3.5 EARTH RESOURCES

The following discussion of earth resources is divided into two major topics: geology and soils. The geology section describes the physiography, and mineral and energy resources of McGregor Range. The soils section describes the soils present on McGregor Range and their associated properties. The ROI for earth resources consists of McGregor Range.

3.5.1 Geology

3.5.1.1 Physiography

McGregor Range is within the Basin and Range Physiographic Province. Extension of the crust throughout the province during the past 30 million years has produced characteristic short, linear mountain ranges separated by intervening valleys (Stewart, 1978). Superimposed along the eastern side of the Basin and Range is a peculiar physiographic feature that extends from west Texas and northern Mexico northward through central New Mexico. This feature, called the Rio Grande Rift Valley, extends northward into the Southern Rocky Mountains physiographic province of southern Colorado and northern New Mexico. From Albuquerque northward, the Rio Grande Rift Valley is a relatively distinct, continuous physiographic feature containing numerous basins. South of Albuquerque, the rift broadens and encompasses several valleys and small, linear mountain ranges. At about the latitude of El Paso, Texas, the Rio Grande Rift Valley turns abruptly to the southeast.

From south to north, McGregor Range is comprised of the Hueco Mountains, Otero Mesa, and the Sacramento Mountains. The Hueco Mountains form the western edge of the Diablo Plateau, which extends far into southeast New Mexico and Texas. Otero Mesa is continuous with the Diablo Plateau. North of Otero Mesa the Sacramento Mountains rise steeply. The west side of McGregor Range encompasses a part of the Tularosa Basin which, at 100 miles long and 60 miles wide, is one of the largest valleys in the Rio Grande Rift Valley.

3.5.1.2 Mineral and Energy Resources

Figure 3.5-1 shows the location of mining districts, quarries, geothermal areas, and exploration holes for oil and gas in and near McGregor Range. Table 3.5-1 lists, and briefly describes the mining districts in the area.

The objective of the BLM minerals program under the White Sands RMP as amended by the McGregor Range RMPA, is to provide for the public use of locatable, salable, and leasable minerals on withdrawn public land on McGregor Range consistent with the laws that govern these activities and to minimize environmental damage. Locatable minerals include metallic minerals such as gold, silver, lead, zinc, and copper and nonmetallic minerals such as barite and fluorspar. Salable minerals include industrial minerals and material such as sand, gravel, clay, caliche, stone, and volcanic cinders. Under leasable minerals, oil, gas, and geothermal are the principal activities. The current management policies for mineral and energy resources are described in Section 3.1.2.2, *Nonmilitary Use*.

Renewal of the land withdrawal for McGregor Range requires that a mineral assessment accompany the withdrawal application. To meet this requirement, a mineral- and energy-resource assessment of McGregor Range was conducted jointly by staff of the New Mexico Bureau of Mines, New Mexico State University, and TRC Mariah Associates, Inc. (U.S. Army, 1998g). The results of this assessment and a review of additional sources are summarized below. Additional material from this study is provided in Appendix C.

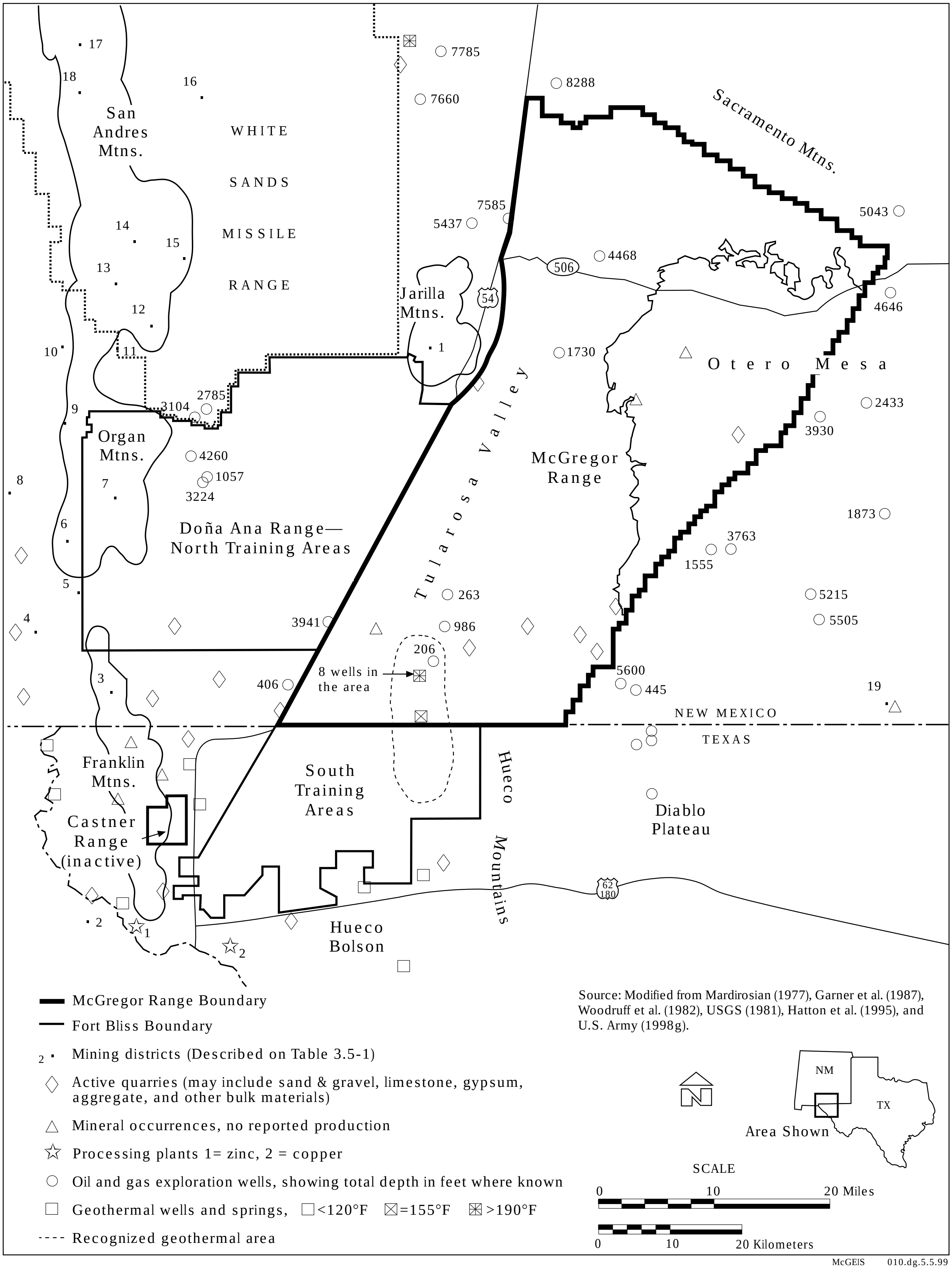

Figure 3.5-1. Mineral and Energy Resources in the McGregor Range Area, Texas and New Mexico.

Table 3.5-1. Mining Districts in the Vicinity of McGregor Range

Mining District or Mine (see Figure 3.5-1)	*Description*
#1. Orogrande (Jarilla)	Replacement and skarn deposits of copper, lead, gold, silver, and iron in Pennsylvanian carbonate rocks adjacent to Tertiary intrusive rocks; also placer deposits. Production estimated between $1 and $10 million.
#2. Brickland	Limestone, clay, and shale from Cretaceous rocks for cement. Production less than $1 million.
#3. North Franklin Mountains (Copiapo)	Iron from replacement deposits in limestone along shear zones. Lead and fluorspar from veins in dolomite. Gypsum from limestone beds. Production less than $1 million.
#4. East Vado (active)	Building stone. Production less than $1 million.
#5. Mesquite	Clay from Pennsylvanian shale. Production less than $1 million.
#6. Bishop Cap	Fluorspar from veins in limestone. Production less than $1 million.
#7. White Spar	Barite from veins in limestone. Production less than $1 million.
#8. Tortugas	Fluorspar from veins and faults in limestone and shale. Production less than $1 million.
#9. Ruby (or Hayner)	Fluorspar from veins in limestone and shale. Production less than $1 million.
#10. Organ	Replacement deposits of copper, gold, lead, silver, and zinc in Paleozoic carbonate rocks near Tertiary intrusive rocks. Production estimated between $1 and $10 million.
#11. Golden Lily	Fluorspar from veins in Precambrian granite. Production less than $1 million.
#12. Tennessee	Fluorspar from contact zone between Precambrian granite and dikes. Production less than $1 million.
#13. Black Mountain	Gold from irregular replacement deposits in dolomite. Production less than $1 million.
#14. Bear Canyon	Barite and lead from replacement deposits in limestone. Production less than $1 million.
#15. Stevens	Fluorspar and barite from replacement deposits in limestone. Production less than $1 million.
#16. Lake Lucero	Sodium compounds and borax from brines in Lake Lucero and surface deposits in nearby alkali flats. Production less than $1 million.
#17. San Andres	Barite and lead from irregular replacement deposits in limestone. Production less than $1 million.
#18. Green Crawford	Copper from veins in limestone. Production less than $1 million.
#19. Cornudas	Nephaline syenite in igneous rocks. A large resource, but no production reported.

Sources: Mardirosian, 1977; Garner et al., 1987; U.S. Army, 1998g.

Metallic Minerals. Five mining districts (or mines) in the vicinity of the McGregor Range have produced metallic minerals (see #1, 3, 10, 13, and 18 on Figure 3.5-1 and Table 3.5-1). None of these districts is currently active (Hatton, et al., 1995). The Orogrande district in the Jarilla Mountains (#1) and the Organ district in the Organ Mountains (#10) have been the largest producers in the area, chiefly copper, gold, lead, silver, zinc, and iron. The value of production at each district was less than $10 million (Mardirosian, 1977). Small amounts of metallic minerals have also been produced from the Black Mountain district (#13, gold), the Green Crawford district (#18, copper), and the North Franklin Mountains district (#3, iron), all of which are in the Organ and San Andres mountains.

Several areas on McGregor Range have been identified as having some potential for gold, silver, copper, lead, zinc, platinum group, iron, niobium, thorium and rare earths, beryllium, tin, and manganese (Figure 3.5-2; [U.S. Army, 1998g]). At most locations the potential is low. The Jarilla Mountains have a moderate potential for deposits of gold, silver, copper, lead, and zinc.

Industrial Minerals and Materials. Industrial minerals and materials are currently produced from numerous quarries in the vicinity of McGregor Range (Figure 3.5-1). The materials produced are mostly sand, gravel, and limestone. Except for #4 on Figure 3.5-1, none of these quarries are within established or recognized mining districts and are shown on Figure 3.5-1 as "active quarries." Large amounts of sand, gravel, and building stone are available throughout the Tularosa Basin and Hueco Bolson, as is limestone from Paleozoic rocks in neighboring mountains and mesas.

Mining districts that have produced industrial minerals and materials are chiefly in the Franklin, Organ, and San Andres mountains (Figure 3.5-1). Materials produced include limestone, clay, and shale for cement; building stone; fluorspar; and barite. The value of the materials produced has been less than $1 million at each district. Only the Vado quarries (#4) are currently active (Hatton et al., 1995). Small amounts of sodium compounds and borax have been produced from a district near White Sands National Monument (#16 on Figure 3.5-1).

Industrial rocks and minerals occur widely on McGregor Range. Commodities with some potential for development, however, are limited to sand and gravel, limestone, caliche, and gypsum (Figures 3.5-3 and 3.5-4; [U.S. Army, 1998g]). The economics of mining these materials depends largely on the costs of transportation. Large amounts of these materials are available in neighboring basins and mountains.

Energy Resources. The discussion of energy resources for McGregor Range includes geothermal resources, oil and gas resources, and uranium resources.

Geothermal. Geothermal resources of commercial proportion (generally hotter than 194º F and capable of generating commercial amounts of electricity) are most prevalent in areas of crustal instability, high heat-flow, and young igneous rocks (Muffler et al., 1978). In contrast, low-temperature geothermal resources (less than 194º F) occur widely, apparently originating from deep groundwater circulation in regions with normal or higher-than-normal geothermal gradients. Low-temperature resources can be used for such things as space heating, heating domestic water, and desalination.

The Rio Grande Rift Valley is characterized by crustal instability, moderate to high heat-flow (from 1.5 to more than 2.5 heat-flow units), and warm to hot subsurface waters. The U.S. Army is investigating the potential of a geothermal area at the south end of McGregor Range (Figure 3.5-5). Water temperatures within the 25-mile-long geothermal area range from 176 to 230º F (Henry and Glock, 1981). Temperatures as high as 134º F have been reported from well depths of only 450 feet (Woodruff et al., 1982). Current information indicates that heated water at temperatures between 180 to 185º F exists at 400 to 600 feet. The maximum temperature record was 192º F at 2,285 feet below the surface; economic use of this resource is currently being evaluated by the U.S. Army (U.S. Army, 1998g). A moderate potential for low-temperature geothermal resources exists along the west side of the range (Figure 3.5-5). Geothermal potential elsewhere on the range is low.

Oil and Gas. The favorability of an area to contain commercial quantities of oil and gas depends on many factors. Important factors include the presence and volume of source rocks; the degree of maturation of the source rocks; the availability of reservoir rocks; and the availability of stratigraphic or structural features to trap the migrating oil and gas. If the severity of post-entrapment tectonic, igneous, and geothermal activity is too intense, the petroleum can vaporize or escape to the atmosphere or hydrosphere along faults and fractures and by fresh-water flushing.

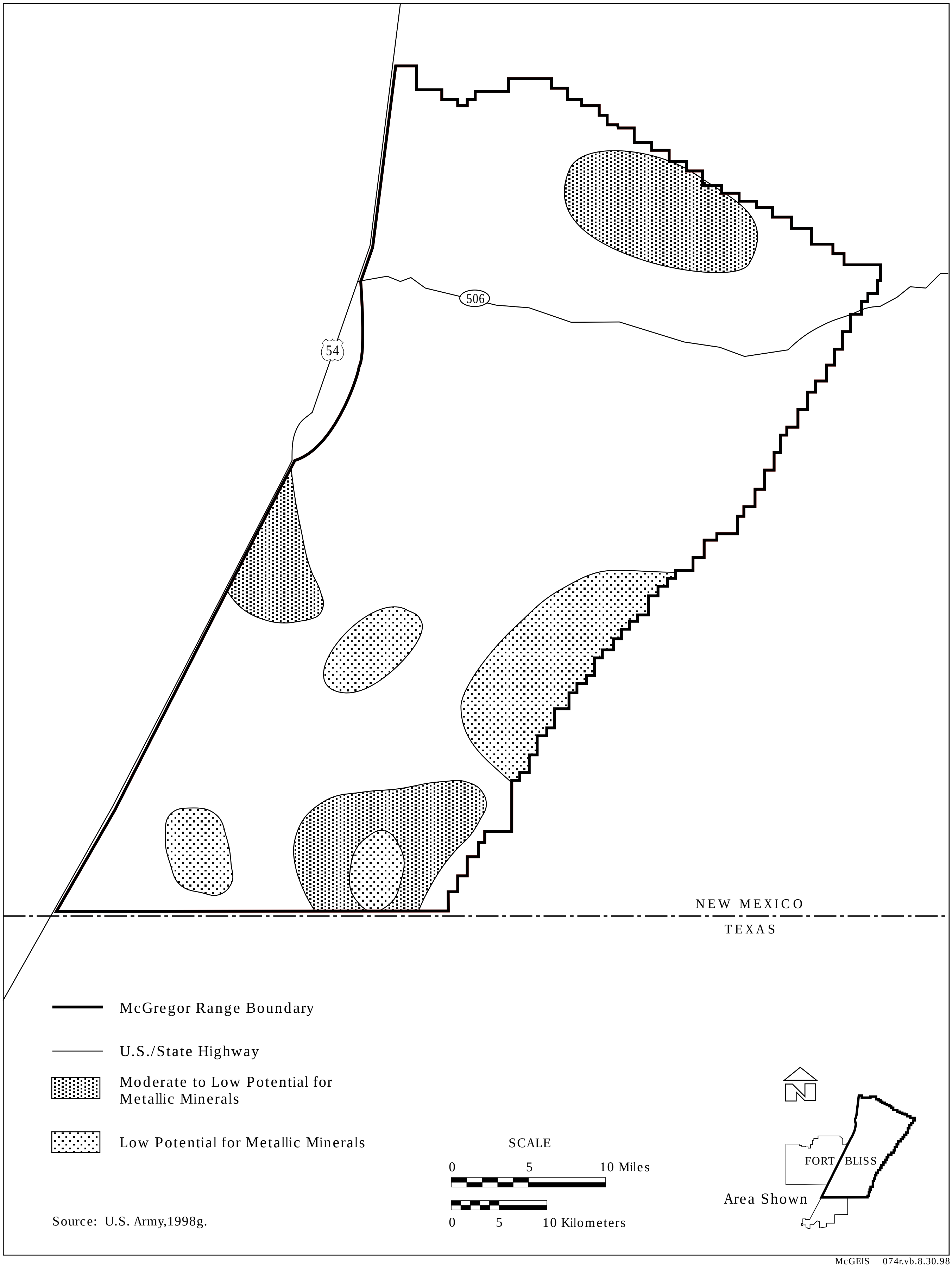

Figure 3.5-2. Areas of Potential for Metallic Minerals on McGregor Range.

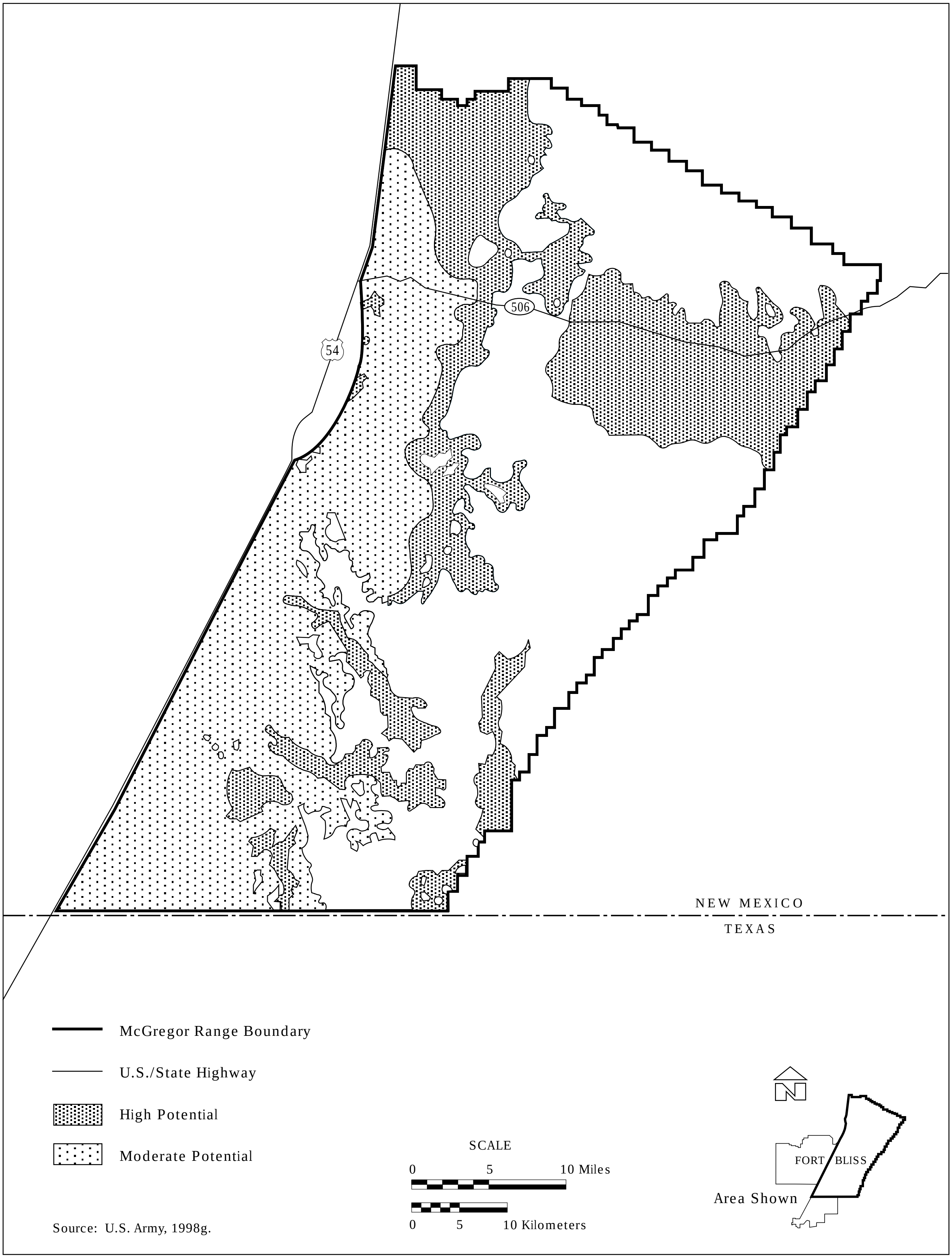

Figure 3.5-3. Resource Potential for Sand and Gravel on McGregor Range.

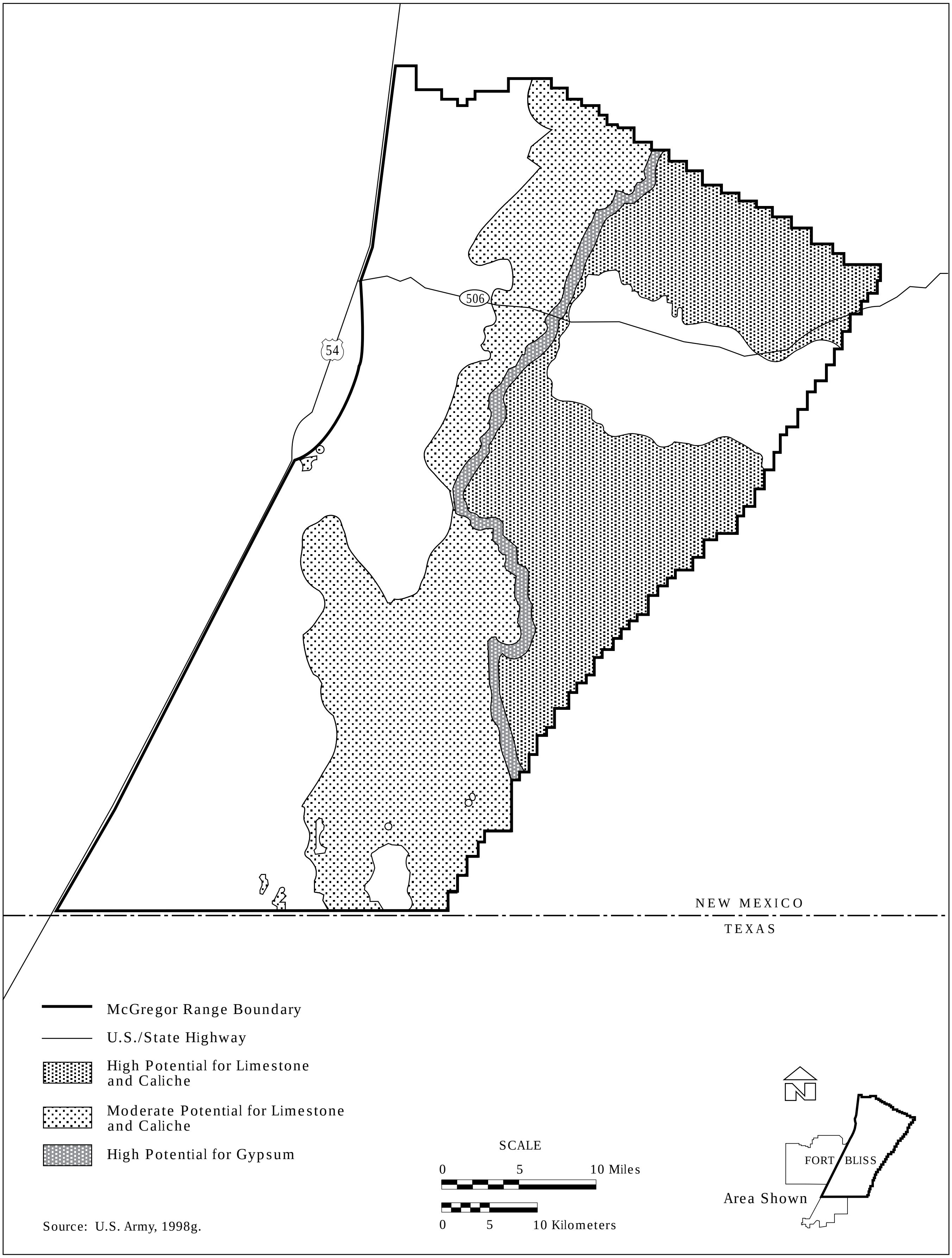

Figure 3.5-4. Resource Potential for Limestone, Caliche, and Gypsum on McGregor Range.

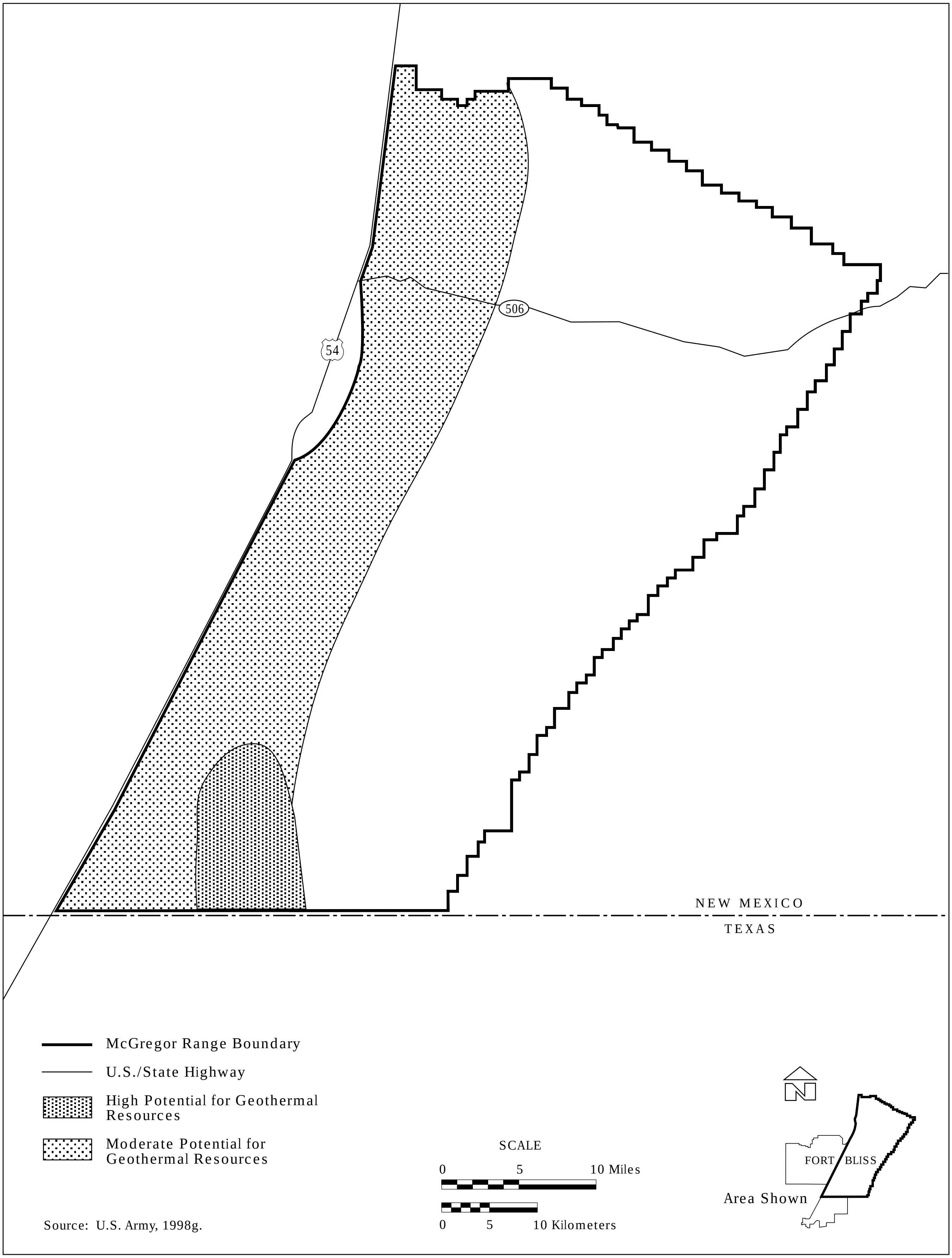

Figure 3.5-5. Areas of Potential for Geothermal Resources on McGregor Range.

Paleozoic source and reservoir rocks underlie the Tularosa Basin (King and Harder, 1985). Through 178
1980, several oil and gas exploration wells had been drilled in the McGregor Range area (Figure 3.5-1),
but all were dry (USGS, 1981). Foster (1978) lists the wells that had oil and gas shows. The most 179
successful test wells were drilled in 1974 at the northern end of the Tularosa Basin near Three Rivers, where noncommercial volumes of natural gas were recovered from Pennsylvanian and Permian strata (King and Harder, 1985). Most oil and gas shows from the Tularosa Basin have been from Pennsylvanian and Permian rocks, and a few from Mesozoic rocks (Foster, 1978). Testing of pre-Pennsylvanian rocks has been limited and generally unsuccessful. According to the appraisal by King and Harder (1985), the Tularosa Basin contains abundant source rocks, reservoir rocks, and hydrocarbon traps (stratigraphic pinchouts, unconformities, and structural traps).

The results of exploration drilling on the Otero Mesa-Diablo Plateau have been disappointing (Black, 1975; King and Harder, 1985). Silurian and Permian rocks account for most of the shows. Black (1975) suggests that the lower Paleozoic rocks of the Orogrande Basin are adequate source rocks and that fault and stratigraphic traps along the flanks of the late Paleozoic Padernal Uplift are favorable targets. Otherwise, the Otero Mesa-Diablo Plateau is not considered by King and Harder (1985) as a particularly favorable area for hydrocarbons because of a relatively small volume of source rocks, few traps, and late Tertiary uplift and erosion.

In addition to the less-than-promising results of drilling to date in the Tularosa Basin, the overall geologic history of south-central New Mexico and west Texas is not particularly favorable for the preservation of moderate to large accumulations of oil and gas. Late Cenozoic crustal extension and high heat-flow during development of the basin and range, and the Rio Grande Rift Valley probably destroyed any moderate- to large-size reservoirs that had survived Early- to Middle-Tertiary igneous activity in the region (Thompson, 1976) (reservoirs with more than 10 million barrels of recoverable oil or 60 billion cubic feet of recoverable gas). If oil and gas resources exist at McGregor Range, they are likely to be small (less than 10 million barrels of recoverable oil or 60 billion cubic feet of recoverable gas). A well drilled recently east of McGregor Range has been determined to be a commercial gas well. This indicates that commercially viable gas resources may exist in the Pennsylvanian rocks on McGregor Range (Jentgen, 1998). This discovery off McGregor Range has prompted oil companies to express interest to the BLM regarding future exploration on McGregor Range (Sanders, 1998), however, there has been no formal request for exploration on McGregor Range. Figure 3.5-6 shows the oil and gas potential of McGregor Range assigned by U.S. Army, (1998g).

Uranium. The Grants Mineral Belt in northwest New Mexico is the nation’s largest producer of uranium (U.S. Department of Energy, 1980). Decreasing demand, however, forced all conventional mines in the state to close in the early 1980s (McLemore and Chenoweth, 1989). Although uranium can occur in a variety of geologic environments, sandstone of Jurassic age has been the most prolific source (Chenoweth, 1976). Jurassic rocks do not occur in south-central New Mexico and west Texas.

Uranium minerals have been reported from several areas at and near McGregor Range, but uranium deposits are not known to exist on McGregor Range. The potential to develop commercial quantities of uranium at these sites, or elsewhere in the region, is low, considering that highly favorable areas exist elsewhere in New Mexico.

3.5.2 Soils

Nearly all of McGregor Range is included in the *Otero County, New Mexico Soil Survey* (U.S. Department of Agriculture [USDA], 1981). This survey was conducted and published by the Natural Resources Conservation Service (NRCS) and was mapped at the series, complex, and association

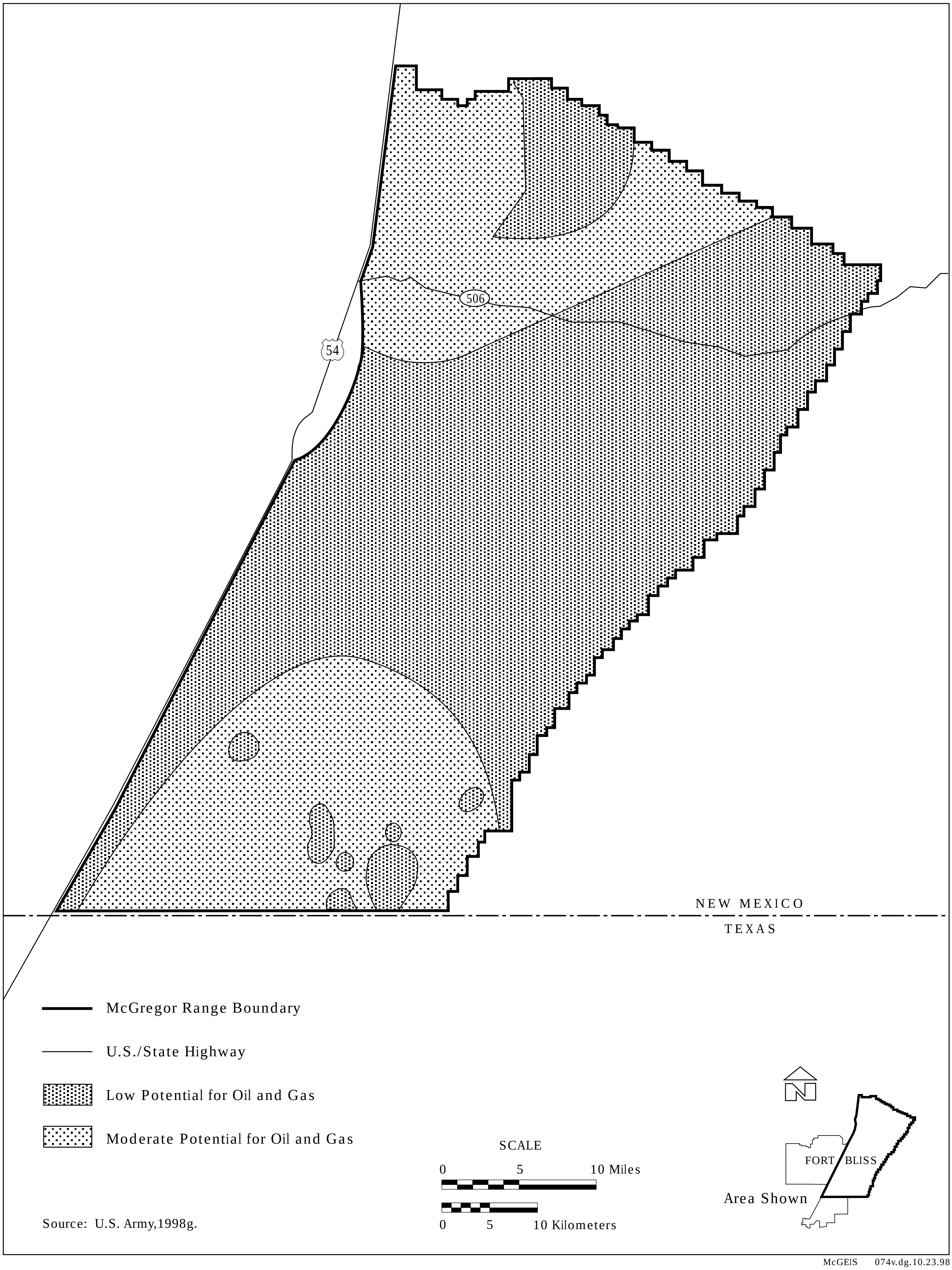

Figure 3.5-6. Oil and Gas Potential on McGregor Range.

levels. An effort is currently underway by the NRCS to resurvey McGregor Range. The purpose of the new survey is to update and refine the current survey, and to map soils that were not previously surveyed. Soils not included in the Otero County survey are found in an unpublished survey conducted by the USFS (Figure 3.5-7).

The majority of the soils on McGregor Range are classified as either aridisols or entisols, although a few mollisols are found in the area. Aridisols are soils with well-developed pedogenic horizons that developed under conditions of low moisture, and have very little water leaching through the profile (Donahue et al., 1977). Consequently, some of these soils have lime-cemented hardpans (caliche). Entisols are young soils with little or no development of soil horizons located in areas where the soil is actively eroding (slopes) or receiving new deposits of soil materials (alluvial fans, flood plains, and eolian sand dunes). Mollisols occur in the mountains of McGregor Range. They are distinguished by a deep, dark-colored surface horizon, rich in organic matter and saturated with bases.

Soils on McGregor Range generally consist of sandy, silty, and gravely loams, and fine sands and silts. The soils are alkaline and calcareous, having developed from the weathering of gypsum, sandstone, limestone, and igneous and metamorphic rocks. Windblown sediments from exposed lakebeds occur widely.

The soils of McGregor Range can be separated into two general categories based upon the following physiographic positions: valley and basin floors; and mountains, mountain foot slopes, and escarpments. Soils in the valleys and basins are shallow to deep, nearly level to very steep, well-drained to excessively drained soils that formed in alluvium, alluvium modified by wind, and eolian material (USDA, 1981).

Most of the basin floors are covered by coppice dunes (eolian deposits trapped by mesquite thickets). These soils are found mainly in the Tularosa Basin. The major soil complexes and associations that occur in the valleys and basins include Mimbres-Tome, Nickel-Tencee, and Pintura-Doña Ana. Soils in the valleys and basins are used mainly for grazing, wildlife habitat, and watershed. Military uses include ground-troop training, wheeled and tracked vehicle maneuvering (off-road vehicle maneuvering is limited to TA 8), and missile launching. On-road vehicle training is conducted on the 1,002 miles of roads that cover 2,673 acres of McGregor Range.

Land surfaces on mountains, mountain foot slopes, and escarpments are either rock outcrops or shallow to deep, well-drained, and nearly level to extremely steep soils that formed in alluvium and colluvium mostly derived from limestone (USDA, 1981). These soils are found mainly in the Sacramento and Hueco mountains, and on Otero Mesa. Major soil units in this category include Ector-Rock outcrop, Lozier-Rock outcrop, and Philder very fine sandy loam. These soils are used mainly for grazing, wildlife habitat, and watershed. In the mountainous areas, military uses are limited because of steep slopes and rough terrain, although some vehicle maneuvering and ground-troop training does occur on these soils.

Wind and water erosion is currently the most significant process affecting soils on McGregor Range. Soils unprotected by vegetation are susceptible to erosion from wind and water runoff. Gullying is the most prevalent form of erosion, but sheet and rill erosion from water, and wind erosion are processes that can also significantly affect soil movement. Wind and water erosion calculations and assumptions are presented in Appendix H, *Soils.*

The BLM natural units (see Section 3.1.2.2) are considered to have no significant wind erosion: Mountain Foothills, Canyonlands, and Rimlands. The Mesa and Alluvial Fans are subject to moderate erosion rates (20 to 23 tons per acre per year gross erosion), while soil movement in the Bolson is very high (140 tons per acre per year gross erosion). Estimates of water erosion in the co-use area have a rate of sediment yield between 0.3 and 0.5 af per square mile per year throughout the McGregor grazing EIS area (BLM, 1989).

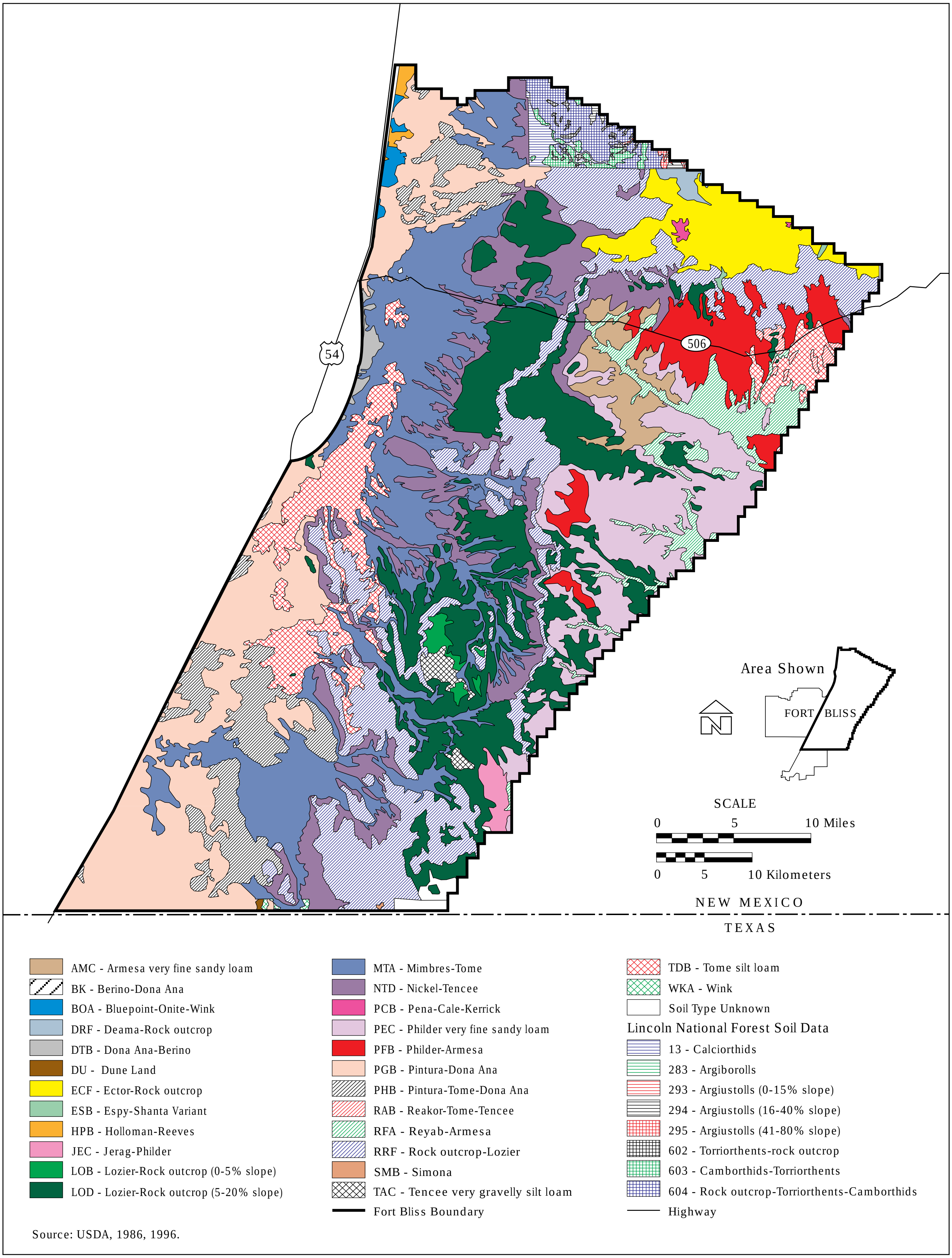

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Figure 3.5-7. Distribution of Soil Associations on McGregor Range.

The annual soil loss from wind and water varies primarily according to soil type and vegetative cover. The analysis conducted by the BLM in 1979 described soil loss by natural unit shown by Table 3.5-2.

Table 3.5-2. Soil Loss from Wind and Water on McGregor Range

*Natural Unit**	*Wind***	*Water****
Mountain Foothills	0	0.47
Canyonlands	0	0.32
Mesa	20	0.37
Rimlands	0	0.35
Alluvial Fans	23	0.45
Bolson	140	0.29

* See Section 3.1.2.2; ** Tons per acre per year; *** Acre feet per square mile per year.
Source: BLM, 1980.

Erodibility of soils varies considerably across McGregor Range. Figure 3.5-8 shows the erodibility of soils, as well as the location of steep slopes on the range. In general, soil erodibility is a function of soil type, slope, and vegetative cover. Sandy soils are extremely susceptible to wind erosion; loamy sands are highly erodible and capable of supporting a productive vegetative cover. Soils with large amounts of clay are moderately erodible and capable of supporting vegetation. Loamy soils with less than 35 percent clay are slightly erodible, and stony or gravely soils and rock outcrops are not generally subject to erosion.

The majority of steep rocky hills and mountains on McGregor Range have only slight erosion potential (USDA, 1981), although during periods of severe thunderstorm activity, large volumes of runoff can build up rapidly, causing flash floods that can produce large gullies. Soils covered by grasses such as those on Otero Mesa have relatively low amounts of erosion, unless they are disturbed, while areas that are predominantly shrublands (creosotebush and mesquite) have higher rates of erosion (particularly from wind) due to the large amounts of exposed soil between shrubs.

There are several areas where accelerated erosion is a problem on McGregor Range. Soils in the coppice-dunes area of the Tularosa Basin are subject to wind erosion. Most of the soil movement in this area is localized from dune to dune, but on windy days, blowing dust particles rise to the atmosphere (BLM, 1988b). This process could significantly lower air quality. On training ranges in the Tularosa Basin, roads have been constructed in such a manner that they have become channels for rainwater runoff. This has caused a considerable amount of erosion (BLM, 1988b). A similar problem has occurred on roads leading up to Otero Mesa (USAF, 1998). Grazing by livestock has reduced the vegetative cover and exposed the soil surface to erosion in localized areas on Otero Mesa, such as holding areas, watering points, and mineral licks.

Qualitative observations during the BLM's 1979 field season indicated that near water facilities, the soil is compacted by livestock over areas as large as 10 acres. On clay soils, the compaction could reduce infiltration capacity by as much as 50 percent. On most other soils, the reduction could be 15 to 30 percent. There is no effect on sandy or gravelly soils. Because of the reduced infiltration, soil moisture is reduced in the vicinity of water supplies and the survival potential of seeds may be reduced slightly. In areas away from water, the effects of grazing generally relate to the breaking of soil crusts by trampling (BLM, 1990a).

Soil contamination is not a problem on McGregor Range, although the potential for releases of reportable soil contaminants does exist.

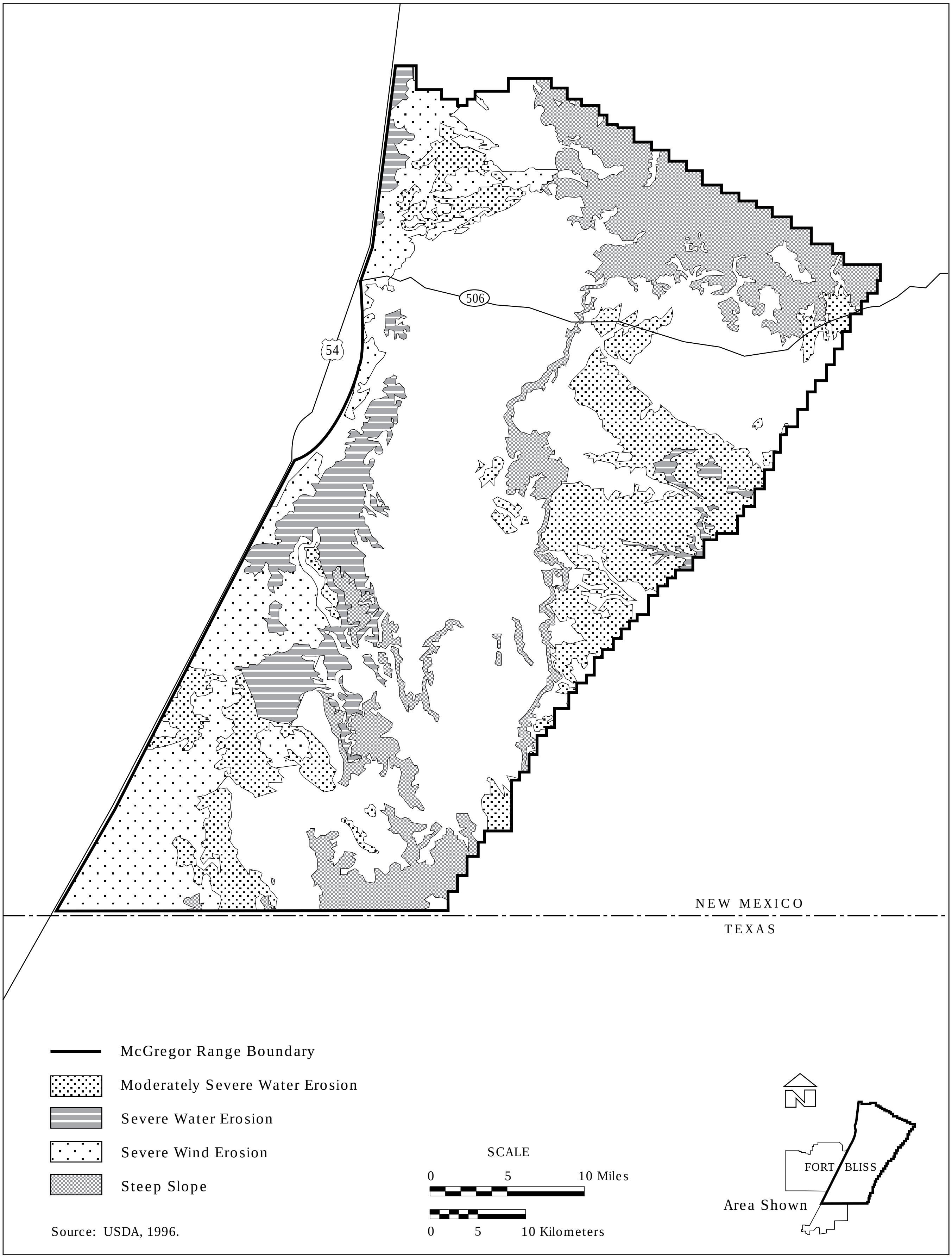

Figure 3.5-8. Steep Slopes and Erodible Soils Within McGregor Range.