4.3 Earth Resources

The region of influence (ROI) for earth resources (geology, soils, minerals, and paleontological resources) includes the immediate areas of disturbance at the Navajo Mine SMCRA Permit and Pinabete SMCRA Permit Areas and the FCPP, all of which are situated on the western flank of the San Juan Basin within the Navajo Section of the Colorado Plateau in northwestern New Mexico. In addition, the ROI extends along the maintained ROWs for four transmission lines. The Navajo Mine SMCRA Permit and Pinabete SMCRA Permit Areas and the FCPP are situated within the same geographical area; therefore, the geology and soils of each location are similar and are therefore discussed together. The Pinabete SMCRA Permit Area is wholly contained within the Navajo Mine Lease Area and is comprised of portions of the currently permitted Area IV North (Navajo Mine SMCRA Permit Area) (OSM Permit No. NM-0003F) and the unpermitted Area IV South (BNCC 2012). The planned land disturbances would occur only within the previously unmined areas of the Navajo Mine SMCRA Permit Area and Pinabete SMCRA Permit Area (portions of Area IV North and Area IV South) and the FCPP Lease Area. No land disturbances are planned within other portions of the Navajo Mine Lease Area, or beneath the four transmission lines, with the exception of on-going reclamation activities.

4.3.1 Regulatory Compliance Framework

No specific Federal, state, or local regulations regarding geology and soils are applicable to the Project. Paleontological resources are the fossilized remains of plants and animals contained within geological formations. They are a fragile and nonrenewable scientific record of past life on earth extending back in time millions of years. Paleontological resources are protected on public lands by certain laws. The Federal laws that protect paleontological resources on public lands include the Antiquities Act of 1906 (16 USC 431-433), and the Paleontological Resources Preservation Act of 2009. No specific regulatory requirements are known for the Navajo Nation tribal trust lands. Fossils found on Navajo Nation tribal trust lands are considered the property of the Navajo Nation, and a permit is required to conduct paleontological salvage and collection on Navajo Nation tribal trust lands (BNCC 2012b).

4.3.2 Affected Environment Pre-2014

4.3.2.1 Geology, Landforms, and Topography

Geology

The Navajo Mine and the FCPP are situated in the Colorado Plateau on the western flank of the San Juan Basin. The Colorado Plateau covers an area of approximately 130,000 square miles in western Colorado, northwestern New Mexico, southeastern Utah, and northern Arizona. The San Juan Basin is a physiographic subdivision of the Colorado Plateau within the northwestern portion of New Mexico; it covers approximately 7,500 square miles across the Colorado/New Mexico border and measures approximately 100 miles from north to south and 90 miles from east to west. The land surface elevations within the basin range from 5,100 feet above mean sea level on the western side to over 8,000 feet on the northern side (BNCC 2012c). Nearly all the hydrocarbon production within the Colorado Plateau is restricted to the San Juan Basin (Huffman 1987). The San Juan Basin is an asymmetrical, Rocky Mountain basin that formed sometime between 55 and 70 million years ago (S.S. Papadopoulos 2006). The structural San Juan Basin is bordered on the east, west, and north by both uplifts and downward sloping geologic structures. The western rim is formed by the Defiance Uplift and Four Corners Platform, and the eastern rim is formed by the Brazos Uplift and the Nacimiento Uplift. The northern boundary of the San Juan Basin is defined by the prominent Hogback outcrop of the Cretaceous Pictured Cliffs Sandstone (PCS). The southern boundary of the San Juan Basin is loosely defined by the Zuni Uplift and northern limit of the Chaco Slope. The interior of the San Juan Basin is defined by gently dipping to flat-lying sedimentary rocks and a few widely distributed low-relief anticlinal structures (Fassett 2000). Very few faults have been mapped at the surface of the San Juan Basin (Huffman 1987). Faulting within the

northern area of the San Juan Basin has been identified in a few locations; however, geologic maps of the area do not indicate large-scale faulting. The lack of widespread faulting indicates the San Juan Basin is relatively unbroken. While small-scale faults may exist in the San Juan Basin, they have yet to be identified and/or published (S.S. Papadopoulos 2006).

The San Juan Basin contains many sedimentary formations deposited over millions of years, extending from the Upper Cambrian approximately 500 million years ago through the middle Paleocene (approximately 40 million years ago) (S.S. Papadopoulos 2006). The principal source rocks in the San Juan Basin include marine black shale, marine limestone, and coal (Huffman 1987). The stratigraphic section beneath the existing Navajo Mine SMCRA Permit Area and the FCPP reflects the change from the Late Cretaceous shallow marine depositional environment to a terrestrial fluvial depositional environment. The four rock sequences within this depositional environment change are (in descending order): Kirtland Shale, Fruitland Formation, PCS, and Lewis Shale (Figure 2-2). The rock strata in the geology ROI strike north-south. The units are almost flat-lying with an average dip of two degrees to the east. The Fruitland Formation is the primary coal-bearing unit of the San Juan Basin and the target of most coalbed methane and coal production. The target geological formation beneath the Navajo Mine and the FCPP is the lower 250 feet of the Fruitland Formation (BNCC 2012c).

The Upper Cretaceous Fruitland Formation and Kirtland Shale have a maximum combined thickness of more than 2,000 feet. The Fruitland Formation is composed of interbedded sandstone, siltstone, shale, carbonaceous shale, and coal. Sandstone is primarily in northerly trending channel deposits in the lower part of the unit. The lower portion of the overlying Kirtland Shale is predominantly siltstone and shale, and differs from the upper Fruitland Formation mainly in its lack of carbonaceous shale and coal. The upper two-thirds or more of the Farmington Sandstone Member of the Kirtland Shale is composed of interbedded sandstone lenses and shale (Huffman 1987). Fruitland Formation coal seams tend to be lens-shaped, and most are only minable in localized areas.

The PCS consists of alternating sandstone, gray siltstone, and interlacing mudstone beds within the Lewis Shale Formation. The Lewis Shale Formation consists of silty marine shale with interbedded limestone, sandstones, and clays. Other surface material present within the geological resources ROI includes several deposits of Quaternary period alluvium and eolian sands. They are important sources of topdressing material for reclamation from mining disturbance in the Navajo Mine SMCRA Permit Area.

Landforms

The most prominent physiographic feature surrounding the Navajo Mine Lease Area and the FCPP is the relatively steep, horseshoe-shaped Hogback monocline, which borders the western, northwestern, northern, and eastern sides of the San Juan Basin. The San Juan Basin is an asymmetric basin with a gently dipping southern flank and steeply dipping northern flank. It has two axes in the northeastern part of the basin, which are separated by the Ignacio Anticline (Huffman 1987).

The northeastern and eastern flanks of the San Juan Basin are characterized by high mesas made of resistant sandstone and shale, ranging in elevation from 6,500 to 8,000 feet. The fragmented land of the San Juan Basin is full of steep slopes and canyons with narrow valley floors (Bierei 1977). The southwestern portion of the San Juan Basin is relatively featureless. The southwestern region is defined by rolling plains where elevations range from 5,500 to 6,500 feet. This plain is cut extensively by badlands developed in soft sands and shales. The badlands in this area usually exist along established drainages. Relief along the badlands is abrupt, commonly with up to 100-foot elevation changes. Badlands are areas of severe erosion, usually found in semiarid climates, and characterized by numerous gullies, steep ridges, and sparse vegetation. The primary waterways in the San Juan Basin have created deep, steep-walled canyons within the plateau. Between the canyons and the upland portions, sand dunes are numerous and well established. Drainages in this portion of the San Juan Basin, like the Chaco River, and respective tributaries, are typically flat, wide, sandy bottom washes (Bierei 1977). The central part of

the San Juan Basin is similar to the southwestern region of the San Juan Basin, as it too is characterized by a dissected plateau that gently slopes to the west (Fassett 2000).

With regard to the subject transmission lines, the ROWs cover a diverse range of landforms. Both the Moenkopi and Cholla lines cross the Chuska Mountains. The Moenkopi line sits mostly within the Colorado Plateau, while approximately the last 40 miles of the line crosses the Moenkopi Plateau. The Cholla line diverges south from the Moenkopi line to cross Defiance Plateau in Arizona. The West Mesa line sits predominantly in the eastern portion of the Colorado Plateau. The San Juan Generating Station has a short transmission line (approximately 10 miles long) directly north of FCPP that connects the FCPP to the San Juan Generating Station. This transmission line sits within the same physiographic region as the Navajo Mine and FCPP; therefore, the geologic features are the same as those described for the Navajo Mine and FCPP.

Topography

Topography in the Navajo Mine Lease Area and the FCPP is characterized by rolling terrain with areas of steep escarpments, badlands, sand dunes, and an incised landscape of drainages and arroyos. The general elevation of the Pinabete SMCRA Permit Area ranges from 5,300 to 5,600 feet. The western border of the permit area is characterized by escarpments that are part of ancient channel walls of the Chaco River. Two major arroyos, Pinabete Arroyo and Cottonwood Arroyo, lie within and adjacent to the permit area.

Cottonwood Arroyo defines the northern portion of Area IV North. The western portion of Area IV North follows a bluff that sits 90 to 120 feet above the surrounding area and drains to the Chaco River, while the southern portion drains to Pinabete Arroyo.

The southern portion of Area IV South is bounded by No Name Arroyo. The western edge of Area IV South is defined by two bluffs west of the permit boundary, approximately 80 feet above the surrounding terrain. Pinabete Arroyo bisects Area IV South, creating eastern and western portions of Area IV South. The majority of the terrain within Area IV South drains to Pinabete Arroyo, while some of the terrain along the eastern edge drains in an eastern direction into a tributary of Cottonwood Arroyo (BNCC 2012c).

The FCPP is generally bounded on the west by the Chaco River and the Hogback sandstone ridge. Terrain near the FCPP is relatively level on the Upper Chaco River terrace in the northern and western portion and includes badlands in the south-central and eastern portions (Figure 4-3.1). Elevation ranges at FCPP from 5,060 to 5,364 feet above mean sea level (Ecosphere 2012a).

With regard to the subject transmission lines, the Moenkopi and Cholla transmission lines span from northwestern New Mexico to northeastern Arizona. The transmission lines sit within the Colorado Plateau in northwestern Arizona. Hills, mesas, buttes, cliff, and canyons characterize the topography in this area. The West Mesa line extends in a southeastern direction and sits within the Colorado Plateau, and does not traverse any major mountain ranges. The transmission line from the FCPP to the San Juan Switchyard sits within the same physiographic region as the FCPP and does not traverse any major topographic features.

4.3.2.2 Minerals

The San Juan Basin is highly recognized for its economic energy resources. The most prominent economic resources within the San Juan Basin include coalbed methane, coal, and conventional oil and gas (S.S. Papadopoulos 2006). The San Juan Basin is one of the most productive coalbed methane basins in North America. Production of coalbed methane from the lower part of the Fruitland Formation has been on-going since the 1950s (Huffman 1987). All coal to be mined at the Navajo Mine Lease Area exists within the Fruitland Formation. The extent of the Fruitland Formation coal seams differs across the permit area depending on geologic formations in the area. The permit area to be mined has eight primary coal seams and eight corresponding overburden or interburden horizons (BNCC 2012c).

The occurrence, thickness, and geometry of Fruitland coal deposits is strongly influenced by the depositional environment in which they were created. Individual coalbeds range from 6 to 100 feet. In the northwest-trend, individual coalbeds average more than 9 feet in thickness. Average thickness of coalbeds in the northeast-trend are approximately 6 feet. The greatest net coal thickness, up to 100 feet, is in a northwest-trending belt in the northern part of the San Juan Basin where thick coal deposits occur in both northwest- and northeast-trending deposits. Fruitland coalbeds are buried under the surface at 4,200-foot depths in the northeastern part of the San Juan Basin (Huffman 1987).

The geological model defined seven minable primary coal seams and seven corresponding overburden/interburden horizons within the Pinabete SMCRA Permit Area (BNCC 2012c). A minable coal seam is defined as a seam, with a 2-foot minimum thickness, a minimum heating value of 6,000 BTUs per pound and an aerial extent and stratigraphic position that makes the seam economically viable to mine (BNCC 2009). Coal produced within the Navajo Mine Lease Area is characterized as subbituminous, which has higher moisture and volatile matter content and lower sulfur content than bituminous coals (EPA 1995). Average total sulfur values of coal in the Pinabete SMCRA Permit Area range from 0.53 to 1.27 percent. Weighted average total sulfur, as a function of average seam thickness, for all seams is 0.76 percent. Average pyritic sulfur values range from 0.10 to 0.71 percent. Weighted average pyritic sulfur, as a function of average seam thickness, for all seams is 0.28 percent. Pyritic sulfur is the main contributor to acid-forming materials and makes up a small percentage of both the coal seams and the overburden/interburden materials (BNCC 2012c).

Historically, the San Juan Basin has produced most of its natural gas from fractured sandstone reservoirs in the Dakota Sandstone, Mesaverde Group, and the PCS in the central San Juan Basin area. Starting in the late 1970s, an increasing amount of gas production has come from Fruitland Formation coalbeds, and annual Fruitland coal-gas production now exceeds gas production from sandstone reservoirs; however, no natural gas reserves are present within the ROI (Fassett 2000).

Oil and gas deposits are present throughout the San Juan Basin. Almost all of the oil and gas within the San Juan Basin occurs in the Upper Cretaceous sandstone of the central portion of the San Juan Basin, most of which has been produced from stratigraphic traps. Some oil and gas occurs in the Cretaceous units around the flanks of the San Juan Basin as well (Huffman 1987).

The Grants Mineral Belt in New Mexico extends along the southern portion of the San Juan Basin. This belt hosts numerous minerals, most of which are not economically feasible to mine. They include metallic and nonmetallic minerals, and uranium. A large deposit of uranium exists within the Grants Mineral Belt. New Mexico ranks second in uranium reserves in the United States. A belt of sandstone-type uranium deposits stretching 135 km (85 miles) exists along the southern boundary of the San Juan Basin. However, uranium is no longer extracted in New Mexico because it has been deemed uneconomical (New Mexico Bureau of Geology and Mineral Resource 2007). No uranium or other mineral deposits are present within the ROI (BNCC 2011a).

108°20'0"W

36°40'0"N

INDIAN RESERVATION

Four Corners Power Plant

Ojo Amarillo Canyon

Cactus Peak

The Hogback

Table Mesa

Barber Peak

Area I

Area II

Area III

Area IV N

Area IV S

Area V

Moncisco Mesa

Bennett Peak

Chaco River

San Juan River

Morgan Lake

Bisti Wash

Dead Mans Wash

Chinde Wash

Cottonwood Arroyo

Middle Fork of the Cottonwood Arroyo

South Fork of the Cottonwood Arroyo

Pinabete Arroyo

No Name Arroyo

Sanostee Wash

Tocito Wash

Brimhall Wash

Farmington

Kirtland

Fruitland

Shiprock Airstrip

Tocito Lake

Burnham

Figure 4.3-1

Landforms and Topography
in the Project Area

PROJECT FACILITIES

Four Corners Power Plant

PROJECT BOUNDARIES

Navajo Mine Resource Areas

Navajo Mine Lease Area and ROWs

Navajo Mine SMCRA Permit Boundary

Proposed Pinabete SMCRA Permit Boundary

TRANSMISSION LINES

345kV

500kV

N

0 2.5 5

Scale in Miles

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4.3.2.3 Soils

The Colorado Plateau is characterized by a wide range of topography, geologic materials, soils, and vegetation. As such, most of the soils within this plateau are extremely complex and variable. The soils on the plateaus, mesas, and badlands in the Navajo Mine Lease Area have been formed by alluvium and eolian sediments derived from shale and sandstone parent material from the Fruitland Formation (Buchanan Consultants 2011). These soils are deep and well-drained. Typically, the surface layer is brown sandy loam (U.S. Department of Agriculture [USDA] 1977). Soil surveys of the San Juan Basin have shown the geomorphic surfaces were influenced by constructional and erosional processes, which has led to a high occurrence of buried and truncated soils with lithologic discontinuity. Many portions of the Colorado Plateau are subject to high wind and water erosion due to sparse vegetation cover and soil type.

Three major soil-mapping units occur within and adjacent to the FCPP, a Huerfano-Muff-Uffens Complex, Badland-Monierco-Rock Outcrop Complex, and Badland. The Huerfano-Muff-Uffens soils are found on mesas and valleys on slopes from 0 to 8 percent. The Huerfano soil is shallow and well drained with low water-holding capacity and slow permeability. Muffs soils are moderately deep and well drained with low water capacity and slow permeability. Uffens soils are deep and well drained with slow permeability and low available water capacity. This complex has slight to severe water erosion potential and severe wind erosion potential. Huerfano soils form in alluvium derived from weathered shale and sandstone. The Badland-Monierco-Rock Outcrop Complex soils sit atop hills, ridges, and mesas with slopes between 0 and 30 percent. Permeability of the Monierco soil is moderately slow and the potential for water erosion is moderate, while wind erosion potential is severe. The Badland soil type is non-stony barren shale uplands, located on slopes ranging from 5 to 80 percent. Rock crops in the area consist of barren sandstone on ridges, benches, and escarpments. The potential for wind and water erosion is severe (Ecosphere 2012a).

Site-specific soil surveys were performed in the Pinabete SMCRA Permit area in 1987, 1998, and 2008. A total of 28 different soil mapping units were used to define the Pinabete SMCRA Permit Area. Of the 28 soil mapping units, 24 are consociation (a unit composed of one kind of component soil), 2 are complexes (a mapping unit made up of 2 or more taxonomic units), and 2 are undifferentiated units (unit made up of 2 or more taxonomic components, not always associated geographically) (BNCC 2012c). Figure 4.3-2 displays the various soil types found at and in the vicinity of the Navajo Mine Lease Area, FCPP Lease Area, and transmission line ROWs based on regional surveys conducted by the Natural Resources Conservation Service. These surveys are conducted at a larger scale than the site-specific surveys and provide a general overview of soils in the region.

All of the soils classified in the survey area have been forming since late-Pleistocene and Holocene eras. Predominate types of soil in the survey area are Aridisols and Entisols; both develop in an aridic moisture regime (dry soil moisture due to climate and typically where annual precipitation is less than potential evapotranspiration) and mesic temperature regime (average annual soil temperature is 8ºC to 15ºC). The prevailing soil types in the Navajo Mine Lease Area and the FCPP consist of sandy loam, loamy sand, and sandy clay loam (Buchanan Consultants 2011).

Aridisols are characterized by dry, desert like soils that have low organic content with little vegetation at the surface. Entisols are soils defined by the absence or near absence of soil horizons that illustrate soil-forming processes. Entisols are found in geographic settings of active erosion or deposition. In the case of the Pinabete SMCRA Permit Area, Entisols exist due to erosional processes (Natural Resources Conservation Service 2012). Nearly all of the soils in the Navajo Mine Lease Area were developed under the influence of erosion as indicated by the frequency of moderate and severely eroded surfaces (Buchanan Consultants 2011). Soils in the Navajo Mine SMCRA Permit Area and Pinabete SMCRA Permit area have a high erodibility factor and proper soil management must be implemented to ensure minimum loss of soil occurs during mining operations.

One of the mapping units in the Pinabete SMCRA Permit area is considered a Natric soil type. Some of the Natric soils in the permit area are defined as sodium-affected soils and would not provide suitable topsoil or topdressing because of electrical conductivity levels, and/or sodium absorption ration that exceeds topsoil suitability criteria, as would badland soils (Buchanan Consultants 2011).

On reclaimed surface mines, topsoil is essential for reestablishing native vegetation and local forage. The removal and replacement of native topsoil is required by SMCRA, unless soil has been characterized as unsuitable. Topsoil is removed as a separate layer before mining and is either spread on regraded areas or stockpiled for later use. SMCRA defines topsoil as the A and E soil horizon layers of the four master soil horizons (30 CFR 701.5). The specific parameters for determining topsoil suitability include pH, electrical conductivity, sodium absorption ratio, texture, saturation, hardness as calcium carbonate, fragment size, erosion factor, acid-base potential, and selenium and boron concentrations in soil. Laboratory data from soil surveys were used to classify soils to help determine topsoil suitability in the permit area (Buchanan Consultants 2011). Topdressing volume was calculated from soil surveys (using a conservative 10 percent soil handling loss) to address the amount available in-situ to reestablish native vegetation and local forage.

The baseline soil units within the permit area are composed of Aridisols and Entisols; both soil types contain limited resources that meet the SMCRA topsoil definition. Therefore, NTEC relies on topsoil substitute material (topdressing) for reclamation. NTEC defines topdressing as, “all unconsolidated material capable of supporting plant growth in the upper 60 inches of the native in-situ soil profile.” NTEC includes all topsoil material (A and E soil horizons) and suitable topsoil substitute material (B and C soil horizons) to ensure compliance with SMCRA regulations.

Overburden and interburden material is defined as the consolidated geologic strata from the geologic formations that lie above and between minable coal seams (OSMRE 2012a). The general nature of the overburden is a geologic formation composed of sandstone, siltstone, claystone, mudstone, and shale. A comprehensive sampling of overburden material within the adjacent Navajo Mine SMCRA Permit Area and proposed Pinabete SMCRA Permit Area was completed in 1987, 1998, and 2007 to characterize the material for suitability for reclamation and to identify any potentially acid- or toxic-forming materials throughout the Navajo Mine Lease Area. The findings for overburden sampling activities indicate that the overburden material is generally acceptable as reclamation root-zone material. Two naturally occurring trace elements of concern—boron and selenium—have been detected in core samples of overburden material. However, elevated levels of the soluble forms are uncommon when averaged throughout the overburden, and therefore, are not considered a limiting factor for reclamation.

Data collected to characterize the overburden suggest that a widespread occurrence of potentially acid- and toxic-forming materials does not occur within the Pinabete SMCRA Permit Area. An acid-base potential characterization suggests a net alkaline environment for the majority of the interburden layers across the Pinabete SMCRA Permit Area. Characterization of the in-situ interburden layers above certain coal seams indicate the saturation percent, sodium adsorption ratio, and pH values are outside the criteria limits established by OSMRE for root-zone suitability. However, there is ample overburden material that would meet OSMRE root-zone suitability and material characterized as outside the criteria limits would not be used.

4.3.2.4 Paleontological Resources

A variety of paleontological resources are found in the geological formations of the San Juan Basin, including fossilized animal bones, fossil leaves, microscopic fossils, petrified wood, and trace fossils. The fossils are found within Triassic, Jurassic, Cretaceous, and Tertiary age rock formations of the area (BLM 2003). Four paleontologically significant areas have been identified on the adjacent public lands managed by BLMs Farmington Office, including one area to the west of Farmington (Pinon Mesa). This area includes the type sections in the PCS, Fruitland Formation, and Kirtland Shale (BLM 2003). A type section is the originally described stratigraphic sequence for a given locality or area.

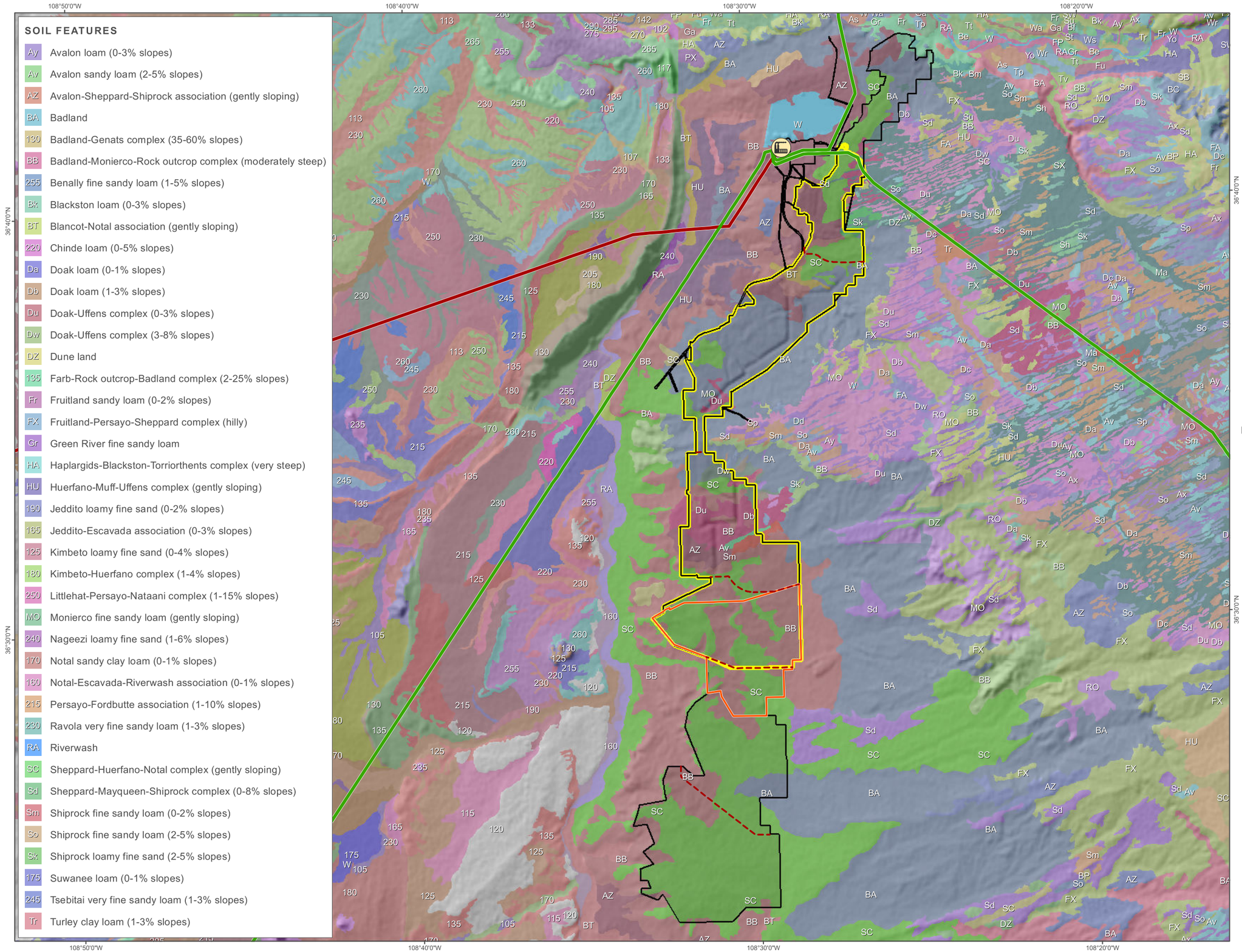

Figure 4.3-2
Soils in the Project Area

PROJECT FACILITIES

Four Corners Power Plant

PROJECT BOUNDARIES

Navajo Mine Resource Areas

Navajo Mine Lease and ROWs

Navajo Mine SMCRA Permit Boundary

Proposed Pinabete SMCRA Permit Boundary

TRANSMISSION LINES

345kV

500kV

Soil Data Source: Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database, 2013.

N

0 1.25 2.5 5

Scale in Miles

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The Navajo Mine Lease Area is located on the western flank of the San Juan Basin. The basin contains sedimentary rocks that range in age from Cambrian to Holocene (560 million years ago to less than 10,000 years ago). Fossil-bearing geologic units in the ROI are Late Cretaceous age (100 to 65 million years old) sedimentary rocks and Holocene age (less than 10,000 years old) alluvial deposits. Late Cretaceous age rock units crop out across most of the Navajo Mine Lease Area. Recent (Holocene) alluvial deposits are found within the river channels, washes, and arroyos (DOI and BIA 2007).

During the Cretaceous period, the northwestern portion of the state of New Mexico was on the western margin of a large interior seaway that split the North American continent into two land masses. In a series of sea-level change cycles during this period, the shoreline of the seaway was moved from central Arizona to northwestern New Mexico. The depositional context of the sediments during this period consisted of shoreline and nearshore environments of the interior seaway (DOI and BIA 2007). Most Cretaceous age vertebrate fossils are found associated with the sedimentary rocks that reflect non-marine and shallow marine depositional sequences (sandstone, siltstone, shale, and coal). Vertebrate fauna associated with these sequences include fish, crocodiles, turtles, and dinosaurs (DOI and BIA 2007).

The fossils that may be found in the ROI are based on the rock types present and the documented paleontological resources associated with them. Marine and non-marine sedimentary rocks of Late Cretaceous, Tertiary, and Holocene age are exposed in the ROI. Inter-tonguing and interbedded sandstones, mudstones, shale, and coal have the potential to yield scientifically significant fossils. The erosion of nearby Tertiary age rocks may also contribute fossils to the alluvial deposits that are present in the ROI (DOI and BIA 2007).

The San Juan Basin is known to contain a rich and diverse paleontological record. As of 2007, the New Mexico Museum of Natural History and Science database indicated that more than 10,000 fossil specimens had been collected from San Juan County. However, only a small number are from the Navajo Nation lands and they are not well documented (DOI and BIA 2007). Cretaceous age formations that crop out in the area include the Mancos Shale, Point Lookout Sandstone, Menefee Formation, Lewis Shale, PCS, Fruitland Formation, and Kirtland Formation (DOI and BIA 2007). The Fruitland Formation and the Kirkland Formation have provided the largest and most diverse Cretaceous age paleontological discoveries in the area (BIA 2007). Tertiary-aged, fossil-bearing formations that overlie the Late Cretaceous formations are located nearby. They include Ojo Alamo Sandstone and Nacimiento Formation. Fossils eroded from these units are found in the unconsolidated Pleistocene-Holocene aged alluvial and colluvial deposits (silts, sands, and gravels) in the washes and arroyos (DOI and BIA 2007).

New Mexico Museum of History and Science records from 2006 indicated a variety of fossils have been recorded in San Juan County from several of the Cretaceous age formations that crop out (DOI and BIA 2007). The Menefee Formation has yielded a variety of fossils including turtles, bivalves, crocodiles, Hadrosaur, and Tyrannosaur. The Lewis Shale was locally rich in fossil ammonites, inoceramid bivalves and gastropods, chonodrichthyes, sharks (selachians), Mosasaurs, and Plesiosaurs. The PCS has yielded fossils from a diverse fauna of sharks and isolated bones and teeth of turtles, Plesiosaurs, crocodiles, dinosaurs, and mammals. Fossil discoveries were not from San Juan County, but from the San Juan Basin. The Fruitland and Kirtland formations have yielded numerous fossils in areas of Cottonwood Arroyo, Ojo Amarillo Creek, Pinabete Wash, and Brimhall Wash, all of which are tributaries of the Chaco River, which is located just west of the Navajo Mine Lease Area. Cottonwood Arroyo and Pinabete Arroyo are within the Navajo Mine Lease Area. Fossils from the Fruitland Formation include diverse fauna of sharks, boney fish (*osteichthyans*), frogs, turtles, lizards, snakes, crocodiles, a broad variety of dinosaurs (*Plesiosaur*, *Mosasaur*, *Albertosaur*, *Tyrannosaur*, *Hadrosaur*, *Tricerotops*, and *Pentaceratops*), and mammals. The overlying Kirtland Formation has yielded nearly identical fossils. Fossilized tree stumps and isolated logs have been noted in the Fruitland/Kirkland formation (DOI and BIA 2007). These formations crop out in Areas I, II, III, IV North, IV South, and V on the Navajo Mine Lease Area (DOI and BIA 2007).

The Tertiary age Ojo Alamo Sandstone has yielded fragments of fossils that were eroded from the underlying Cretaceous age formations. However, the overlying Nacimiento Formation has yielded some of the most diverse fauna from the early Paleocene epoch and has been the object of research by several major institutions since the historic Wheeler Survey of 1874. The primary fossil yields from this formation include some of the earliest mammal and plant fossils found in the ROI. These Tertiary formations do not occur within the Navajo Mine Lease Area, but outcrops do occur on the surrounding mesas (DOI and BIA 2007).

Surveys of the lease area were conducted as early as 1916 and 1924 (Marshall and Breed 1974). In 1972, a survey by paleontologists from the University of California, Berkeley yielded 38 fossil localities within and immediately adjacent to the lease area (Marshall and Breed 1974). An Office of Contract Archaeology at the University of New Mexico small-scale archaeological survey in 1973 and 1974 found some additional fossil localities (Marshall and Breed 1974).

The Museum of Northern Arizona (MNA) University undertook a larger-scale paleontological survey and collection project in 1974 in Areas III, IV, and V of the Navajo Mine Lease Area, and the construction of the FCPP facilities (Table 4.3-1). This survey examined outcrops for four Late Cretaceous (65 to 75 million years) age formations within the lease area (Lewis Shale, Pictured Cliff Sandstone, Fruitland Formation, and the Kirtland Formation). No significant fossil localities were found in the Lewis Shale formation or the Pictured Cliff formation. Ninety localities within the Fruitland/Kirtland formation containing plants, invertebrates, and vertebrates were found within the lease area, and an additional 30 were found immediately adjacent (Marshall and Breed 1974).

Table 4.3-1 Significant Fossil Localities from MNA Survey (1974)

Fossil Type	Significant Locality #s	Significant Localities within Project Boundaries	Collections at Significant Localities within Project Boundaries
Plants	65, 70, 95	65, 70	70
Invertebrates	10, 30, 33, 34, 35, 67, 71, 116, 117, 118	30, 33, 34, 35, 67, 71, 117, 118	30, 33, 34, 35, 67, 71, 117, 118
Microvertebrates	16, 88, 93	16, 88, 93	16, 88, 93
Macrovertebrates	26, 55-67, 70, 80-82, 94-97, 100-102	26, 55-67, 70, 80-82, 94,96,97	26, 55, 59-64, 66, 67, 70, 81, 94,96

Source: Marshall and Breed 1974.

A total of 37 significant fossil localities were identified by MNA. Three fossil plant localities identified during the survey were considered to be of major significance. The localities contained a rare and highly significant impression of a large palm tree (collected for further analysis) from one site, and small to medium-sized leaf impressions were collected from the other two (Marshall and Breed 1974). Seventeen invertebrate localities were identified, 10 of which were considered to be of major significance. Additional fossil collection was recommended to obtain samples of the full range of invertebrates present (Marshall and Breed 1974). Twelve microvertebrate fossil (fossil of teeth and small bones) localities were also identified within the lease area. Three of them were considered significant and recommended for additional collection activity (Marshall and Breed 1974). Seventy-nine macrovertebrate localities containing the remains of dinosaurs, crocodiles, alligators, and turtles were also identified. Twenty-five of these localities were considered significant and additional survey and collection was recommended; however, no additional collection has been conducted to date with the exception of the excavation and collection of a well preserved and nearly complete hadrosaurian dinosaur that was likely from Locality 82 (Marshall and Breed 1974). Four of the identified significant localities (localities 65, 67, 70, and 95) contained more than one significant fossil type. Of the 37 significant localities identified, 31 are located within the project boundaries (see Table 4.3-1).

Collections were made at 24 localities (see Table 4.3-1). No collections were made from seven localities within the current project boundaries (localities 56, 57, 58, 65, 80, 82, 97).

The New Mexico Bureau of Mines undertook salvage excavations at two vertebrate fossil localities in 1985 under a permit issued by the Navajo Nation and the BIA (Wolberg 1997). J.H. Hartman of the University of Minnesota found three fossil localities on Navajo Mine Lease Area, and collections included a significant fossilized clam shell locality along Cottonwood Arroyo (Wolberg 1997). Navajo Mine employee O.J. Estrada had made a number of significant fossil discoveries in the Yazzie area of the mine over several years. Discoveries have included the fossilized remains of turtle, crocodile, gar, snail, dinosaurs, and logs (Wolberg 1997). In 1997, the MNA's localities were reassessed, and 27 of the localities within the project boundaries were determined to be significant (localities 70, 87, 88, 93, and 118 contain multiple significant fossil types); additional study and fossil collections were recommended (Wolberg 1997) (Table 4.3-2). A majority of the significant fossil localities contain macrovertebrate fossils. In the summer of 2000, a dinosaur (Hadrosaur) skeleton was recovered from the Hosteen-Yazzie area of the Navajo Mine SMCRA Permit Area (BHP Minerals 2000). The locality from which this specimen came from is unknown, but may have been from MNA Locality 82.

Table 4.3-2 Significant Fossil Localities in Pinabete SMCRA Permit Area

Fossil Type	Significant Localities within Project Boundaries (Wolberg 1997)	Significant Localities within Project Boundaries (Clifford 2005)
Plants	70, 118	1, 3-12, 14
Invertebrates	67, 71, 118	2
Microvertebrates	16, 33, 87, 88, 93	
Macrovertebrates	26, 42, 49, 54, 57, 58, 61-64, 66, 68, 70, 80-82, 87, 88, 90, 93, 95, 96, 118	13

Sources: Wolberg 1997, Clifford 2005.

To date, few areas of the Navajo Nation lands have been surveyed for paleontological resources. In 2005, a survey was conducted of Area IV North and another was conducted of Area V (Clifford 2005). No vertebrate fossils were found during field survey of Area V, but it was noted that the potential for both vertebrate and invertebrate fossils existed in the area (DOI and BIA 2007). Clifford (2005) identified 14 fossil localities within the project boundaries (Table 4.3-1). Fossil Site 1 yielded the largest array of fossils including crocodile teeth and fragmented scute plates; abundant turtle shell fragments; fish gar scale; fish teeth; brackish water ray stingers and teeth; plant fragments; dinosaur bones fragments (Plesiosaur, Hadrosaur, Tyrannosaur) and eggshell fragments. Fossil Site 2 yielded unionid bivalves and freshwater gastropods (Clifford 2005). Fossil Site 13 contained possible dinosaur bone fragments (Clifford 2005). The other fossil sites all contained petrified logs and stumps.

MMCo completed an updated paleontological inventory within unmined portions of Area Ill and Area IV North of the Navajo Mine SMCRA Permit Area and the proposed Pinabete Permit Area in the fall of 2013 (Wolberg 2013). The Navajo Nation retains ownership of all paleontological resources. From the paleontological resource information gathered during the inventory, MMCo in consultation with the Navajo Nation Minerals Department developed the Paleontological Resources Management Plan (PRMP) to document and protect known and previously unknown paleontological resources within the Navajo Mine Lease Area. The PRMP is a management tool which establishes the inventory methodology, the criteria to be used to determine significance, and mitigation strategies for affected paleontological resources. The PRMP also includes procedures and requirements for reporting and curation. MMCo submitted copies of the PRMP to both the Navajo Nation Minerals Department and OSMRE in February 2014. The paleontological inventory identified 20 localities as potentially significant. Using the PRMP significant criteria, 10 of these localities were determined to be significant (Paleo West 2014). Of these 10 localities,

only 3 were located within the area of proposed surface disturbance and thus require further management actions. In consultation with Navajo Nation Minerals Department, one of these three significant sites was mitigated in the fall of 2013.

4.3.3 Changes to Earth Resources Affected Environment Post-2014

Two completed Federal Actions have been incorporated into the baseline for this analysis: (1) the EPA has made its ruling with respect to BART to control air emissions; and (2) OSMRE has approved the SMCRA permit transfer from BNCC to NTEC (Section 2.4). Neither of these completed Federal Actions would change the affected environment for earth resources.

4.3.4 Environmental Consequences

Potential impacts to geology include the removal of coal, rock layers, and potential changes to surface drainage patterns and topography. Potential impacts to soil include removal, erosion, changes in productivity, and contamination (OSMRE 2012a). The ROI for geology and soils is restricted to only those areas that would be disturbed by the Proposed Action or alternatives – the Navajo Mine and Pinabete SMCRA Permit areas and associated roadways, and the DFADAs proposed at the FCPP. Erosion from maintenance activities within the subject transmission line ROWs are also considered. Paleontological impacts include the removal of fossils or other historical resources from geologic strata during mining operations.

Impacts to earth resources are considered adverse if the Proposed Action or alternatives would result in:

- Major changes to topographic features that could result in elimination of key features of the landscape or significantly change surface relief;
- Construction or clearing on slopes that are prone to mass movement or have very high susceptibility to erosion, such that accelerated erosion, sedimentation, or disruption of unstable slopes would occur;
- Loss of soil or adverse impacts to soil productivity, such that revegetation would be ineffective;
- Destruction of unique geologic features or resources, including mineral resources;
- Loss of coal resources due to mining operations and handling; and,
- Destruction of significant paleontological resources.

The primary potential adverse impact to paleontological resources is physical damage or destruction of significant individual specimens or stratigraphic units within the geological formations that contain a wide array of life forms in great abundance. The greatest potential for adverse impacts to paleontological resources would occur during ground-disturbing activities. At the Navajo Mine and Pinabete SMCRA Permit Areas, these activities include the excavation of the open pits and the construction of ancillary facilities and infrastructure (roads and power lines). At the FCPP, these activities would include the excavation and construction of DFADA cells as well as excavation of soils for the construction of berms around the DFADAs. Adverse indirect impacts would occur if significant paleontological resources (as identified in surveys conducted at the project sites) were removed from their context due to increased access to sensitive areas.

4.3.4.1 Alternative A – Proposed Action

Navajo Mine

Landforms and Topography

Under the Proposed Action, impacts to landforms and topography as a result of mining operations within the Navajo Mine SMCRA Permit Area and Pinabete SMCRA Permit Area would be extensive and would continue for the proposed life of the mine (25 years) or until reclamation was completed. The coal removal process would alter topographic features such as slope gradients and surface drainage patterns, and would also cause topographic alteration to accommodate ditches and coal storage and handling areas. Under the Proposed Action, surface mining of overburden and subsurface coal resources would disturb 4,103 acres of rock and soil and modify topographic and landform features, such as hills, slopes, and surface drainage patterns, while forming high walls in the mining pits and temporary spoil stockpiles of overburden (BNCC 2012c). Proposed mining operations, including topsoil and suitable subsoil salvage, would increase the potential for wind and water erosion and off-site sedimentation.

Per the SMCRA permit, NTEC would be required to remediate and reclaim all areas disturbed by mining. As described in Chapter 3, reclamation to the AOC is required for reclamation and includes backfilling pits and grading highwalls and spoils to closely mimic the original shape, topographic relief, and major drainage patterns of the pre-mining permit area. Reclamation plans for the permit area are based specifically on meeting the AOC's drainage requirements. The actual reclaimed surface would closely approximate the approved AOC, and NTEC would ensure current AOC drainage designs are maintained, meet the established SMCRA and OSMRE requirements, and meet the material balance (BNCC 2012c). In doing so, reclamation to the AOC would minimize the long-term impact on topography and landforms within and adjacent to the permit area after mining ceased. Naturally occurring slopes and topographic gradients vary substantially in the Navajo Mine SMCRA Permit Area and Pinabete SMCRA Permit Area. The AOC surfaces for Areas IV North and South have been designed using a combination of fluvial geomorphic and traditional reclamation approaches (based on "hard-engineered" structures). Areas designed with the traditional reclamation approach would have interior slopes equal to or less than 6.5h:1v and outslopes less than or equal to 4h:1v. The slopes for post-reclamation slope stability have been designed to minimize land slide potential (BNCC 2012c). The reclaimed permit area would likely have gently rolling hills with smoother contours and less topographic relief than the original topography. The flatter topography would make the reclaimed area suitable for various land uses (e.g., grazing, residential uses). Slight permanent changes would occur to the topographic contouring as the AOC would be slightly altered within the permit area after reclamation. Therefore, the Proposed Action would result in minor impacts to landforms and topography.

Realignment of Burnham Road and construction of other ancillary roads within the permit area could slightly alter surface topography; however, these impacts are considered minor because road construction and removal would only marginally change the approximate contours of topography. At the end of the permit period, Burnham Road would remain realigned, and NTEC would remove the ancillary roads, and the affected areas would be regraded to the AOCs, top dressed, and revegetated. Proper construction would include embankments with slopes of 2h:1v in unconsolidated material and not steeper than 1h:1v in consolidated material (BNCC 2012c). These features would be designed to withstand landslides and slumping. Approved construction design and methods would be utilized to maintain slope stability.

NTEC does not plan to retain any of the mine roads constructed for the Proposed Action unless the Navajo Nation requires their preservation after the permit expires. Following reclamation, impacts to landform and topography would be considered minor.

Soils

Surface mining activities from the Proposed Action would considerably disturb the soil resources in the Navajo Mine SMCRA Permit Area and Pinabete SMCRA Permit Area; however, all soil handling activities would be in compliance with SMCRA regulations, which are designed to minimize impacts associated with this disturbance. Over the next 25 years, NTEC estimates a total soil disturbance of 4,100 acres. Within the new permit area, NTEC would be required to conduct surface mining reclamation and soil reclamation operations on the disturbed soil areas as part of the mine closure. BNCC has prepared a Topdressing Management Plan that NTEC would implement that details the requirements for topsoil replacement over the regraded spoil surface. OSMRE guidelines for reclamation projects identify soil conditions that must be considered during reclamation, including soil pH and acid-forming spoils, sodic zones, and toxic substance occurrence in soil. OSMRE has reviewed the Topdressing Management Plan and confirmed that it meets OSMRE guidelines. As described in Section 4.3.3.3, overburden analysis in the permit area concluded that the soils in Area IV North and Area IV South are alkaline, and potentially acid- or toxic-forming materials are not widespread within the permit area (BNCC 2012c). The analysis also concluded the soil material met SMCRA root-zone soil suitability criteria for selenium, boron, and pH.

The total estimated volume of in-situ topdressing within the permit area is 8,042,225 cubic yards. Approximately 42 percent of the permit area would provide all of the suitable in-situ topdressing, and the remaining 58 percent of the permit area has no suitable topdressing. Based on the analysis provided by BNCC, OSMRE has determined that sufficient quantities of suitable topdressing are available from the permit area to support successful reclamation.

NTEC would utilize numerous stockpiles within the permit area for storing topdressing (and potentially regolith material, if needed). To minimize loss from wind and water erosion, stockpile surfaces (top and sides) would be mulched and seeded. Topdressing stockpiles that are left undisturbed for greater than 6 months would also be mulched, and those undisturbed for 1 year or greater would be seeded and mulched during the appropriate seeding period. These practices would effectively reduce erosion potential and soil loss. In addition, backfilling and grading spoil material to AOC topography would be conducted using fluvial geomorphic principles. These specific methods would decrease and minimize erosion in the permit area and efficiently stabilize graded spoil material and reclaimed surfaces. Therefore, impacts with regard to erosion would be minor.

Post-reclamation activities would have permanent beneficial impacts on the majority of soils in the permit area. Revegetation of the soil would result in a higher percentage of vegetative cover, improving soil stability, decreasing soil erodibility, and increasing overall productivity of the reclaimed soils compared to pre-mining conditions. Beneficial impacts would be most significant on the 58 percent of the permit area with no suitable topdressing.

Soil excavation, stockpiling, and salvaging during mining operations would have short-term impacts on soil productivity in the 42 percent of the permit area that had suitable topdressing. Stockpiling soil can disturb natural processes that occur in the soil and mix established soil horizons. In general, stockpiled soil that is used for reclamation can be deficient in organic matter, nutrients, and beneficial soil biota compared to native undisturbed soil. However, because the native undisturbed soil within the Navajo Mine SMCRA Permit Area and Pinabete SMCRA Permit Area is already low in organic matter, nutrients and beneficial soil biota, a decrease in these factors would cause negligible impacts to the establishment of vegetation. The reclaimed (post-mining) soil would not be reclaimed to its original pre-mining soil productivity immediately, but soil productivity would be maximized by reclamation, which would create a suitable root zone over the entire reclaimed area and establish a productive, diverse, and permanent vegetation cover.

Following mining operations, the potential for erosion of redistributed soil would be minimized by constructing gradient terraces. Gradient terraces are earthen embankments or ridges that reduce erosion by slowing, collecting, and redistributing surface runoff. Gradient terraces would be built in the permit area

to reduce sheet and rill erosion, prevent gullies, and provide water harvesting mechanism for the semi-arid region (BNCC 2012c). Two types of gradient terraces would be implemented if necessary, flat bottom terraces and v-ditch terraces. All design components would be in compliance with SMCRA regulations. Soil productivity and soil suitability are expected to increase over conditions prior to mining activity following completion of mine closure activities.

Direct impacts to soil would be caused by construction of the proposed access roads, maintenance activities, and site preparation. Minor displacement of earth material would be expected during construction of roads. Small quantities of earth material would be irretrievably lost due to these activities. However, this resource is not considered unique or irreplaceable in the Pinabete SMCRA Permit Area and abundant quantities of like material exists in the vicinity. Approximately 5.2 miles of primary roads would be constructed under the Proposed Action. Topdressing would be salvaged along primary roadways and stockpiled or hauled to regraded areas. Fugitive dust emissions would be controlled by application of water and chemical road stabilizers. To minimize additional surface disturbance, road maintenance would consist of light blading. Ancillary roads will be maintained in a manner to minimize adverse environmental impacts. To minimize additional surface disturbance, the maintenance is limited to occasional light blading particularly after heavy precipitation that may cause damage. The drainage control structures (i.e., culverts, riprap channels, etc.) will be properly maintained. Periodic inspections will be conducted to ensure proper maintenance and safe operating conditions. With the implementation of these measures, impacts to soils (e.g., erosion, productivity, and soil loss) during road construction and maintenance would be minimized

NTEC does not plan to retain any of the mine roads constructed for the Proposed Action, unless the Navajo Nation requires otherwise after the permit expires. Following removal, the affected areas would be regraded, topdressed, and revegetated. Impacts to soils from primary and ancillary road construction, maintenance, and deconstruction would be considered minor due to slight soil loss by wind and water erosion and a decrease of soil productivity due to compaction.

Geology

The minable coal sits within the Fruitland Formation. As such, the overlaying geologic strata, the Kirtland Shale, and the Fruitland Formation, would be removed to access minable coal seams. Geologic hazards within the mining area are limited to those created during the mining process, mostly from exposed high walls and spoil piles. Hazards encountered during mining activities would be managed in accordance with MSHA regulations.

The level of impacts to geologic features from primary and ancillary roads is considered negligible because no existing or proposed unique geologic features in or around the permit area would be disturbed by the construction, maintenance, or removal of roads.

Mineral Resources

Since no unique geologic features are within the permit area, no impacts to unique geologic features would occur. Removal and permanent alteration of the coal resources within the permit area would be conducted according to all permit conditions and would maximize the economic recovery of the resources; therefore, no major impacts would occur. Mining of coal would not adversely impact any other mineral resources in the area. Uranium exists within the Grant Mineral Belt in New Mexico along the southern portion of the San Juan Basin, outside the permit area. The proposed mining would not have a major impact on this resource. Oil and gas resources would not be affected by the proposed coal mining operations under the Proposed Action.

Coal is the dominant mineral resource in the permit area, and the only resource to be extracted during mining operations. Coal extraction from the permit area would be conducted in the Fruitland Formation. Coal mining must be conducted in a way to maximize resource recovery while protecting remaining coal deposits after mining. BNCC estimated that a total of 134,439 million tons of coal would be extracted over

the 25-year permit period (BNCC 2012c). A small percentage (8 to 10 percent) of coal resources would be lost as wedges and ribs, and at the top and bottom of coals seams. Numerous operational and safety-related conditions would ensure limited coal loss during normal mining activities. The permanent loss of coal resources in the permit area is considered normal given current mining technology and the nature of the coal extraction in the Fruitland Formation.

Paleontological Resources

Under the Proposed Action, two known significant paleontological resources (Localities 30 and 42 found during the 1974 survey) would be impacted within the pre-2016 striplines of Area III in the Navajo Mine SMCRA Permit Area. Under the Proposed Action, 32 known significant paleontological resources would be physically affected by excavation of the pits in the Pinabete SMCRA Permit Area and construction of the haul roads. Development of the Pinabete SMCRA Permit Area would affect 14 significant localities from the 1974 survey (Localities 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 80, 81, and 82), 6 significant localities from the 1997 reassessment (Localities 49, 54, 68, 70, 87, and 90), 10 significant localities from the 2005 survey (Localities 2, 3, 4, 5, 8, 10, 11, 12, 13, and 14), and 3 significant localities from the 2014 survey (Localities 53, 88, 192). Locality No. 88 was mitigated in the fall of 2013. The destruction of, or damage to, this number of significant localities within the Navajo Mine Lease Area would be considered a major adverse impact to paleontological resources. Furthermore, the potential exists for previously unknown paleontological resources to occur within the permit area. However, an inadvertent discoveries plan would be prepared as a condition of the SMCRA permit. The inadvertent discoveries plan would seek to minimize the potential damage or destruction of paleontological resources by putting in place protocols for pre-surveying and monitoring activities, procedures for evaluating the significance of a discovery, and stipulate the level of training that personnel must have in order to conduct identification, collection, and curation activities. While ground-disturbing activities associated with the Project may damage or destroy paleontological resources, these protocols would ensure that the Navajo Nation is not deprived of the opportunity to realize benefits from these Indian Trust Assets (ITAs). Therefore, impacts to paleontological resources would be minor.

Four Corners Power Plant

Landforms and Topography

As part of the Proposed Action, five new DFADAs would be created to accommodate future disposal of all fly ash through the end of the lease term. The soil needed to create the berms for stormwater control as well as evapotranspiration covers for closed DFADA cells would be borrowed from areas inside the existing FCPP Lease Area. Impacts to landform and topography would occur due to the construction and closure of the five new Ash Disposal Areas. These features would permanently alter topography through both the creation of borrow pits on flat areas of the lease and construction of impoundments as high as 80 feet. These alterations would permanently change the surface relief of the fly ash disposal area; although due to the limited areal extent of the DFADA and because the DFADAs would be located in the same area of the FCPP lease as the existing ash disposal areas and would be consistent with the topography in this area of the lease, impacts are considered minor.

Soils

Impacts to soils at the DFADA could occur due to runoff of CCR if berms and embankments were to fail; however, as discussed in Section 4.5, Water Resources/Hydrology, the berms would be constructed around the areas to restrict any runoff. Equipment and vehicles operating around the DFADA would also have the potential to increase soil erosion; however, design features of the roadways in the DFADAs and BMPs (dust suppression) have been established to minimize any soil erosion. With regard to productivity, placement of CCR would reduce soil productivity and prevent vegetation growth over the long-term on this portion of the lease area. Potential impacts to soil as a result of erosion and productivity would be considered minor due to

erosion control features and the limited areal extent of the DFADA. At such time that the FCPP is decommissioned, reclamation should be conducted to increase soil productivity in the DFADAs.

Geology

Although the surface relief of the land would change as a result of emplacement of the new DFADA, no unique geologic features exist in or around the proposed DFADAs; therefore, impacts to geology are expected to be negligible.

Mineral Resources

Although the surface of the land would change as a result of emplacement of the new DFADA, no known mineral resources are present in the proposed DFADA; therefore, impacts to mineral resources are expected to be negligible.

Paleontological Resources

The construction of the five additional DFADAs between the base of the escarpment and the Chaco River near the base of the Hogback geologic feature could affect paleontological resources. The geological context suggests some potential for paleontological resources. However, given the eroded nature of the deposits in the area of the proposed DFADA, the potential for intact paleontological resources is considered low. The Proposed Action within the FCPP Lease Area is unlikely to impact any significant paleontological resources. A plan would be put in place to manage any inadvertent discoveries during development of the new DFADAs.

Transmission Lines

Landforms and Topography

No construction activities or soil disturbing activities are proposed during operation of the subject transmission lines; therefore, no impacts to geology and soils would occur. Similarly, no impacts to mineral resources would occur. Most vehicle access to the transmission lines is via paved roadways; however, some occurs on unpaved roadways. Minor erosion and soil disturbance would result from vehicle traffic on unpaved roadways. Implementation of applicant proposed measures would minimize any potential for erosion or soil disturbance.

Paleontological Resources

Operations and maintenance would continue as they do currently. No new towers or access roads would be constructed and no changes in the ROW would occur as a result of the Proposed Action. The renewal of the ROWs for the four transmission lines would have no impact to paleontological resources.

4.3.4.2 Alternative B – Navajo Mine Extension Project

Navajo Mine

Topography, Soils, Geology, and Mineral Resources

Under Alternative B, surface mining of overburden and subsurface coal resources would disturb 4,998 acres of rock and soil and modify topographic and landform features, such as hills and slopes, while forming highwalls in the mining pits and temporary spoil stockpiles of overburden during the life of the permit. Alternative B would disturb an additional 894.5 acres compared to the Proposed Action.

The impacts to topography, soil, geology, and mineral resources would be similar to those described under the Proposed Action. Alternative B would include all SMCRA-required reclamation activities described under the Proposed Action. Therefore, impacts to topography, soils, geology, and mineral resources would be comparable to impacts described under the Proposed Action.

Under Alternative B, approximately 12.6 miles of primary roads and 14.1 miles of ancillary roads would be constructed (BNCC 2013). An additional 7.4-mile primary road would be constructed, compared to the Proposed Action. Impacts to topography and soils would be similar to those described for the Proposed Action. As such, impacts to topography and soil resources from construction, maintenance, facilities removal, and reclamation are considered minor because road construction and removal would only marginally change the approximate contours of the landscape in certain locations.

Impacts to geologic and mineral resources from construction, maintenance, and removal of primary and ancillary roads would be comparable to the Proposed Action. As such, impacts are considered minor.

Paleontological Resources

Under Alternative B, six known significant paleontological resources would potentially be affected. Two known significant paleontological resources (Localities 30 and 42 found during the 1974 survey) would be impacted within the pre-2016 striplines of Area III in the Navajo Mine SMCRA Permit Area. Localities 117 and 118 found during the 1974 survey are located at the southern end of the Pinabete SMCRA Permit Area These localities contain a significant concentration of vertebrate, invertebrate, and plant fossils. More than 60 specimens were previously collected from these localities, but they have the potential to yield additional important specimens and paleoenvironmental information. The destruction of, or damage to, these significant localities would be considered a major adverse impact to paleontological resources. In addition, the 2014 survey located an additional two significant localities (Localities 53 and 192). Locality 88 was mitigated in fall of 2013 (Paleo West 2014). However, an inadvertent discoveries plan would be prepared as a condition of the SMCRA permit. The inadvertent discoveries plan would seek to minimize the potential damage or destruction of paleontological resources by putting in place protocols for pre-surveying and monitoring activities, procedures for evaluating the significance of a discovery, and stipulate the level of training that personnel must have in order to conduct identification, collection, and curation activities. While ground-disturbing activities associated with the Project may damage or destroy paleontological resources, these protocols would ensure that the Navajo Nation is not deprived of the opportunity to realize benefits from these ITAs. Therefore, impacts to paleontological resources would be mitigated to be minor.

Four Corners Power Plant

Under Alternative B, impacts to topography, soils, geology, minerals, and paleontological resources would be the same as described for the Proposed Action.

Transmission Lines

Under Alternative B, the transmission line ROWs would be approved, and the lines would continue to be operated and maintained as described under the Proposed Action. No changes from the Proposed Action are proposed under this alternative; therefore, no impacts to topography, soil, geology, minerals, or paleontological resources would occur under Alternative B.

4.3.4.3 Alternative C – Alternative Pinabete Mine Permit

Navajo Mine

Topography, Soils, Geology, and Mineral Resources

Under Alternative C, proposed mining would disturb 6,492 acres. Mining would take place in Areas IV North and South as described in the Proposed Action. Operations, maintenance, and reclamation would be conducted as described under the Proposed Action. Therefore, impacts to topography, soil, geology, and mineral resources would be comparable to impacts discussed under the Proposed Action; however, under Alternative C an additional 2,388.7 acres would be disturbed.

Under Alternative C, approximately 15.1 miles of primary roads would be constructed, along with 14.8 miles of ancillary roads. Primary and ancillary roads would be constructed, maintained, and decommissioned as described in the Proposed Action. Therefore, impacts to topography, soil, geology, and mineral resources would be comparable to the Proposed Action; however, under Alternative C an additional 9.9 miles of primary roads would be constructed compared to the Proposed Action.

Paleontological Resources

Under Alternative C, 40 known significant paleontological resources would be physically affected by excavation of the pits in the Pinabete SMCRA Permit Area and construction of the haul roads. Development of lease areas within Area IV North would affect 20 significant localities from the 1974 survey (Localities 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 80, 81, 82, 87, 88, 90, 96, 97, 117, and 118), 5 significant localities from the 1997 reassessment (Localities 49, 54, 68, 87, and 90), 13 localities from the 2005 survey (Localities 2 to 14), and 3 significant localities from the 2014 survey (Localities 53, 88, 192). Locality No. 88 was mitigated in fall of 2013. In addition, two known significant paleontological resources (Localities 30 and 42 found during the 1974 survey) would be impacted within the pre-2016 striplines of Area III in the Navajo Mine SMCRA Permit Area. The destruction of, or damage to, this number of significant localities within the Navajo Mine Lease Area is considered a major adverse impact to paleontological resources (see Table 4.3-1). However, an inadvertent discoveries plan would be prepared as a condition of the SMCRA permit. The inadvertent discoveries plan would seek to minimize the potential damage or destruction of paleontological resources by putting in place protocols for pre-surveying and monitoring activities, procedures for evaluating the significance of a discovery, and stipulate the level of training that personnel must have in order to conduct identification, collection, and curation activities. While ground-disturbing activities associated with the Project may damage or destroy paleontological resources, these protocols would ensure that the Navajo Nation is not deprived of the opportunity to realize benefits from these ITAs.

Four Corners Power Plant

Topography, Soils, Geology, and Mineral Resources

Under Alternative C, impacts to topography, soils, geology, minerals, and paleontological resources would be the same as described for the Proposed Action.

Transmission Lines

Under Alternative C, the transmission line ROWs would be approved, and the lines would continue to be operated and maintained as described under the Proposed Action. No changes from the Proposed Action are proposed under this alternative; therefore, no impacts to topography, soil, geology, minerals, or paleontological resources would occur under Alternative C.

4.3.4.4 Alternative D – Alternative Ash Disposal Area Configuration

Navajo Mine

Under this alternative, OSMRE would approve the Pinabete SMCRA Permit application and renew the Navajo Mine SMCRA Permit.. The Navajo Mine would operate as described under the Proposed Action. Therefore, no impacts to topography, soil, geology, or minerals would occur under Alternative D and impacts to paleontological resources would be minor.

Four Corners Power Plant

Under this alternative, the area of disturbance required for the DFADAs would be 350 acres instead of 385 acres. The 10 percent reduction in surface area of the DFADAs could result in a reduction in the potential for unanticipated discoveries of paleontological resources than the Proposed Action. All other

FCPP components of this alternative are the same as for the Proposed Action. Therefore, impacts to topography, soil, geology, and minerals would the same as described for the Proposed Action.

Transmission Lines

Under this alternative, the transmission line ROWs would be approved and they would continue to be operated and maintained as described for the Proposed Action. No changes from the Proposed Action are proposed under this alternative; therefore, no impacts to topography, soil, geology, minerals, or paleontological resources would occur under Alternative D.

4.3.4.5 Alternative E – No Action Alternative

Navajo Mine

Topography, Soils Geology, and Mineral Resources

Under the No Action Alternative, the Navajo Mine would close, and Areas IV North and IV South would not be mined. Reclamation mandated under the existing SMCRA permit would occur and the mine and all its associated facilities would be closed. As such, no impacts to topography, soils, geology, or mineral resources would occur within Areas IV North and South from mining operations or road construction. All areas within the existing Navajo Mine permit area would be reclaimed in accordance with SMCRA regulations; however, a slight permanent alteration in topographic relief would occur compared to pre-mining conditions. These impacts are considered minor.

Paleontological Resources

Under the No Action Alternative, the Navajo Mine would close. The Pinabete SMCRA Permit area (Areas IV North and South) would not be mined. Burnham Road would not be realigned. Mining in the Navajo SMCRA Mine Permit Area (Areas III and IV North) would continue until the ROD is issued in 2015. Areas I and II, which are also part of the Navajo SMCRA Mine Permit Area, have already been reclaimed and no new mining would occur in these areas. Upon permit expiration, NTEC would begin reclamation activities in Areas III and IV North. Reclamation activities would continue until OSMRE provides approval that all requirements have been met. It is expected that all reclamation would be completed by June 2021. All ancillary buildings and facilities (e.g., communication lines, railroad) would be removed and the land would be reclaimed.

Under the No Action Alternative, two known significant paleontological resources would be impacted within the pre-2016 striplines of Area III. Localities 30 and 42 found during the 1974 survey of the Navajo Mine Lease Area are located in two portions of Area III that would be mined under the current SMCRA permit that expires in 2016. Locality 30 contains a bed of freshwater shells with turtle bone fragments and dinosaur bone fragments above and below it. Locality 42 contains an abundance of fossil wood and reptile bone fragments including dinosaur bones and turtle shell. The destruction of, or damage to, these significant localities would be considered a major impact to paleontological resources. However, an inadvertent discoveries plan is part of the condition of the Navajo Mine SMCRA permit. Therefore, while ground-disturbing activities associated with the Project may damage or destroy paleontological resources; these protocols would ensure that the Navajo Nation is not deprived of the opportunity to realize benefits from these ITAs.

Four Corners Power Plant

Topography, Soils Geology, and Mineral Resources

Under the No Action Alternative, Units 4 and 5 of the FCPP would shut down in 2016 and soon after be decommissioned. The DFADA would not be constructed under the No Action Alternative. Soil disturbance would occur during reclamation of the decommissioned facilities and ash disposal area. This would be a

short-term minor impact. Reclamation activities would not impact topography, geology, or mineral resources within the area of the FCPP.

Paleontological Resources

Under the No Action Alternative, Units 4 and 5 would be shut down when the lease expires in 2016. The plant facilities would be decommissioned and dismantled if the current lease were allowed to expire and the units were shut down. The three switchyards would also be decommissioned and dismantled.

Under the No Action Alternative, no known significant paleontological resource within the current FCPP Lease Area would be affected (see Table 4.3-1).

Transmission Lines

Topography, Soils Geology, and Mineral Resources

Under the No Action Alternative, the ROW would not be approved and the transmission lines would be decommissioned, dismantled, or left in place. If the transmission lines were dismantled, erosion could occur during construction activity. However, decommissioning would be addressed under its own set of permits and approvals and BMPs and mitigation measures would be put in place to minimize erosion to the extent feasible. As such, no impacts to topography, soils, geology, or mineral resources are anticipated under Alternative E.

Paleontological Resources

Under the No Action Alternative, no known significant paleontological resources within the current ROWs of the four transmission lines would be affected (see Table 4.3-1) because no previously undisturbed areas would be affected.

4.3.5 Earth Resources Mitigation Measures

Impacts to geology, soils, minerals, and paleontological resources as a result of the Proposed Action, including the continuing operations of Navajo Mine, FCPP, and the transmission lines, would not result in major adverse impacts. The Project Applicants have proposed measures that would be implemented to reduce or eliminate some of the environmental impacts of the Proposed Action. These measures include specific practices or standard operating procedures that reduce or avoid environmental impacts, and BMPs for specific activities. These are described in Section 3.2.6.3. These measures are part of their application materials and are enforceable through permit or lease conditions. In addition, the Project Applicants must comply with additional protective regulatory requirements including laws, ordinances, regulations, and standards that are enforceable by the responsible agency over that activity. These are described in the Regulatory Compliance Framework (Section 4.3.1). If the environmental analysis in this EIS recommends additional protective measures, over and above the applicant proposed measures and regulatory compliance, they would be listed below as specific mitigation measures. Since no major adverse impacts to geology, soils, minerals, and paleontological resources have been identified, no additional mitigation measures are recommended.

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