n	Remarks	Study
Abert and Summer Lakes	60	3		Davis, 1976
Alkali Spring	64	2		Davis, 1976
Alvord Lake	12	1		Davis, 1976
Amargosa River	267	3		Davis, 1976
Big Smoky, North Valley	139	4		Davis, 1976
Big Smoky, South Valley	100	8		Davis, 1976
Buffalo Valley	92	6		Davis, 1976; Bohannon and Meier 1976
Christmas and Silver Lakes	33	1		Davis, 1976
Clayton Valley	118	12		Davis, 1976; Bohannon and Meier 1976
Columbus Salt Marsh	150	2		Davis, 1976
Death Valley	207	7		Davis, 1976
Diamond Valley	56	4	180 cm auger hole in playa	Davis, 1976; Bohannon and Meier 1976
Dixie Valley	62	3		Davis, 1976
Edwards Creek Valley	58	5	170 cm auger hole in playa	Davis, 1976; Bohannon and Meier 1976
Eureka Valley	162	5		Davis, 1976
Fish Lake Valley	213	7		Davis, 1976
Gabbs Valley	36	3	playa surface samples	Davis, 1976; Bohannon and Meier 1976
Goshute Lake	25	4		Davis, 1976
Granite Springs Valley	102	3		Davis, 1976
Grass Valley	208	5	140 cm auger hole in playa	Davis, 1976; Bohannon and Meier 1976
Harney Lake	43	4		Davis, 1976
Jakes Valley	60	1		Davis, 1976
Kumiva Valley	56	3	30 cm auger hole in playa	Davis, 1976; Bohannon and Meier 1976
Lahontan Valley	107	15		Davis, 1976
Lake Valley	16	1		Davis, 1976; Bohannon and Meier 1976
Long Valley	250	4		Davis, 1976
Monitor Valley	43	9	playa surface samples	Davis, 1976
Newark Lake	70	6		Davis, 1976
Owens Lake (dry)	48	4		Davis, 1976
Panamint Valley	190	1		Davis, 1976
Railroad Valley	84	7	120 cm auger hole in playa	Davis, 1976; Bohannon and Meier 1976
Ralston Valley	60	6		Davis, 1976
Rhodes Salt Marsh	31	1		Davis, 1976
Ruby Valley	64	4		Davis, 1976
Saline Valley	33	3		Davis, 1976
Smith Creek Valley	61	4	160 cm auger hole in playa	Davis, 1976; Bohannon and Meier 1976
Soda Spring Valley	32	4		Davis, 1976
Spring Valley	37	7		Davis, 1976
Steptoe Valley	24.25	4	115 cm auger hole in Goshute Lake	Davis, 1976; Bohannon and Meier 1976
Stonewall Flat	64.5	4	surface sediment	Davis, 1976; Bohannon and Meier 1976
Tikaboo Valley	40	26	playa surface samples	Davis, 1976; Bohannon and Meier 1976
Adobe Flat	102	3	60 cm auger hole in playa	Bohannon and Meier, 1976
Alkali Flat	640	1	3 m pit in playa center	Bohannon and Meier, 1976
Baking Powder	20	4	surface samples and one 30 cm auger in playa	Bohannon and Meier, 1976
Big Smokey Valley	94	3	75 cm auger hole in playa	Bohannon and Meier, 1976
Black Rock Desert	94	3	75 cm auger hole in playa	Bohannon and Meier, 1976
Buena Vista Valley	88	6	160 cm aguer hole in playa	Bohannon and Meier, 1976
Carson Sink	80	13	5 holes near Nutgrass Dike, Indian Lakes, Fourmile Flat, Salt Wells, and Carson Lake	Bohannon and Meier, 1976
Coal Valley	31	5	110 cm auger hole in playa	Bohannon and Meier, 1976
Delmar Lake	62	4	two 15 cm auger holes in playa	Bohannon and Meier, 1976
Dry Lake	63	2	20 cm auger hole in playa	Bohannon and Meier, 1976
Dry Lake	93	6	80 cm auger hole in playa	Bohannon and Meier, 1976
Eldorado Valley	101	4	85 cm auger hole in playa	Bohannon and Meier, 1976
Fish Lake Valley	184	4	playa surface samples	Bohannon and Meier, 1976
Franklin Lake	64	4	175 cm auger hole in playa	Bohannon and Meier, 1976
Humbolt Marsh	62	3	85 cm auger hole in playa	Bohannon and Meier, 1976
Jean Lake	63	4	75 cm auger hole in playa	Bohannon and Meier, 1976
Mud Lake	73	4	100 cm auger hole in playa	Bohannon and Meier, 1976
Newark Valley	70	6	130 cm auger hole in playa	Bohannon and Meier, 1976
North Spring Valley	54	3	50 cm auger hole in playa	Bohannon and Meier, 1976
Pahrangat Valley	10	1	valley floor sediment	Bohannon and Meier, 1976
Pyramid Lake	46	5	shore sediments	Bohannon and Meier, 1976
Rawhide Flats	125	6	100 cm auger hole in playa	Bohannon and Meier, 1976
Roach Lake	66	3	70 cm auger hole in playa	Bohannon and Meier, 1976
Ruby Lake	26	2	Lakeshore sediment	Bohannon and Meier, 1976
Smoke Creek Desert	62	4	140 cm auger hole in playa	Bohannon and Meier, 1976
Stewart Valley	80	2	surface samples	Bohannon and Meier, 1976
Teels Marsh	76	30	playa surface samples	Bohannon and Meier, 1976
Winnemucca Lake	89	3	2 auger holes in playa	Bohannon and Meier, 1976

APPENDIX C

Lithium Content and Li:Cl of Groundwater in Study Area Playas

CHEMID	UTM-E (83)	UTM-N (83)	SITE NAME	LOCALE	REGION	COUNTY	WATER TEMP	SITE	DATE	Cl PPM	Li PPM	Li/CL	Vine (1980) Classification	Golder Potential
278	448397	4431911	Lower Ranch Hot Springs	Lower Ranch	Dixie Valley	Pershing	Hot	Spring	7/1/1972	29.0	1.2000	0.04138	Major Resource Potential	H/C
3052	438726	4428407	Hyder Hot Springs / Cone Hot Springs	Spring Creek	Dixie Valley	Pershing	Hot	Spring	11/3/1997	46.6	1.7100	0.03670	Major Resource Potential	H/C
268	438726	4428343	Hyder Hot Springs / Cone Hot Springs	Spring Creek	Dixie Valley	Pershing	Hot	Spring	9/20/1975	45.0	1.6000	0.03556	Major Resource Potential	H/C
3088	438726	4428407	Hyder Hot Springs / Cone Hot Springs	Spring Creek	Dixie Valley	Pershing	Hot	Spring	5/4/1998	45.4	1.5900	0.03502	Major Resource Potential	H/C
2762	438726	4428343	Hyder Hot Springs / Cone Hot Springs	Spring Creek	Dixie Valley	Pershing	Hot	Spring		47.5	1.5900	0.03347	Major Resource Potential	H/C
567	340265	4380380	Shallow Research Well 5	Soda Lake	Lahontan Valley	Churchill	Warm	Well	9/1/1957	110.0	1.3000	0.01182	Major Resource Potential	H/C
3110	429194	4416918	Geothermal Well DF 27-33 / Dixie Federal 27-33	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	421.0	2.2700	0.00539	Major Resource Potential	H/C
3108	428995	4426624	Geothermal Separator V101 (3 wells) - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	449.0	2.4000	0.00535	Major Resource Potential	H/C
3003	427954	4426830	Drill Hole Well DJ 1 / Dixie Jack 1	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	5/17/1998	316.0	1.6500	0.00522	Major Resource Potential	H/C
3114	430144	4426460	Geothermal Well DF 28-33 / Dixie Federal 28-33	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	446.0	2.2800	0.00511	Major Resource Potential	H/C
3009	426797	4424414	Geothermal Plant LP Brine - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/24/1996	519.0	2.6100	0.00503	Major Resource Potential	H/C
3030	429194	4416918	Geothermal Well DF 27-33 / Dixie Federal 27-33	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/30/1997	443.0	2.2200	0.00501	Major Resource Potential	H/C
3112	429299	4426636	Geothermal Well DF 37-33 / Dixie Federal 37-33	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	444.0	2.2100	0.00498	Major Resource Potential	H/C
3047	426797	4424414	Geothermal Plant HP Brine - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/31/1997	464.0	2.2800	0.00491	Major Resource Potential	H/C
3031	428995	4426624	Geothermal Separator V101 (3 wells) - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/30/1997	463.0	2.2700	0.00490	Major Resource Potential	H/C
3010	413399	4412590	North Injection Well DF 45-14 / Dixie Federal 45-14	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/24/1996	518.0	2.5000	0.00483	Major Resource Potential	H/C
3035	430144	4426460	Geothermal Well DF 28-33 / Dixie Federal 28-33	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/30/1997	470.0	2.2400	0.00477	Major Resource Potential	H/C
3034	429299	4426636	Geothermal Well DF 37-33 / Dixie Federal 37-33	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/30/1997	475.0	2.2600	0.00476	Major Resource Potential	H/C
3045	426797	4424414	Geothermal Plant Brine - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/31/1997	571.0	2.6600	0.00466	Major Resource Potential	H/C
3115	427019	4423546	Geothermal Well DF 76-7 / Dixie Federal 76-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	556.0	2.5800	0.00464	Major Resource Potential	H/C
3015	428995	4426624	Geothermal Separator V101 (3 wells) - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/25/1996	438.0	2.0300	0.00463	Major Resource Potential	H/C
3002	427239	4424101	Geothermal Well DF 84-7 / Dixie Federal 84-7 / DIXE102-W	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/2/1995	495.0	2.2900	0.00463	Major Resource Potential	H/C
3012	426639	4422245	South Injection Well DF 65-18 / Dixie Federal 65-18	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/24/1996	556.0	2.5700	0.00462	Major Resource Potential	H/C
3011	425493	4423029	Injection Well Lamb 1 / SWL-1 Well	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/24/1996	549.0	2.5200	0.00459	Major Resource Potential	H/C
3038	426797	4424414	Geothermal Plant Brine - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/31/1997	579.0	2.6200	0.00453	Major Resource Potential	H/C
3119	426929	4424080	Geothermal Well DF 74-7 / Dixie Federal 74-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	564.0	2.5300	0.00449	Major Resource Potential	H/C
3040	413399	4412590	North Injection Well DF 45-14 / Dixie Federal 45-14	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/31/1997	511.0	2.2900	0.00448	Major Resource Potential	H/C
3098	428145	4426099	Geothermal Well DF 97-2 / Dixie Federal 97-2	Boyer Ranch	Dixie Valley	Churchill	Cold	Well	5/5/1998	325.0	1.4500	0.00446	Major Resource Potential	H/C
3133	426797	4424414	Geothermal Plant LP Brine - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/29/1998	589.0	2.6100	0.00443	Major Resource Potential	H/C
3041	426639	4422245	South Injection Well DF 65-18 / Dixie Federal 65-18	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/31/1997	590.0	2.6100	0.00442	Major Resource Potential	H/C
3018	427239	4424101	Geothermal Well DF 84-7 / Dixie Federal 84-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/29/1997	558.0	2.4600	0.00441	Major Resource Potential	H/C
3123	426979	4424265	Geothermal Well DF 73-7 / Dixie Federal 73-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/29/1998	547.0	2.4000	0.00439	Major Resource Potential	H/C
3014	427019	4423546	Geothermal Well DF 76-7 / Dixie Federal 76-7 / V104 Separator	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/25/1996	524.0	2.2900	0.00437	Major Resource Potential	H/C
3039	413399	4412590	North Injection Well DF 45-14 / Dixie Federal 45-14	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/31/1997	515.0	2.2400	0.00435	Major Resource Potential	H/C
3121	426939	4424266	Geothermal Well DF 63-7 / Dixie Federal 63-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	560.0	2.4300	0.00434	Major Resource Potential	H/C
3042	426114	4422931	South Injection Well 32-18	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/31/1997	588.0	2.5300	0.00430	Major Resource Potential	H/C
3021	427239	4424101	Geothermal Well DF 84-7 / Dixie Federal 84-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/29/1997	580.0	2.4800	0.00428	Major Resource Potential	H/C
3117	426623	4424093	Geothermal Separators V102 + 103 - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/28/1998	567.0	2.4200	0.00427	Major Resource Potential	H/C
3124	426979	4424265	Geothermal Well DF 73-7 / Dixie Federal 73-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/29/1998	388.0	1.6300	0.00420	Major Resource Potential	H/C
3019	426929	4424080	Geothermal Well DF 74-7 / Dixie Federal 74-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/29/1997	584.0	2.4300	0.00416	Major Resource Potential	H/C
3004	427954	4426830	Drill Hole Well DJ 1 / Dixie Jack 1	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	5/20/1998	282.0	1.1700	0.00415	Major Resource Potential	H/C
3016	426979	4424265	Geothermal Well DF 73-7 / Dixie Federal 73-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/29/1997	594.0	2.4500	0.00412	Major Resource Potential	H/C
73545	425036	4473228	Kyle Hot Springs	Hot Spring Canyon	Buena Vista Valley	Pershing	Hot	Spring	1/1/1978	850.0	3.5000	0.00412	Major Resource Potential	H/C
3028	427055	4424098	Geothermal Well DF 73B-7 / Dixie Federal 37B-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/30/1997	571.0	2.3400	0.00410	Major Resource Potential	H/C
3127	427010	4424356	Geothermal Separator V105 - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/29/1998	572.0	2.3200	0.00406	Major Resource Potential	H/C
3130	427055	4424098	Geothermal Well DF 73B-7 / Dixie Federal 37B-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/29/1998	561.0	2.2700	0.00405	Major Resource Potential	H/C
270	424989	4473290	Kyle Hot Springs	Hot Spring Canyon	Buena Vista Valley	Pershing	Hot	Spring	6/12/1973	770.0	3.1000	0.00403	Major Resource Potential	H/C
3023	427010	4424356	Geothermal Separator V105 - Dixie Valley	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/29/1997	574.0	2.2900	0.00399	Major Resource Potential	H/C
3125	426917	4424490	Geothermal Well DF 82A-7 / Dixie Federal 82A-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/29/1998	561.0	2.2200	0.00396	Major Resource Potential	H/C
3126	426917	4424490	Geothermal Well DF 82A-7 / Dixie Federal 82A-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/29/1998	281.0	1.0900	0.00388	Major Resource Potential	H/C
3025	426917	4424490	Geothermal Well DF 82A-7 / Dixie Federal 82A-7	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	10/29/1997	575.0	2.2200	0.00386	Major Resource Potential	H/C
3060	423686	4426786	Dead Travertine Spring / Cottonwood Travertine Spring	Stillwater Range	Dixie Valley	Churchill	Cold	Spring	11/5/1997	527.0	2.0300	0.00385	Major Resource Potential	H/C
3081	420217	4420690	Geothermal Well DF 66-21 / Dixie Federal 66-21	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/30/1998	1440.0	4.8900	0.00340	Major Resource Potential	H/C
3071	420349	4420540	Geothermal Well DF 66-12 / Dixie Federal 66-12	SW Boyer Ranch	Dixie Valley	Churchill	Hot	Well	11/7/1997	1476.0	4.5700	0.00310	Major Resource Potential	H/C
3080	413399	4412590	North Injection Well DF 45-14 / Dixie Federal 45-14	Boyer Ranch	Dixie Valley	Churchill	Hot	Well	4/30/1998	481.0	1.0600	0.00220	Minor Resource Potential	M/C
80541	364139	4357747	Hot Spring - Eightmile Flat	Eightmile Flat	Salt Wells Basin	Churchill	Hot	Spring	5/10/2005	1090.0	1.8000	0.00165	Minor Resource Potential	M/C
80545	363585	4357433	Hot Spring - Eightmile Flat	Eightmile Flat	Salt Wells Basin	Churchill	Hot	Spring	5/19/2005	1250.0	2.0000	0.00160	Minor Resource Potential	M/C
80544	363657	4356105	Hot Spring - Eightmile Flat	Eightmile Flat	Salt Wells Basin	Churchill	Hot	Spring	5/18/2005	1170.0	1.8400	0.00157	Minor Resource Potential	M/C
80543	363810	4354270	Hot Spring - Eightmile Flat	Eightmile Flat	Salt Wells Basin	Churchill	Hot	Spring	5/18/2005	1460.0	2.2900	0.00157	Minor Resource Potential	M/C

CHEMID	UTM-E (83)	UTM-N (83)	SITE NAME	LOCALE	REGION	COUNTY	WATER TEMP	SITE	DATE	Cl PPM	Li PPM	Li/CL	Vine (1980) Classification	Golder Potential
82669	364364	4352160	Anadarko Corporation Geothermal Observation Well 14-25	Eightmile Flat	Salt Wells Basin	Churchill	Hot	Well		1300.0	2.0000	0.00154	Minor Resource Potential	M/C
80540	364052	4357327	Hot Spring - Eightmile Flat	Eightmile Flat	Salt Wells Basin	Churchill	Hot	Spring	5/10/2005	1210.0	1.7900	0.00148	Minor Resource Potential	M/C
80542	364412	4353264	Hot Spring - Eightmile Flat	Eightmile Flat	Salt Wells Basin	Churchill	Hot	Spring	5/17/2005	1400.0	2.0000	0.00143	Minor Resource Potential	M/C
80356	366223	4351062	W Rock Springs Well	Eightmile Flat	Salt Wells Basin	Churchill	Cold	Well	7/13/2002	1320.0	1.7900	0.00136	Minor Resource Potential	M/C
73078	341005	4381536	USGS Geothermal Well CDDH-14A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	12/7/1982	4300.0	5.8000	0.00135	Minor Resource Potential	M/C
73121	344803	4384018	USGS Well CDDH-41A	Upsal Hogback	Lahontan Valley	Churchill	Warm	Well	4/3/1980	1000.0	1.3000	0.00130	Minor Resource Potential	M/C
73064	340129	4380752	USGS Well CDDH-31	Soda Lake	Lahontan Valley	Churchill	Warm	Well	5/5/1976	1300.0	1.6000	0.00123	Minor Resource Potential	M/C
73111	342574	4383571	USGS Well CDAH-2A	Upsal Hogback	Lahontan Valley	Churchill	Warm	Well	5/6/1976	1400.0	1.7000	0.00121	Minor Resource Potential	M/C
73065	340920	4380859	USGS Geothermal Well CDDH-30A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	5/4/1976	1400.0	1.7000	0.00121	Minor Resource Potential	M/C
73079	340534	4381823	USGS Well CDDH-32A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	5/6/1976	1900.0	2.3000	0.00121	Minor Resource Potential	M/C
73080	340534	4381823	USGS Well CDDH-32A	Soda Lake	Lahontan Valley	Churchill	Warm	Well	3/31/1980	2000.0	2.4000	0.00120	Minor Resource Potential	M/C
73120	344803	4384018	USGS Well CDDH-41A	Upsal Hogback	Lahontan Valley	Churchill	Warm	Well	5/20/1976	1100.0	1.3000	0.00118	Minor Resource Potential	M/C
73066	340920	4380859	USGS Geothermal Well CDDH-30A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	3/28/1980	1400.0	1.6000	0.00114	Minor Resource Potential	M/C
60	341954	4380041	Soda Lake Geothermal Well 84-33 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	7/21/1983	3500.0	4.0000	0.00114	Minor Resource Potential	M/C
73047	341954	4380041	Soda Lake Geothermal Well 84-33 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	7/21/1983	3500.0	4.0000	0.00114	Minor Resource Potential	M/C
2241	340206	4381028	Soda Lake Geothermal Well 1-29 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	1/1/1989	3400.0	3.8000	0.00112	Minor Resource Potential	M/C
73070	341616	4381092	USGS Well CDAH-37	Soda Lake	Lahontan Valley	Churchill	Hot	Well	5/6/1976	1800.0	2.0000	0.00111	Minor Resource Potential	M/C
73054	340340	4380532	USGS Well CDAH-17A	Soda Lake	Lahontan Valley	Churchill	Unknown	Well	8/17/1983	1800.0	2.0000	0.00111	Minor Resource Potential	M/C
2763	357495	4357605	Carson Resort Well No 6 / Churchill Drilling Corp TCID Well - Carson Lake Hot Springs	Carson Lake	Lahontan Valley	Churchill	Hot	Well	2/1/1981	2138.0	2.3000	0.00108	Minor Resource Potential	M/C
73077	341005	4381536	USGS Geothermal Well CDDH-14A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	7/27/1976	2800.0	3.0000	0.00107	Minor Resource Potential	M/C
57	341005	4381536	USGS Geothermal Well CDDH-14A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	7/27/1976	2800.0	3.0000	0.00107	Minor Resource Potential	M/C
58	341005	4381536	USGS Geothermal Well CDDH-14A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	7/27/1976	2800.0	3.0000	0.00107	Minor Resource Potential	M/C
59	341954	4380041	Soda Lake Geothermal Well 84-33 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	7/21/1983	3200.0	3.4000	0.00106	Minor Resource Potential	M/C
56	341005	4381536	USGS Geothermal Well CDDH-14A	Soda Lake	Lahontan Valley	Churchill	Hot	Well	2/10/1976	2750.0	2.9000	0.00105	Minor Resource Potential	M/C
73100	341614	4383282	Drill Hole Well 36	Soda Lake	Lahontan Valley	Churchill	Warm	Well	5/6/1976	3200.0	3.3000	0.00103	Minor Resource Potential	M/C
73067	340206	4381028	Soda Lake Geothermal Well 1-29 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	5/23/1975	2580.0	2.6000	0.00101	Minor Resource Potential	M/C
1748	340706	4380925	Shallow Research Well 4	Soda Lake	Lahontan Valley	Churchill	Hot	Well	5/25/1958	1500.0	1.5000	0.00100	Minor Resource Potential	M/C
73068	340206	4381028	Soda Lake Geothermal Well 1-29 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	12/18/1981	2300.0	2.3000	0.00100	Minor Resource Potential	M/C
73051	341506	4380354	USGS Well CDDH-27A	Soda Lake	Lahontan Valley	Churchill	Unknown	Well	7/20/1983	1400.0	1.4000	0.00100	Minor Resource Potential	M/C
4101	340206	4381028	Soda Lake Geothermal Well 1-29 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	9/11/1995	2895.0	2.7800	0.00096	Warrants further Search	M/B
4102	340206	4381028	Soda Lake Geothermal Well 1-29 (Chevron)	Soda Lake	Lahontan Valley	Churchill	Hot	Well	9/11/1995	2985.0	2.7800	0.00093	Warrants further Search	M/B
73207	343818	4387216	USGS Well CDAH-12A	Upsal Hogback	Lahontan Valley	Churchill	Cold	Well	11/21/1978	2800.0	2.6000	0.00093	Warrants further Search	M/B
73236	347317	4388041	USGS Well CDDH-51A	Upsal Hogback	Lahontan Valley	Churchill	Cold	Well	11/6/1978	1400.0	1.3000	0.00093	Warrants further Search	M/B
73206	343818	4387216	USGS Well CDAH-12A	Upsal Hogback	Lahontan Valley	Churchill	Cold	Well	5/20/1976	2700.0	2.4000	0.00089	Warrants further Search	M/B
72998	366346	4378219	USGS Geothermal Well CDPW-44A	Stillwater	Lahontan Valley	Churchill	Hot	Well	4/21/1978	2400.0	2.1000	0.00088	Warrants further Search	M/B
73101	341614	4383282	Drill Hole Well 36	Soda Lake	Lahontan Valley	Churchill	Warm	Well	4/1/1980	3200.0	2.8000	0.00088	Warrants further Search	M/B
72946	367019	4375739	USGS Well CDD-117A	Stillwater	Lahontan Valley	Churchill	Hot	Well	4/19/1978	2300.0	2.0000	0.00087	Warrants further Search	M/B
62	366683	4375623	Hot Well (Artesian) - Stillwater	Stillwater	Lahontan Valley	Churchill	Hot	Well	8/1/1973	2200.0	1.9000	0.00086	Warrants further Search	M/B
73312	347098	4390235	USGS Well CDDH-53A	Upsal Hogback	Lahontan Valley	Churchill	Warm	Well	11/6/1978	1900.0	1.6000	0.00084	Warrants further Search	M/B
72999	366346	4378219	USGS Geothermal Well CDPW-44A	Stillwater	Lahontan Valley	Churchill	Hot	Well	6/26/1984	2200.0	1.8000	0.00082	Warrants further Search	M/B
72950	366712	4375900	USGS Geothermal Well CDPW-26A	Stillwater	Lahontan Valley	Churchill	Hot	Well	6/22/1984	2400.0	1.9000	0.00079	Warrants further Search	M/B
72788	366987	4372473	USGS Well CDDH-108A	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/21/1978	2600.0	2.0000	0.00077	Warrants further Search	M/B
72997	366346	4378219	USGS Geothermal Well CDPW-44A	Stillwater	Lahontan Valley	Churchill	Hot	Well	1/13/1989	2700.0	2.0000	0.00074	Warrants further Search	M/B
72843	368106	4373625	USGS Well CDAH-24	Stillwater	Lahontan Valley	Churchill	Warm	Well	6/28/1973	2400.0	1.7000	0.00071	Warrants further Search	M/B
72789	366987	4372473	USGS Well CDDH-108A	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/28/1984	2600.0	1.8000	0.00069	Warrants further Search	M/B
72971	366204	4376957	USGS Well CDDH-123A	Stillwater	Lahontan Valley	Churchill	Hot	Well	4/23/1978	2200.0	1.5000	0.00068	Warrants further Search	M/B
73053	341506	4380385	USGS Well CDAH-27B	Soda Lake	Lahontan Valley	Churchill	Unknown	Well	7/19/1983	5100.0	3.4000	0.00067	Warrants further Search	M/B
73093	366661	4382623	USGS Well DH-102B	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/21/1979	4900.0	3.0000	0.00061	Warrants further Search	M/B
73095	366661	4382623	USGS Well DH-102B	Stillwater	Lahontan Valley	Churchill	Cold	Well	8/11/1986	4300.0	2.6000	0.00060	Warrants further Search	M/B
73361	348239	4396717	USGS Well CDAH-13A	Stillwater	Lahontan Valley	Churchill	Warm	Well	11/9/1978	3000.0	1.8000	0.00060	Warrants further Search	M/B
73243	346401	4388767	Kennametals Well	Upsal Hogback	Lahontan Valley	Churchill	Warm	Well	12/12/1978	3000.0	1.7000	0.00057	Warrants further Search	M/B
73094	366661	4382623	USGS Well DH-102B	Stillwater	Lahontan Valley	Churchill	Cold	Well	7/6/1984	4200.0	2.3000	0.00055	Warrants further Search	M/B
72797	367733	4372798	NWIS Well 101 N19 E31 19DADB1	Stillwater	Lahontan Valley	Churchill	Cold	Well	8/11/1986	15000.0	8.2000	0.00055	Warrants further Search	M/B
73328	348876	4390940	USGS Well CDDH-64A	Stillwater	Lahontan Valley	Churchill	Hot	Well	12/18/1981	3800.0	1.9000	0.00050	Warrants further Search	M/B
72709	365465	4371481	USGS Well CDAH-23	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/28/1973	2300.0	1.1000	0.00048	Warrants further Search	M/B
72790	366987	4372473	USGS Well CDDH-108B	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/19/1978	8700.0	3.9000	0.00045	Warrants further Search	M/B

CHEMID	UTM-E (83)	UTM-N (83)	SITE NAME	LOCALE	REGION	COUNTY	WATER TEMP	SITE	DATE	Cl PPM	Li PPM	Li/CL	Vine (1980) Classification	Golder Potential
73014	370558	4378826	USFWS Well 2 (West Canal) - Stillwater	Stillwater	Lahontan Valley	Churchill	Warm	Well	4/3/1989	2300.0	1.0000	0.00043	Warrants further Search	M/B
73156	371595	4385161	USGS Lead Lake Well 7	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/15/1989	8500.0	3.6000	0.00042	Warrants further Search	M/B
2764	362701	4404461	Churchill Drilling Corp Well TCID 1	Stillwater	Lahontan Valley	Churchill	Hot	Well	2/1/1981	4531.0	1.9000	0.00042	Warrants further Search	M/B
73183	367076	4385978	USGS Lead Lake Well 2	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/14/1989	7500.0	3.1000	0.00041	Warrants further Search	M/B
73155	371595	4385161	USGS Lead Lake Well 7	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/3/1989	8400.0	3.2000	0.00038	Warrants further Search	M/B
73192	366935	4386073	USGS Lead Lake Well 1	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/14/1989	9300.0	3.5000	0.00038	Warrants further Search	M/B
73154	371595	4385161	USGS Lead Lake Well 7	Stillwater	Lahontan Valley	Churchill	Cold	Well	12/15/1988	8300.0	3.0000	0.00036	Warrants further Search	M/B
73170	367478	4385756	USGS Lead Lake Well 4	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/14/1989	8900.0	3.2000	0.00036	Warrants further Search	M/B
73182	367076	4385978	USGS Lead Lake Well 2	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/4/1989	8100.0	2.9000	0.00036	Warrants further Search	M/B
73191	366935	4386073	USGS Lead Lake Well 1	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/4/1989	9100.0	3.2000	0.00035	Warrants further Search	M/B
73190	366935	4386073	USGS Lead Lake Well 1	Stillwater	Lahontan Valley	Churchill	Cold	Well	12/15/1988	9300.0	3.2000	0.00034	Warrants further Search	M/B
73169	367478	4385756	USGS Lead Lake Well 4	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/4/1989	8700.0	2.9000	0.00033	Warrants further Search	M/B
73073	342549	4381134	USGS Well CDAH-29B	Upsal Hogback	Lahontan Valley	Churchill	Warm	Well	8/16/1983	8800.0	2.9000	0.00033	Warrants further Search	M/B
73181	367076	4385978	USGS Lead Lake Well 2	Stillwater	Lahontan Valley	Churchill	Cold	Well	12/14/1988	9000.0	2.9000	0.00032	Warrants further Search	M/B
73168	367478	4385756	USGS Lead Lake Well 4	Stillwater	Lahontan Valley	Churchill	Cold	Well	12/14/1988	8500.0	2.7000	0.00032	Warrants further Search	M/B
73165	367691	4385629	USGS Lead Lake Well 5 (Fence)	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/15/1989	10000.0	3.1000	0.00031	Warrants further Search	M/B
73164	367691	4385629	USGS Lead Lake Well 5 (Fence)	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/5/1989	9500.0	2.6000	0.00027	Warrants further Search	M/B
72970	366300	4376955	USGS Well CDAH-123B	Stillwater	Lahontan Valley	Churchill	Unknown	Well	4/22/1978	4500.0	1.2000	0.00027	Warrants further Search	M/B
73163	367691	4385629	USGS Lead Lake Well 5 (Fence)	Stillwater	Lahontan Valley	Churchill	Cold	Well	12/14/1988	9400.0	2.4000	0.00026	Warrants further Search	M/B
72875	363677	4374473	USGS Well CDAH-106D	Fallon Indian Reservation	Lahontan Valley	Churchill	Cold	Well	4/22/1978	7500.0	1.3000	0.00017	Warrants further Search	M/B
73015	363924	4379002	Fallon Tribe Well 13	Fallon Indian Reservation	Lahontan Valley	Churchill	Cold	Well	4/5/1989	20000.0	3.3000	0.00017	Warrants further Search	M/B
72711	362983	4371679	USGS Well CDR-28	Fallon Indian Reservation	Lahontan Valley	Churchill	Cold	Well	6/21/1988	19000.0	2.5000	0.00013	Warrants further Search	M/B
73199	372022	4386418	USGS Lead Lake Well 6	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/15/1989	35000.0	4.3000	0.00012	Warrants further Search	M/B
73216	370383	4386878	USGS Lead Lake Well 8	Stillwater	Lahontan Valley	Churchill	Cold	Well	6/15/1989	31000.0	3.6000	0.00012	Warrants further Search	M/B
73198	372022	4386418	USGS Lead Lake Well 6	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/3/1989	35000.0	4.0000	0.00011	Warrants further Search	M/B
73197	372022	4386418	USGS Lead Lake Well 6	Stillwater	Lahontan Valley	Churchill	Cold	Well	12/15/1988	34000.0	3.8000	0.00011	Warrants further Search	M/B
73215	370383	4386878	USGS Lead Lake Well 8	Stillwater	Lahontan Valley	Churchill	Cold	Well	4/4/1989	32000.0	3.3000	0.00010	Warrants further Search	M/B
73214	370383	4386878	USGS Lead Lake Well 8	Stillwater	Lahontan Valley	Churchill	Cold	Well	12/15/1988	32000.0	3.2000	0.00010	Warrants further Search	M/B

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