TABLE 3.1-12 CLASS I VISIBILITY IMPACT RESULTS		
Modeled Year	Maximum 24-Hour Visibility Decrease at Grand Canyon National Park (%)	Maximum 24-Hour Visibility Decrease at Sycamore Canyon (%)
1993	2.54	2.44
1994	2.51	2.47
1995	3.25	2.98
1996	**3.40**	**3.20**
1997	**3.40**	**3.20**

Bold face entries indicate the year with highest predicted visibility impact.

TABLE 3.1-13 CLASS II AND HUALAPAI LANDS VISIBILITY IMPACT RESULTS				
Modeled Year	Maximum 24-Hour Visibility Decrease (%)			
	Mount Nutt Peach Springs (Hualapai Reservation)	Warm Springs Wabayuma Swansea Rawhide Mountains Tres Alamos	Aubrey Peak Hualapai Tribal Lands	Arrasta Mountains Upper Burro Creek
1993	2.88	3.15	2.23	1.06
1994	2.84	**4.78**	2.56	3.02
1995	2.97	4.11	**3.04**	**3.54**
1996	3.38	4.39	2.25	2.03
1997	**3.45**	4.26	2.57	2.72

Bold face entries indicate the year with highest predicted visibility impact.

TABLE 3.1-14 CLASS I DEPOSITION RESULTS				
Modeled Year	Maximum 24-Hour Acid Deposition (kilograms/hectare)			
	Maximum 24-Hour Deposition at Grand Canyon National Park (kilogram/hectare)		Maximum 24-Hour Deposition at Sycamore Canyon (kilogram/hectare)	
	Nitrogen	Sulfur	Nitrogen	Sulfur
1993	0.000424	0.0000366	0.000405	0.0000347
1994	0.000408	0.000030	0.000408	0.0000275
1995	**0.000495**	**0.0000431**	**0.000484**	**0.0000433**
1996	0.000374	0.0000277	0.000326	0.0000255
1997	0.000374	0.0000277	0.000326	0.0000255

Bold face entries indicate the year with highest predicted deposition impact.

TABLE 3.1-15 BLM CLASS II WILDERNESS AND HUALAPAI LANDS DEPOSITION RESULTS								
	Maximum 24-Hour Acid Deposition (kilograms/hectare)							
Modeled Year	Mount Nutt Peach Springs (Hualapai Reservation)		Warm Springs Wabayuma Swansea Rawhide Mountains Tres Alamos		Aubrey Peak Hualapai Tribal Lands		Arrasta Mountains Upper Burro Creek	
	Nitrogen	Sulfur	Nitrogen	Sulfur	Nitrogen	Sulfur	Nitrogen	Sulfur
1993	**0.000823**	0.000060	0.000906	0.000077	0.000997	0.000119	0.00209	0.000282
1994	0.000615	0.000050	0.000794	0.000077	0.00127	0.000116	0.00191	0.00020
1995	0.000674	**0.000064**	0.00111	0.000111	0.00114	0.000150	**0.00323**	**0.000336**
1996	0.000669	0.000055	**0.00126**	**0.000121**	0.00109	0.000139	0.00151	0.000176
1997	0.000633	0.000051	0.00106	0.000095	**0.00176**	**0.000187**	0.00292	0.000288

Bold face entries indicate the year with highest predicted deposition impact.

cations) and other baseline levels for environmental parameters have not been developed for the area surrounding the proposed power plant site to allow such comparisons. However, the predicted deposition rates for the Project are small, in part because of the distance to the Class I areas. Consequently, the contribution to the sulfur and nitrogen loading resulting from long-range transport from the distant Project is very small compared to the natural processes that replenish the soil reservoirs of nitrogen and sulfur species, and not significant.

Global Warming Impact

The combustion turbines selected for the proposed Project are state-of-the-art natural gas combined-cycle technology that emphasize high fuel efficiency expressed by the "heat rate" of the combined-cycle generating process. They are the highest efficiency fossil fuel combustion power plants currently available in their class, and produce the least greenhouse gas per MW of electricity per BTU of fossil fuel consumed.

SF_6, a potent greenhouse gas, would be used in substation circuit breakers. The equipment is sealed and certified to not release SF_6 gas. At the time of servicing, SF_6 gas is evacuated using sealed gas containment equipment, thereby remaining totally contained.

Communication Facilities

OPGW installation activities would not be expected to have a significant impact on regional air quality due to the limited time frame and extremely small areal extent (500 to 1,000 linear feet) of construction activity.

The microwave dishes would be installed on existing towers and would have no impact on air quality.

Alternative R and T Gas Pipeline Corridors

The lengths of the Alternative R and T gas pipeline corridors are comparable to that for the Proposed Action, and these corridors do not run substantially closer to potentially sensitive receptors, Class I areas, or Class II areas. Therefore, there is no identifiable difference in the anticipated air quality impact between the Proposed Action and the alternative pipeline corridors.

No-Action Alternative

If the Proposed Action were not to occur there would be no impact on the existing air quality.

3.1.2.6 Mitigation and Residual Impacts

No significant impacts would result from the implementation of the Proposed Action with the actions incorporated to reduce or prevent impacts. No additional measures to mitigate significant impacts have been identified for air resources and there would be no residual significant impacts.

3.2 GEOLOGY/PALEONTOLOGY

This section describes the affected environment and environmental consequences as they apply to geological and paleontological resources in the vicinity of the Proposed Action.

3.2.1 Affected Environment

The following sections describe the current geological and paleontological environment. The description of current conditions represents the baseline for the assessment of impacts and environmental consequences.

3.2.1.1 Region of Influence

The region of influence for assessing impacts on geological and paleontological resources includes the proposed power plant site, well sites, access roads, rights-of-way where ground-disturbing activities could occur, agricultural areas, OPGW installation sites, the proposed or alternative pipeline corridors (R, T, or crossover segment C2), and the adjacent parcels of land.

3.2.1.2 Existing Conditions

The proposed power plant site is located within the southeastern portion of the Big Sandy groundwater basin, which is part of the Basin and Range physiographic province of northwestern Arizona. The Basin and Range physiographic province is characterized by fault block mountain ranges separated by aggraded desert plains (Figure 3.2-1).

The Big Sandy basin generally trends north-south and is bounded by the Hualapai and McCracken mountains to the west; Aquarius Cliffs and Aquarius Mountains to the east; and Cottonwood and Peacock mountains to the north. To the north, a divide in the Peacock Mountains separates the Big Sandy basin from the Hualapai valley to the west. To the south, a granitic gorge separates the Big Sandy basin from the Burro Creek drainage basin.

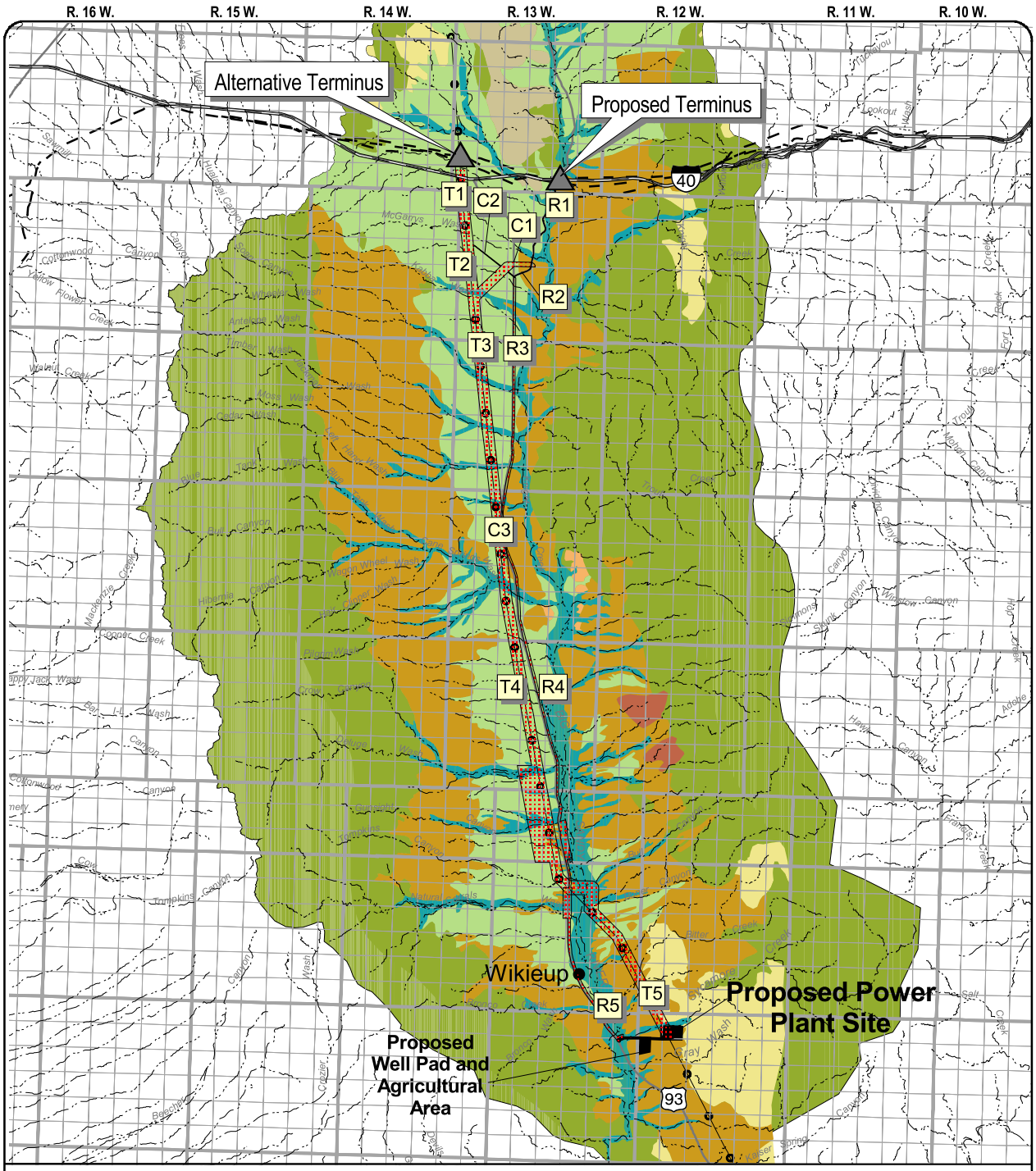
The proposed power plant site is located on a terrace approximately 2 miles east of the Big Sandy River. The elevation of the site ranges from 2,060 to 2,250 feet, and the ground surface generally slopes to the south at between 4 and 40 percent. The site is crossed by several ephemeral drainages that are tributaries to Gray Wash, which is a westerly flowing tributary to the Big Sandy River.

Geological Resources

The geology of the Big Sandy groundwater basin within the region of influence can be separated into the following seven units, from youngest to oldest:

- stream and floodplain deposits
- upper basin fill
- lower basin fill (includes the Big Sandy Formation, which constitutes the upper member of this unit)
- basaltic volcanic rocks
- volcanic rocks of Sycamore Creek
- arkosic gravels and conglomerate
- granitic gneiss

Detailed descriptions of these units, their thickness and extent, and their relationships, including geologic cross-sections, are provided in Caithness' water resources (Caithness 2000a)



Legend

Resource Components

- QTg - Terrace Gravel
- Qal - Stream and Floodplain Alluvium
- Qbu - Upper Basin Fill
- Ta - Arkosic Gravel
- Tb - Basalt Flows
- Tbl - Lower Basin Fill
- Tv - Volcanic Rocks of Sycamore Creek
- Pcg - Granitic Gneiss

Project Components

- Pipeline Corridor Segments
- Proposed Pipeline Corridor - R1, C1, T3, C3, T4, R5
- Alternative R Corridor - R1, R2, R3, C3, R4, R5
- Alternative T Corridor - T1, T2, T3, C3, T4, T5
- Proposed Plant Facilities

General Reference

- Existing Pipelines
- Mead-Liberty/Mead-Phoenix Transmission Lines
- Stream/River
- Interstate
- U.S. Route

0 5

Scale in Miles

Universal Transverse Mercator Projection
1927 North American Datum
Zone 12

N

Geologic Map of the Big Sandy Basin

Big Sandy Energy Project EIS

x:/bigsandy/projects/surfacewater.apr

Figure 3.2-1

and geology reports (Caithness 2000b); a previous water resources study of the Big Sandy area (Davidson 1973); the *Big Sandy Energy Project Groundwater Technical Report* (Appendix F); and in the Hydrogeologic Units and Model Development discussion in Section 3.4.

The proposed power plant site is situated on lower basin fill just west of the contact with the volcanic rocks of Sycamore Creek. The surface geology of the site consists of a minimum 30-foot-thick layer of silty sand to sandy clay material designated as partially cemented weathered volcanic ash or tuff that likely is derived from volcanic rocks that crop out upgradient of the site (Western Technologies, Inc. [Westech] 2000). These surface deposits likely are underlain by lacustrine clays, which represent the upper member of the lower basin fill unit.

Hard-rock mining for gold, silver, copper, and allied minerals historically has occurred in the Hualapai Mountains to the west and northwest of the proposed power plant site; however, most of these mines are inactive. Arizona Green Sands has an active mining operation in the southeast corner of Section 7, Township 15 North, Range 12 West (T15N, R12W) (Figure 3.2-2). This is a small surface mine that extracts a group of minerals known as zeolites from the surface clays, which are part of the exposed upper member of the lower basin fill. Numerous small sand and gravel operations exist along the Big Sandy River, which exploit the stream and floodplain deposits for construction of roads and other projects. There are no known significant coal, oil, or natural gas resources, or known potential mineral resource development areas of economic importance, within the region of influence.

Geologic Hazards

Potential geologic hazards that exist within the region of influence include earthquakes, mass movements (e.g., slope failures, slumps, rockfalls), expansive soils, and flash floods. The region of influence lies within seismic risk Zone +2, which is characterized as moderate risk.

A total of 13 earthquakes were reported to have occurred within Mohave County since 1891, with the greatest having a magnitude of approximately 5.75 on the Richter scale. The Richter scale is a common method of classifying earthquake severity, which uses a logarithmic measure of the maximum motions of the seismic waves as recorded by a seismograph. A search of the U.S. Geological Survey (USGS) National Earthquake Information Center (NEIC) database (1999) indicates that two significant earthquake events occurred within a 100-kilometer radius of the proposed power plant site. The largest event had a magnitude of 4.6 on the Richter scale.

The maximum impact that can be expected to occur at the proposed power plant site is moderate damage from an earthquake with an intensity of 7 (scale from 1 to 12) on the Modified Mercalli Intensity (MMI) scale. The MMI scale is the method used most often to classify earthquake intensity. The higher the number, the greater the associated ground-shaking intensity and/or damage. Earthquakes have varying intensities that generally decrease with increasing distance from the source (Bausch and Brumbaugh 1997).

The potential for mass movement is mainly restricted to the steep slopes along the northern margin of the proposed power plant site. In this area, there is a potential for rockfalls and slope failure. Figures 3.3-5, 3.3-6, and 3.3-7 in Section 3.3 show areas of slopes exceeding 20 percent in the vicinity of the proposed power plant site and proposed or alternative pipeline corridors (R, T, or crossover segment C2). Hazards from expansive soils exist in areas where proposed Project-related structures would be constructed on clayey soils, and particularly where these soils are hydrated due to poor drainage or the presence of springs/seeps (Westech 2000). Flash flood hazards exist within the washes that drain the site, with the highest potential to occur

during the monsoon season between July and September.

Paleontological Resources

One of the geological units in the Big Sandy Valley is the Big Sandy Formation, which is a sequence of lake-deposited sediments interbedded with volcanic ash, marginal sandstone, and conglomerate. These deposits are exposed within an area of approximately 20 square miles. The deposits are up to 65 meters thick in the center of the basin, but thin to only a few meters at the basin margins.

Vertebrate fossils have been found at two localities within a 4- to 5-meter-thick horizon of the Big Sandy Formation. These fossils are of Late Miocene to Early Pliocene age (about 5 million years old). A number of research institutions have made collections from these quarries and recovered a diversity of land mammal and bird fossils. The avian fossils are characterized as the most significant pre-Pleistocene bird assemblage in North America.

The two studied fossil quarries at both of these localities are about 3 miles south of the proposed power plant site. The plant site, well field, new access road, plus the southern 6 to 7 miles of the proposed and alternative pipeline corridors (parts of corridor segments T4, T5, R4, and R5) and the route of OPGW installation are within areas where the Big Sandy Formation is exposed or buried at shallow depth. A field survey was conducted in these areas. Although the survey did not encompass the full width of the proposed and alternative pipeline corridors, the results can be interpolated to the entire width of the corridors with two exceptions. The eastern portions of corridor segment T5 at the crossings of Sycamore Creek and Bitter Creek would warrant additional survey if that corridor segment were selected for construction of the pipeline (Archer 2000).

The survey discovered previously unreported plant fossils in the form of root casts (probably of aquatic or semi-aquatic plants) and stromatolites (algal clumps) within the proposed power plant site. These fossils are indicative of a shallow, near-shore lake environment. Further study of the root casts and stromatolite fossils would not yield important information (Archer 2000).

The ancient lake that formed within the Big Sandy Valley apparently had little through-flow or was completely blocked from draining at times and became highly saline. The salty water was unlikely to have supported abundant life. The two known fossil localities apparently represent rare situations where mammals and birds either died near the edge of the lake and were quickly buried, or died along adjacent freshwater streams and their bones were washed into the lake. Potential lake inlets that might represent such rare situations have been noted north of the proposed power plant site and to the east of the Mead-Phoenix Project 500-kV transmission line along Sycamore Creek and Bitter Creek.

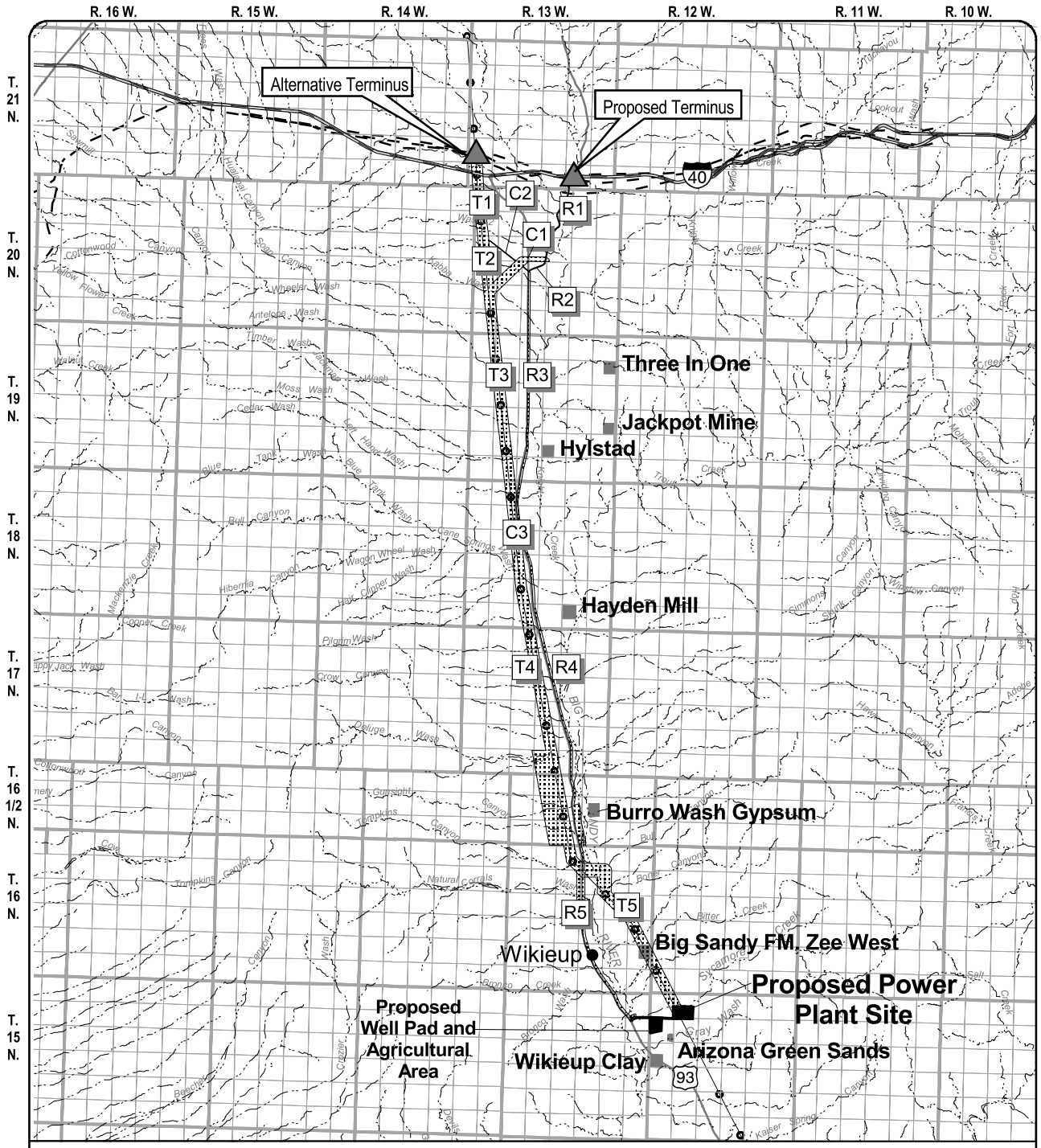
3.2.2 Environmental Consequences

The following sections outline the environmental issues related to geology and paleontology, significance criteria, and methodology and conclusions of the impact assessment. Also described are mitigation measures that could be implemented to prevent significant impacts on geological and/or paleontological resources.

3.2.2.1 Identification of Issues

The following is a list of issues that were identified as relating to geology and paleontology; these issues form the basis for the assessment of potential impacts:

- potential impacts on areas of regional geological importance
- potential impacts on paleontological resources (fossils) of scientific importance



Legend

Resource Components

Active Mining Operations

Project Components

Pipeline Corridor Segments
Proposed Pipeline Corridor - R1, C1, T3, C3, T4,R5
Alternative R Corridor - R1, R2, R3, C3, R4, R5
Alternative T Corridro - T1, T2 T3, C3, T4, T5

General Reference

Existing Pipelines
Mead-Liberty/Mead-Phoenix Transmission Lines
Stream/River
Interstate
U.S. Route

0 5 10

Scale in Miles

Universal Transverse Mercator Projection
1927 North American Datum
Zone 12

N

Map of Active Mining Operations

Big Sandy Energy Project EIS

x:/bigsandy/projects/mining.apr

Figure 3.2-2

- potential impacts on mining operations or areas of potential mineral resource development of economic importance

- potential impacts on the influences of geologic hazards (e.g., slope failure)

- potential for land subsidence due to groundwater withdrawal

3.2.2.2 Significance Criteria

Listed below are the significance criteria established for the identified issues. Impacts would be considered significant if they would result in the following:

- destruction of or future inaccessibility to areas of regional geological importance

- destruction of or future inaccessibility to scientifically important paleontological resource areas

- destruction of or future inaccessibility to potential mineral resource development areas of economic importance

- adverse impacts on existing mining operations that could not be mitigated

- a substantial increase in the probability or magnitude of mass movements (e.g., slope failures, slumps, rockfalls) or impacts on lands or humans from earthquakes that could be attributed to the Proposed Action.

3.2.2.3 Impact Assessment Methods

In order to assess potential impacts on geological and paleontological resources within the region of influence, available information was compiled related to geological, paleontological, and mineral resources; and geologic hazards. All relevant reports prepared by Caithness and its consultants were reviewed in order to independently evaluate and verify the accuracy and comprehensiveness of information provided by Caithness, and, where necessary, supplement this information.

After data were compiled and reviewed, and the information provided was verified, potential direct and indirect impacts on geological and paleontological resources were assessed. Particular consideration was given to the identified issues, and the significance criteria described in Section 3.2.2.2 were used to assess whether significant impacts potentially could occur.

3.2.2.4 Actions Incorporated Into the Proposed Action to Reduce or Prevent Impacts

The Proposed Action includes the following measures to reduce or prevent potential adverse environmental impacts on geological resources:

- erosion control measures on slopes (waterbars, diversion ditches, riprap, revegetation)

- compliance with UBC Seismic Zone 2b construction practices.

3.2.2.5 Impact Assessment

Proposed Action

The assessment of impacts on geological and paleontological resources is described below in terms of the significance criteria outlined in Section 3.2.2.2.

Geological Resources

There are no areas of geological importance within the region of influence. Therefore, no areas of geological importance would be destroyed or made inaccessible by the Proposed Action.

There are no known potential mineral resource development areas of economic importance within the region of influence of the Proposed

Action. Thus, the Proposed Action would not destroy nor make inaccessible any such areas.

The Proposed Action would not impact any existing mining operations. The active zeolite mine in the southeast corner of Section 7, T15N, R12W, would not be impacted by the Proposed Action, and only a very small portion of the valley's sand and gravel resources would be removed from potential development through construction of the proposed power plant, substation, and evaporation ponds. The potential economic impact of this is insignificant.

The Proposed Action would not cause a substantial increase in the probability or magnitude of mass movements. The Proposed Action requires that areas of substantial cut or fill be engineered to ensure stability, which is a common construction practice. No substantial increase in impacts on lands or humans would occur as a result of the Proposed Action because structures would comply with Uniform Building Code (UBC) Seismic Zone 2b construction practices.

There would be no potential for land subsidence as a result of groundwater withdrawal for the Proposed Action. Groundwater would be pumped solely from the volcanic aquifer, from a depth of approximately 1,000 to 1,500 feet below ground surface. The volcanic aquifer is confined, and relatively isolated from overlying aquifers. It has been estimated that groundwater levels in the volcanic aquifer may decline by as much as 85 feet as a result of groundwater pumping, and that groundwater levels in the overlying middle aquifer may decline by as much as 12 feet (refer to Section 3.4). Because the volcanic and middle aquifers are confined and have high confining pressures, these impacts would be expressed as a decrease in confining pressure. Since the aquifers would not be dewatered and become unconfined, subsidence would not occur. Furthermore, the volcanic and middle aquifers both consist of relatively incompressable materials. Pulling and tensioning sites for the OPGW would not impact any geologic resources. The sites would not impact any existing mining operations, or substantially increase the probability or magnitude of mass movements. Similarly, the installation of the microwave dishes on existing structures would have an insignificant effect on geologic resources.

Paleontological Resources

Although significant vertebrate fossils have been found within portions of the Big Sandy Formation, no significant fossils have been found or would be expected within the areas to be disturbed based on the surveys conducted. Pulling and tensioning sites for the installation of the OPGW may be located in areas not surveyed. If scientifically important paleontological resources were found there, their destruction as a result of the construction of the OPGW would be considered a significant impact. The microwave dishes would be installed on existing towers and would have no impact on paleontological resources.

Alternative R Gas Pipeline Corridor

Potential impacts resulting from the Alternative R gas pipeline corridor would be the same as those described for the Proposed Action.

Alternative T Gas Pipeline Corridor

Potential impacts resulting from the Alternative T gas pipeline corridor would be the same as those described for the Proposed Action except that the pipeline may be located in areas not surveyed. If scientifically important paleontological resources were found there, their destruction as a result of the construction of the transmission line would be considered a significant impact.

No-Action Alternative

Under the No-Action Alternative, the Project would not be constructed and there would be no change or disturbance of geological or

paleontological resources within the Big Sandy Valley.

3.2.2.6 Mitigation and Residual Impacts

If adopted, the following measures would be implemented to avoid or reduce significant impacts:

- If unknown invertebrate fossils (or suspected invertebrate fossils) are encountered, construction activities in the immediate area would cease and a qualified paleontologist would be contacted. Construction activities would not re-commence until the area is cleared, or the area is avoided.

- If the eastern portion of corridor segment T5 more than 100 feet east of the Mead-Phoenix Project 500-kV transmission line right-of-way is selected for construction, a paleontological field survey would be conducted at the crossings of Sycamore Creek and Bitter Creek. If significant fossil localities are found in these areas, construction activities would not re-commence until the area is cleared, or the area avoided.

With the implementation of these measures, there would be no residual significant impacts.

3.3 SOILS

This section describes the affected environment and environmental consequences as they relate to soils in the vicinity of the Proposed Action.

3.3.1 Affected Environment

The following sections describe the various soils in the vicinity of the Proposed Action. The location and description of each soil type serves as a baseline for the assessment of environmental consequences, and assists in determining appropriate mitigation measures.

3.3.1.1 Region of Influence

The region of influence for assessing impacts on soils includes the power plant site and ancillary facilities, access roads, rights-of-way where ground-disturbing activities (e.g., water pipelines) could occur, the proposed gas pipeline corridor, the alternate gas pipeline corridors, and the areas of disturbance associated with the potential installation of the OPGW. The region of influence also is considered to be all surface areas that could be impacted by soil erosion.

3.3.1.2 Existing Conditions

Soils in the region of influence were surveyed and mapped by the Natural Resources Conservation Service (NRCS) in 1974. The survey is described by the NRCS as “tentative and subject to revision, correction, or completion,” and has not yet been published. The soils survey data were compiled onto a map and described in the *Big Sandy Energy Project Soils Report* (Caithness 2000).

Figures 3.3-1 through 3.3-4 (taken from the above-named soils report) show 36 soil map units in the region of influence, based on the soils survey data provided by the NRCS. These figures also show locations of steep slopes (greater than 20 percent) and identify four areas along the corridors where steep slopes coincide with soil types that have severe or very severe erosion potential. Mapping of potential pulling and tensioning sites for the OPGW installation was not done, since these have not yet been located.

- The 36 soil map units presented on Figures 3.3-1 through 3.3-4 represent 25 soil types or associations, which are listed in Table 3.3-1 by soil name and associated map unit number(s). Table 3.3-1 includes the description, setting, and parent material of each soil type/association, range in slope, percentage rock fragments, permeability, runoff, depth, drainage, pH, water erosion hazard, wind erosion hazard, and shrink-

swell potential. Table 3.3-1 also indicates whether each soil type falls within the footprint of the proposed power plant site and ancillary facilities, or within any of the pipeline corridor segments. Of the 36 soil map units, 25 are intersected by either the proposed power plant site and/or pipeline corridor segments.

- It should be noted that the 1974 soils survey was not completed in Township 21 North, in corridor segment T1, in the vicinity of I-40. For this area, the NRCS STATSCO database (NRCS 1998) was used to identify the two soil associations included at the end of the bulleted list (Romero-Rock Outcrop-Gila and Continental-Rillino-Gila). The other 23 entries are soil types.

In general, most of the soils within the Project area are classified as gravelly sandy loam derived from alluvium from mixed sources. The soils typically are alkaline, and the percentage of rock fragments is high. Slopes range from 1 to 70 percent. Most soils are deep and well drained, with slow to moderate permeability and slow to medium runoff. Water erosion hazard typically ranges from moderate to severe, whereas wind erosion hazard ranges from slight to moderately high. Shrink-swell potential is low for most soil types.

A preliminary geotechnical evaluation of the proposed power plant site was performed (Westech 2000). The geotechnical report includes detailed descriptions of subsurface soils to depths of 30 feet below ground surface. The report describes the soils at the proposed power plant site as severely corrosive to concrete, and recommends that Type V (or equivalent) sulfate-resistant cement be used.

Some soil types are known to uniquely support special status species. The only known threatened or endangered plant species that is dependent on a unique soil in the region of influence is the Arizona cliffrose, which grows only on Tertiary limestone lakebed deposits and is restricted to the nutrient-poor lakebed clays. There are two small deposits along corridor segment T5 and others may exist.

3.3.2 Environmental Consequences

The following sections outline the environmental issues related to soils, the significance criteria used in assessing impacts, and the methodology and conclusions of the impact assessment. Also described are measures that would be used to prevent significant impacts on soils.

3.3.2.1 Identification of Issues

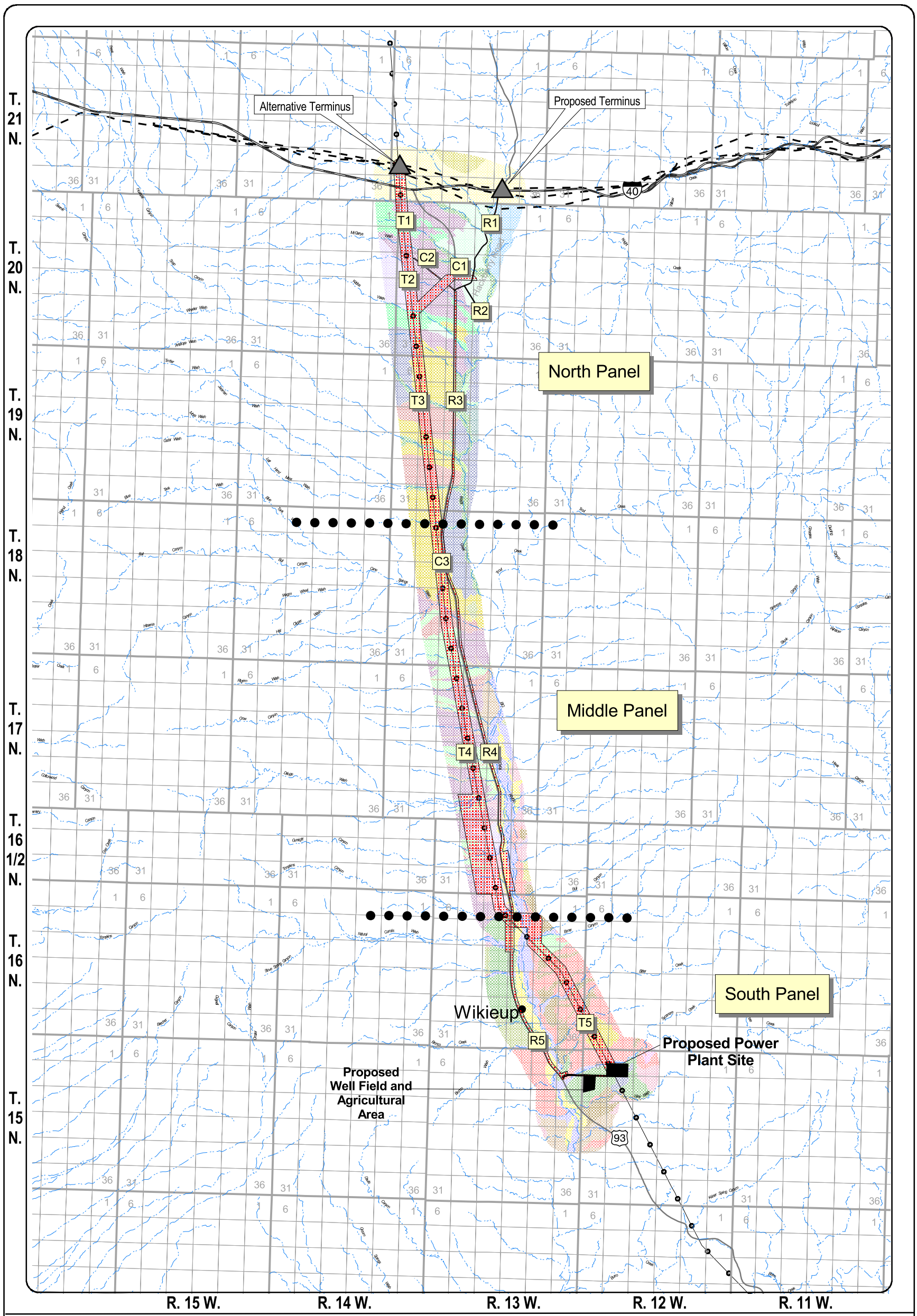
The primary issues related to soils that form the basis for the assessment of potential impacts are as follows:

- potential impacts on soils from wind or water erosion
- potential impacts on soils that uniquely support special status plant species

3.3.2.2 Significance Criteria

The effects of the Proposed Action or alternatives would be considered significant if any of the following were to occur:

- proposed construction on areas of steep slopes (greater that 20 percent) that coincide with soils having a high or severe erosion potential, where mitigation cannot reduce impacts
- loss of soils that uniquely support threatened or endangered plant species
- alterations of stormwater runoff from the Proposed Action that could cause substantial soil erosion



Legend

Soil Types are Indentified on the Individual Soil Panel Maps

Project Components
- Pipeline Corridor Segments
  - Proposed Pipeline Corridor - R1,C1,T3,C3,T4,R5
  - Alternative R Corridor - R1,R2,R3,C3,R4,R5
  - Alternative T Corridor - T1,T2,T3,C3,T4,T5
- Proposed Plant Facilities

General Reference
- Existing Pipelines
- Mead-Liberty/Mead-PhoenixTransmission Lines
- Stream/River
- Interstate
- U.S. Route

0 5
Scale in Miles

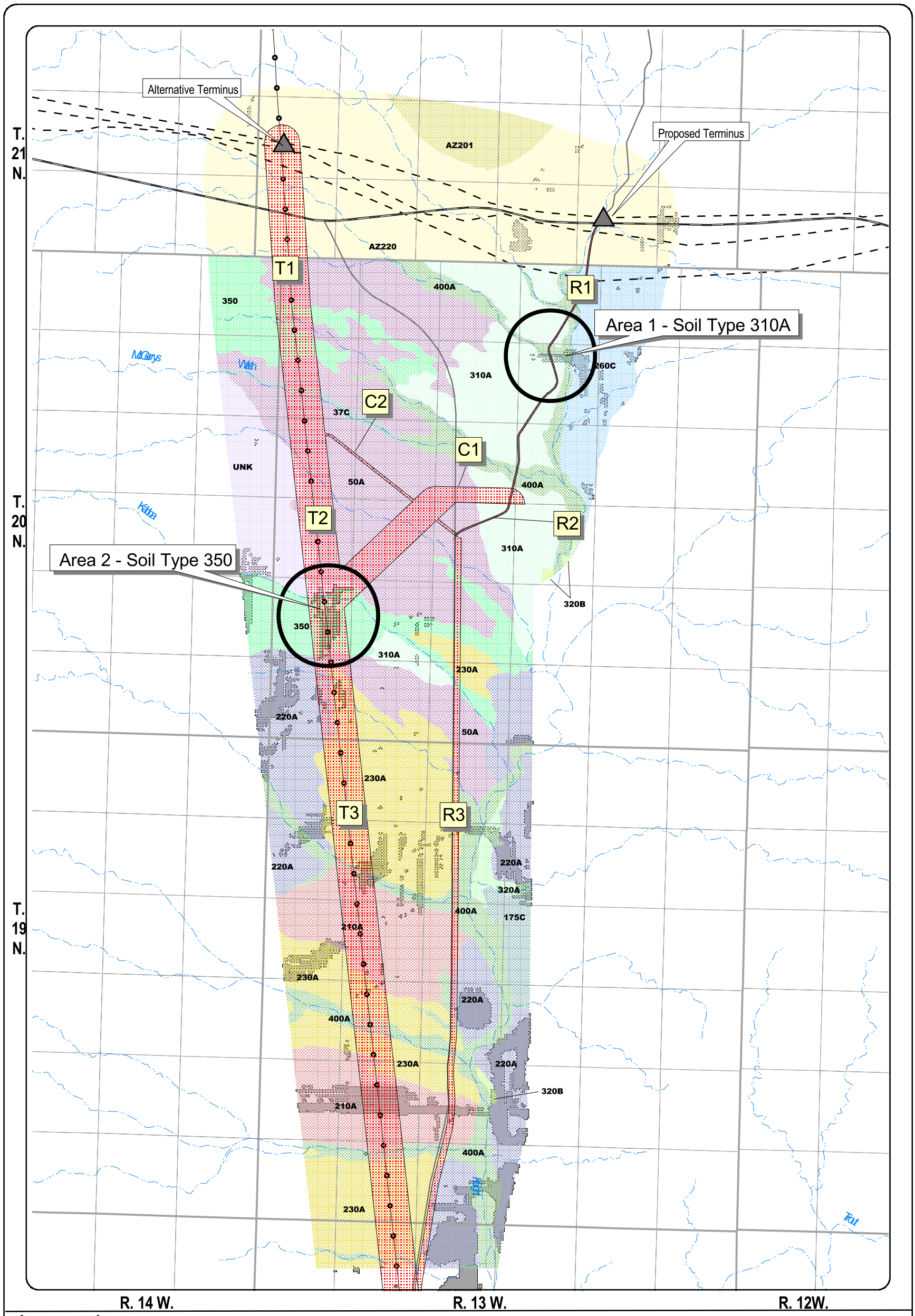
Universal Transverse Mercator Projection
1927 North American Datum
Zone 12

N

Soils Key Map
Big Sandy Energy Project EIS

Figure 3.3-1

x:/bigsandy/projects/Soils.apr



Legend

Resource Components

- 175C Wikieup-Rock outcrop complex, 20-60 percent slopes
- 210A Vekol gravelly loamy sand, dry, 2-7 percent slopes
- 220A Nickel-Topawa family-Eba family complex, 10-50 percent slopes
- 230A Mohon-Kinley complex, 2-5 percent slopes
- 260C Goodsprings gravelly loam, 10-5 percent slopes
- 310A Kinley gravelly loamy sand, 15-35 percent slopes
- 320A Gila-Glendale complex, 1-3 percent slopes
- 320B Gila-Glendale complex, 1-3 percent slopes
- 350 White House family very gravelly loamy sand, 2-15 percent slopes
- 37C Arizo-Franconia-Riverwash complex, 1-3 percent slopes
- 400A Ireteba-Arizo complex, 1-3 percent slopes
- 50A Dutchflat fine sandy loam, 1-3 percent slopes
- AZ201 Romero-Rock Outcrop-Tombstone
- AZ220 Continental-Rillino-Gila
- UNK
- Areas of Slope Greater than or Equal to 20%

Project Components

- Pipeline Corridor Segments
  - Proposed Pipeline Corridor - R1,C1,T3,C3,T4,R5
  - Alternative R Corridor - R1,R2,R3,C3,R4,R5
  - Alternative T Corridor - T1,T2,T3,C3,T4,T5
- Proposed Plant Facilities

General Reference

- Existing Pipelines
- Mead-Liberty/Mead-PhoenixTransmission Lines
- Stream/River
- Interstate
- U.S. Route

Scale in Miles: 0 1 2

Universal Transverse Mercator Projection
1927 North American Datum
Zone 12

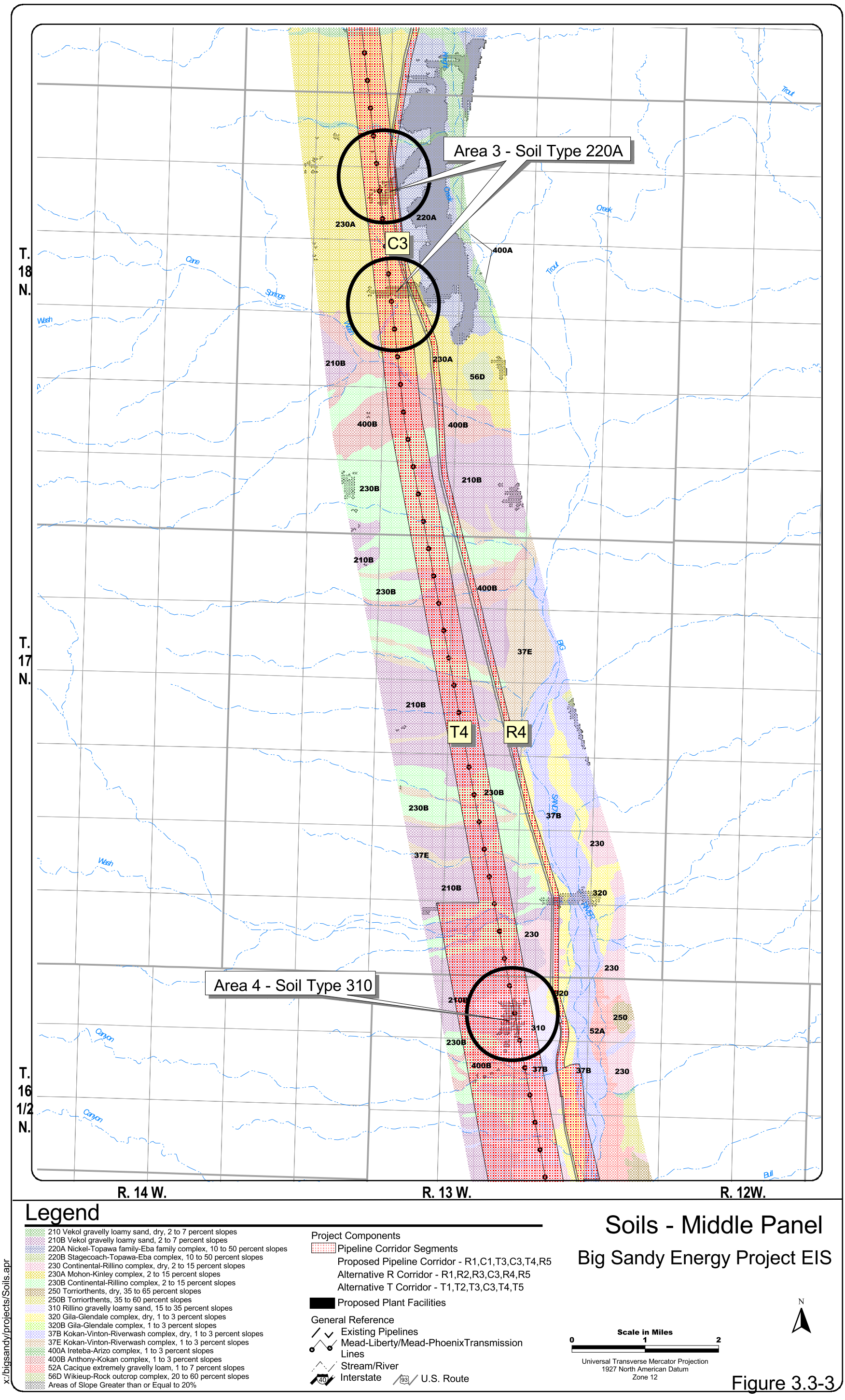
N

Soils - North Panel

Big Sandy Energy Project EIS

Figure 3.3-2

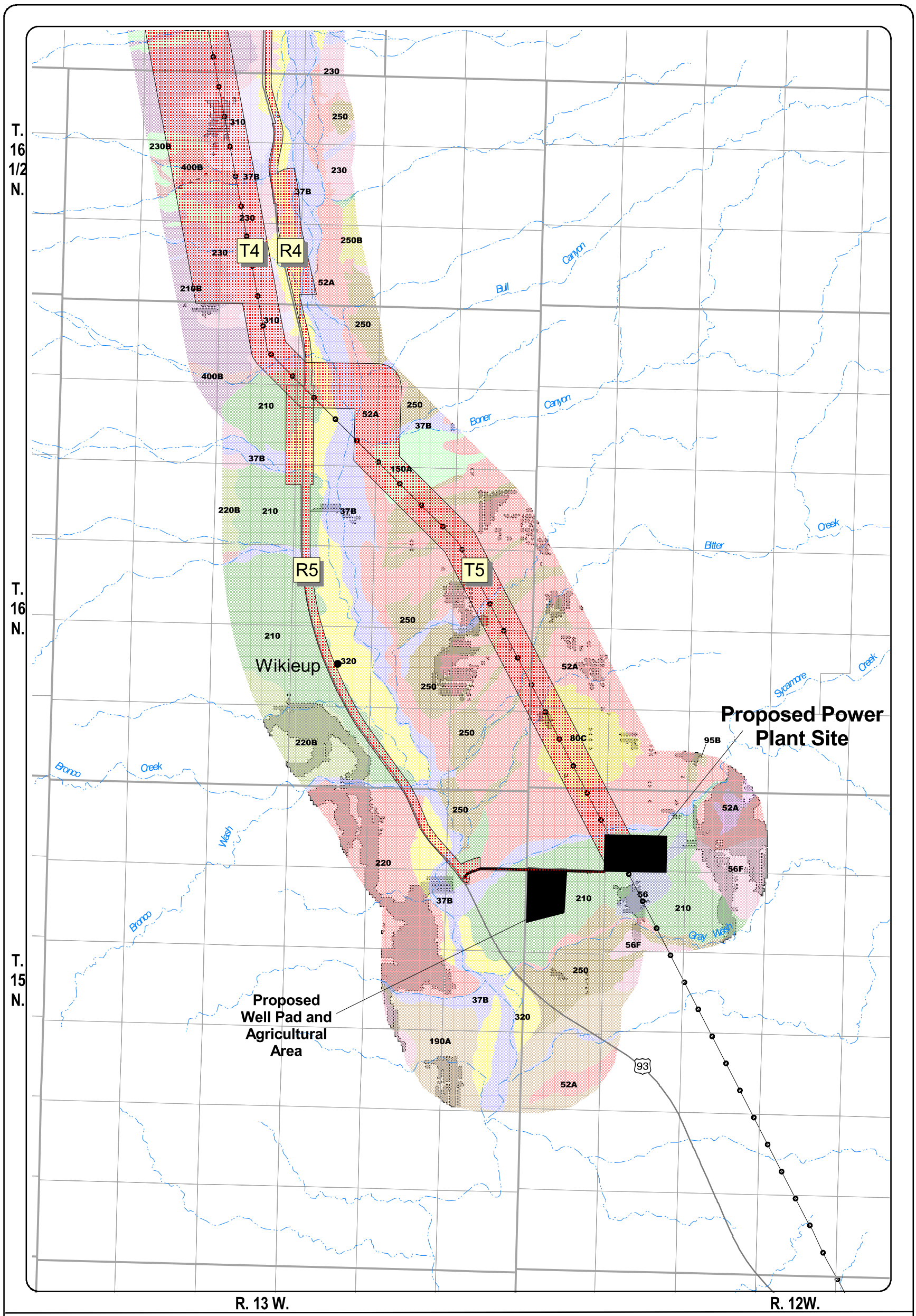
x:/bigsandy/projects/Soils.apr



Soils - Middle Panel

Big Sandy Energy Project EIS

Figure 3.3-3



Legend

- 150A Continental-Dona Ana complex, dry, 2 to 15 percent slopes
- 190A Stagecoach very gravelly sandy loam, dry, 5 to 35 percent slopes
- 210 Vekol gravelly loamy sand, dry, 2 to 7 percent slopes
- 210B Vekol gravelly loamy sand, 2 to 7 percent slopes
- 220 Stagecoach-Topawa-Eba complex, dry, 10 to 50 percent slopes
- 220B Stagecoach-Topawa-Eba complex, 10 to 50 percent slopes
- 230 Continental-Rillino complex, dry, 2 to 15 percent slopes
- 230B Continental-Rillino complex, 2 to 15 percent slopes
- 250 Torriorthents, dry, 35 to 65 percent slopes
- 250B Torriorthents, 35 to 60 percent slopes
- 310 Rillino gravelly loamy sand, 15 to 35 percent slopes
- 320 Gila-Glendale complex, dry, 1 to 3 percent slopes
- 37B Kokan-Vinton-Riverwash complex, dry, 1 to 3 percent slopes
- 400B Anthony-Kokan complex, 1 to 3 percent slopes
- 52A Cacique extremely gravelly loam, 1 to 7 percent slopes
- 56 Cellar-Rock outcrop complex, dry, 20 to 60 percent slopes
- 56F Cellar-Rock outcrop complex, 20 to 60 percent slopes
- 80C Cline very stony loam, dry, 2 to 15 percent slopes
- 80F Cline very stony loam, dry, 40 to 70 percent slopes
- 95B Alela-Rock outcrop-Rubble land complex, dry, 40-70 percent slopes
- Areas of Slope Greater than or Equal to 20%

Project Components

- Pipeline Corridor Segments
  - Proposed Pipeline Corridor - R1,C1,T3,C3,T4,R5
  - Alternative R Corridor - R1,R2,R3,C3,R4,R5
  - Alternative T Corridor - T1,T2,T3,C3,T4,T5
- Proposed Plant Facilities

General Reference

- Existing Pipelines
- Mead-Liberty/Mead-PhoenixTransmission Lines
- Stream/River
- Interstate
- U.S. Route

Scale in Miles: 0 1 2

Universal Transverse Mercator Projection
1927 North American Datum
Zone 12

Soils - South Panel

Big Sandy Energy Project EIS

N

Figure 3.3-4

x:/bigsandy/projects/Soils.apr

TABLE 3.3-1
SOILS

Map Unit No.	Intersected by Pipeline or Plant Site	Soil Name	Soil Description and Setting	Slope (%)	Parent Material	Rock Fragments (%)	Permeability	Runoff	Depth and Drainage	pH	Water Erosion Hazard	Wind Erosion Hazard	Shrink-Swell Potential
150A	T5	Continental - Dona Ana Complex	Gravelly sandy loam to clay loam formed on alluvial fans and fan terraces (50 percent Continental, 25 percent Dona Ana).	2 – 15	alluvium from sedimentary and igneous rocks	<15	slow to moderate	slow to medium	deep, well drained	slightly acid to moderately alkaline	moderate	slight	moderate to high
175C	--------	Wikieup-Rock Outcrop Complex	Extremely cobbly coarse sandy loam formed on hills and mountains.	20 – 60	alluvium and colluvium from igneous and metamorphic rocks	35 – 70	moderately rapid	very rapid	very shallow to shallow, well drained	slightly to moderately alkaline	severe	slight	low
56D	--------												
190A	--------	Stagecoach	Very gravelly sandy loam formed on fan terraces.	5 – 35	alluvium from mixed sources	35 – 85	moderately rapid	medium	very deep, well drained	slightly to strongly alkaline	slight	slight	low
210	PS, R4, R5, T5	Vekol	Gravelly loamy sand formed on basin floors.	2 – 7	alluvium from mixed sources	0 – 50	slow	slow	deep, well drained	moderately alkaline	moderate	moderately high	high
210A	R3, T3												
210B	R4, T4												
220	R5	Stagecoach-Topawa-Eba Complex	Very gravelly sandy loam formed on fan terraces (35 percent Stagecoach, 30 percent Topowa, 25 percent Eba).	10 – 50	alluvium from mixed sources	35 – 85	slow to moderately rapid	slow to medium	very deep, well drained	slightly to strongly alkaline	severe	slight	low to high
220B	--------												
220A	C3, R3, T3	Nickel-Topawa Family-Eba Family Complex	Gravelly sandy loam formed on fan terraces, erosional fan remnants, and alluvial flats (35 percent Nickel, 30 percent Topawa, 25 percent Eba).	10 - 50	alluvium from mixed igneous and metamorphic sources	35 – 75	slow to moderately slow	slow to medium	very deep, well drained	neutral to strongly alkaline	severe to very severe	slight	low to high
230	R4, T4	Continental-Rillino Complex	Gravelly sandy loam to gravelly fine sandy loam formed on fan terraces (50 percent Continental, 35 percent Rillino).	2 – 15	alluvium from mixed sources	15 – 35	slow to moderate	slow to medium	very deep, well drained	slightly acid to moderately alkaline	moderate	slight	low
230B	R4, T4												
230A	C3, R3, R4, T3, T4	Mohon-Kinley Complex	Gravelly sandy loam to very cobbly loam formed on fan terraces (50 percent Mohon, 35 percent Kinley).	2 – 15	alluvium from volcanic rocks and mixed sources	0 – 35	slow to moderately rapid	medium	very deep, well drained	slightly to moderately alkaline	moderate	slight to moderately high	low
250	T5	Torriorthents	Soils formed on the distal portions of fans and lake-bed deposits.	35 – 65	alluvium from fans and lake-bed deposits		variable	very rapid	variable depth, well drained	--------	very severe	slight	variable
250B	--------												
260C	R1	Goodsprings	Gravelly loam formed on alluvial fans and valley-fill plains.	10 – 35	alluvium from limestone and sandstone	15 – 35	moderate	medium to rapid	shallow, well drained, soil over a lime-cemented hardpan	moderately to very strongly alkaline	severe	slight	low
310	R4, T4	Rillino	Gravelly loamy sand formed on fan terraces.	10 – 35	alluvium from mixed sources	15 – 35	moderate	rapid	deep, well drained	moderately alkaline	severe	moderately high	low
310A	C1, R1, R2, R3	Kinley	Gravelly sandy loam formed on fan terraces.	15 – 35	alluvium from mixed sources	15 – 35	moderately rapid	medium to rapid	very deep, well drained	slightly to moderately alkaline	severe	moderately high	low
320	R4, R5, T5	Gila-Glendale Complex	Loam formed on alluvial fans and floodplains (50 percent Glendale, 30 percent Gila).	1 – 3	stratified alluvium from mixed sources	0 – 15	moderate	slow	deep, well drained	neutral to very strongly alkaline	moderate to moderately high	moderate to moderately high	moderate
320A	--------												
320B	--------												
350	C1, R3, T1, T2, T3	White House Family Loamy Sand	Very gravelly loamy sand formed on fan terraces.	2 – 15	alluvium from mixed sources	<35	slow to very slow	slow to medium	very deep, well drained	moderately acid to moderately alkaline	slight to severe	slight to moderately high	high

TABLE 3.3-1
SOILS

Map Unit No.	Intersected by Pipeline or Plant Site	Soil Name	Soil Description and Setting	Slope (%)	Parent Material	Rock Fragments (%)	Permeability	Runoff	Depth and Drainage	pH	Water Erosion Hazard	Wind Erosion Hazard	Shrink-Swell Potential
37B	R4, R5, T4, T5	Kokan-Vinton-Riverwash Complex	Coarse sandy loam to very gravelly coarse sand formed on alluvial fans and in washes (40 percent Kokan, 30 percent Vinton, 20 percent Riverwash).	1 – 3	alluvium from mixed sources	--------	moderately rapid to very rapid	very slow to medium	deep, excessively drained	neutral to strongly alkaline	slight	moderately high	low
37E	R4, T4												
37C	T1	Arizo-Franconia-Riverwash Complex	Sandy loam to very gravelly fine sand formed on alluvial fans, stream terraces, and floodplains (40 percent Arizo, 30 percent Franconia, 20 percent Riverwash).	1 – 3	alluvium from mixed sources	0 – 85	moderate to very rapid	very slow to medium	very deep, excessively drained	neutral to strongly alkaline	slight	slight	low
400A	R1, R3, T3	Iretiba-Arizo Complex	Loam to very gravelly fine sand formed on alluvial fans, stream terraces, floodplains and flat basins (45 percent Iretiba, 30 percent Arizo).	1 – 3	alluvium from mixed sources	0 – 85	moderately rapid to rapid	very slow to medium	very deep, excessively drained	neutral to strongly alkaline	slight	slight	low
400B	R4, T4	Anthony-Kokan Complex	Gravelly sand to sandy loam formed on alluvial fans and floodplains (45 percent Anthony, 30 percent Kokan).	1 – 3	stratified and wash alluvium from mixed sources	5 – 70	moderately rapid to very rapid	very slow to medium	very deep, well drained	neutral to strongly alkaline	slight	slight	low
50A	C1, C2, R2, R3, T1, T2	Dutchflat	Fine sandy loam formed on fan terraces.	1 – 3	alluvium from igneous and metamorphic sources	<35	moderate	medium	very deep, well drained	slightly to moderately alkaline	slight	moderately high	moderate
52A	R5, T5	Cacique	Extremely gravelly loam formed on basin floors.	1 – 7	sandy alluvium	--------	moderately slow	medium	moderately deep, well drained	slightly to moderately alkaline	moderate	slight	moderate
56	PS	Cellar-Rock Outcrop Complex	Very gravelly sandy loam formed on hills and mountains (50 percent Cellar, 25 percent Rock Outcrop).	20 – 60	slope alluvium from granitic rock	30 – 60	moderately rapid	--------	shallow to very shallow, somewhat excessively drained	slightly acid to moderately alkaline	very severe	very slight	low
56F	--------												
80C	T5	Cline	Very stony loam formed on mesas.	2 – 70	alluvium from volcanic rock	35 – 70	moderate	medium to rapid	shallow to very shallow, well drained	slightly alkaline	moderate	slight	low
80F	--------												
95B	--------	Akela-Rock Outcrop-Rubble Land Complex	Very gravelly loam formed on uplands, rolling hills, and basalt mountain sides.	40 – 70	alluvium from basalt and rhyolitic tuff	35 – 80	moderate	medium to rapid	shallow, well drained	---------	high	slight	low
AZ201	--------	Romero-Rock Outcrop-Tombstone Association	Gravelly sandy loam to very gravelly loam formed on pediments, hills, and mountains.	3 – 35	slope alluvium from schist or granitic rock	35 – 90	moderately rapid	medium	shallow to very shallow, well drained	slightly acid to mildly alkaline	moderate to high	low	--------
AZ220	R1, T1	Continental-Rillino-Gila Association	Loam to gravelly loam formed on lower mountain slopes.	0 – 10	alluvium from mixed sources	---------	slow to moderate	slow to medium	deep, well drained	slightly acid to moderately alkaline	slight to moderate	slight to moderate	--------

PS = Proposed plant site
C1-C3, R1-R5, T1-T5 = Gas pipeline corridor segments

3.3.2.3 Impact Assessment Methods

In order to assess the potential impacts on soils within the region of influence, soil survey maps and reports from available sources were compiled and reviewed, including all relevant reports prepared by Caithness and its consultants, as well as reports and maps prepared by the NRCS. The objective of this task was to independently evaluate and verify the accuracy and comprehensiveness of information provided by Caithness and supplement this information as needed. The data compilation and review resulted in the preparation of Figures 3.3-1 through 3.3.-4, and Table 3.3-1.

After data were compiled and reviewed, and information provided was verified, potential direct and indirect impacts on soils were assessed. Particular consideration was given to the identified issues described in Section 3.2.2.1, and the significance criteria described in Section 3.3.2.2 to assess whether significant impacts potentially could occur.

3.3.2.4 Actions to Reduce or Prevent Impacts Incorporated Into the Proposed Action

The Proposed Action includes the following measures to reduce or prevent adverse environmental impacts on soils:

- During design, the pipeline would be routed to avoid steep slopes, if at all possible. OPGW pulling and tensioning sites would be sited to avoid steep slopes.

- For segments of the pipeline corridor that cannot be altered to avoid steep slopes and erosive soils, soil loss would be minimized during revegetation through the use of erosion control measures such as mulching, water bars, silt fences, and staked hay bales. Section 2.2.8.5 describes the erosion control measures proposed in more detail.

- No permanent access would be built along the pipeline corridor, and steep washes would be inspected on foot.

- Grading would be done only where necessary.

- Local soil conservation specialists would be consulted to select the best seed mixes and best management practices (BMPs) for soils disturbed by the Proposed Action. The BLM Kingman Field Office will have the final approval on plant seed mixes on BLM-managed lands within the Project area.

- Soil loss from wind erosion during construction would be controlled through implementation of standard BMPs for controlling fugitive dust emissions, including wet suppression, limiting vehicle speeds, chemical suppression, physical suppression, and vegetative stabilization. The dust control measures included in the Proposed Action are listed in Section 2.2.8.1.

- The potential impacts of expansive soils would be minimized through avoidance or the use of special engineering and construction methods.

- If excessive percentages of rock fragments were encountered during pipeline construction, potential impacts would be reduced through the use of sand or other bedding material, which would assist in preventing damage to the pipeline.

- The potential impacts of corrosive soils would be avoided through the use of corrosion-resistant materials, such as Type V (or equivalent) sulfate-resistant materials.

3.3.2.5 Impact Assessment

Proposed Action

Soil Erosion

The potential for soil loss through water and wind erosion is of primary concern. Many of the soils that would be impacted during construction are susceptible to water erosion and, to a lesser extent, wind erosion.

Soil erosion can occur wherever ground is disturbed. The Proposed Action (the power plant and associated facilities and the proposed pipeline) would involve the permanent or temporary disturbance of land. Erosion potential is dependent on several factors, including slope, vegetation cover, climate, and the physical and chemical characteristics of the soil. Increased soil erosion may occur when vegetation is removed during construction or in areas where the surface is disturbed by heavy equipment. Compaction of soils, loss of topsoil, and mixing of topsoils and subsoils may inhibit natural revegetation, which may cause increased soil erosion and further loss of soils after construction is complete. Increased water erosion may reduce the productivity of the soil as well as affect the water quality of streams by accelerated sediment loading. Loss of productivity of grazing land due to soil compaction and/or increased erosion may result from Project activities.

Steep slopes (exceeding 20 percent) were mapped in the vicinity of the power plant and along the pipeline corridors. No steep slopes occur in the footprint of the power plant and associated facilities, including the wells and access road. Steep slopes do exist along the pipeline corridors, as shown on Figures 3.3-2 through 3.3-4. Significant impacts could occur where these steep slope areas coincide with soils having high or severe erosion potential. Figures 3.3-2 through 3.3-4 identify four such areas of potentially significant impact within the pipeline corridors:

- Area 1 – in corridor segment R1
- Area 2 – at the intersection of corridor segments T2, T3, and C1
- Area 3 – in corridor segment C3
- Area 4 – in corridor segment T4 near the Carrow-Stephens Ranches ACEC

All four areas are located within the proposed pipeline corridor. Crossing Area 1 in corridor segment R1 would not result in significant impacts, since the pipeline alignment would fall within the already-graded Hackberry Road right-of-way. Area 2 may be difficult to avoid, since it extends almost the entire width of the corridor. Area 3 could be avoided if the final alignment is sited in the western portion of the corridor. Area 4 could be avoided with a route along the western side of the corridor, outside the Carrow-Stephens Ranches ACEC.

If the final alignment falls within these areas, the measures included in the Proposed Action to minimize soil loss in areas of steep slopes that cannot be avoided would reduce these impacts to less than significant.

Erosion also is of concern in the installation of the OPGW for the redundant communication system. However, selection of OPGW pulling and tensioning sites would avoid steep slopes and utilize already disturbed areas to the extent feasible along the Mead-Liberty 345-kV transmission line right-of-way, thus eliminating or minimizing adverse impacts to soils. The microwave dishes would be installed on existing towers and would have no impact on soils.

Trenching for the gas pipeline across the Big Sandy River would result in less than significant soil erosion. The directional drilling option for the crossing of Big Sandy River would result in less soil erosion than trenching.

Expansive Soils

Expansive soils tend to swell and increase in volume in response to increase in moisture content. Conversely, some soils tend to develop swell pressures if their volume change is restricted.

Special engineering and construction methods or avoidance are proposed for expansive soils encountered during construction. The geotechnical report describes the soils in the vicinity of the spring near the proposed power plant as highly expansive and recommends that those soils be avoided during construction (Westech 2000). No adverse impact would be expected.

Rock Fragments

The percentages of rock fragments in each of the soil types are highly variable, but may range from less than 35 to more than 85 percent. Where the gas pipeline would be buried within soils with high rock fragment content, special construction methods would be employed to protect the pipeline from damage during and after construction. No adverse impact would be expected.

Corrosivity

Because sulfate-resistant cement would be used in areas with highly corrosive soils, no adverse impacts from corrosive soils would be expected.

Soils that Uniquely Support Threatened or Endangered Plant Species

The soil type that is known to uniquely support the Arizona cliffrose would not be affected by the Proposed Action. Therefore, no impacts related to this concern would be expected.

Alterations in Stormwater Runoff

There would be alterations to stormwater runoff from the construction activities that would occur in all locations. However, there are no areas of steep slopes in the proposed power plant area and very few steep areas along the proposed gas pipeline route or OPGW route. Also, environmental protection measures would be applied in all areas. Therefore, it is unlikely that substantial soil erosion would occur from stormwater diversions or changes in flow, and no significant impacts would be expected.

Alternative Gas Pipeline Corridors

Soil Erosion

Similar concerns with soil erosion would exist for the alternative gas pipeline corridors. There are areas of steep slopes located along both of these corridors, including the same four areas where steep slopes coincide with highly erodible soils as discussed under the Proposed Action (Figures 3.3-2 through 3.3-4). As discussed previously under the assessment of the Proposed Action, there may be alignments that can avoid these areas, except perhaps for Area 2, which extends across the corridor. Construction and operation of the alternative pipeline routes would include the same measures as described for the Proposed Action to reduce these impacts to below the level of significance.

Expansive Soils

Several of the soil types listed in Table 3.3-1 are described as having high, or low to high, shrink-swell potential, indicating that the soils are expansive. As with the Proposed Action, no adverse impacts from expansive soils encountered during pipeline construction would be expected.

Rock Fragments

As with the Proposed Action, no adverse impacts would be expected.